RESTRICTED



# WORKSHOP MANUAL

## TATA SA / SAK 1212 TC / 32 BS-III

TATA MOTORS LIMITED

Mumbai Jamshedpur Pune Lucknow Pantnagar Dharwad

RESTRICTED

All specifications are given in C. G. S. System (Metric System)
unless otherwise specified.

Errors & Omissions Excepted.

Contents given in this book are subject to change without notice.

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## INTRODUCTION :

This manual brings you the technical specifications and know-how on the maintenance and repair procedures of TATA SA / SAK 1212 TC BS-III vehicles fitted with TATA CUMMINS 6 BT engine. Assuming that the technicians in the workshop are fully conversant with the repair and maintenance practices of the commercial vehicles in general; the repair procedures outlined in this manual emphasizes the special features of the product. Compliance with procedures given in this manual will enable you to drive the maximum service from the Tata Diesel Vehicles.

The convenient handling, the contents of this manual have been arranged groupwise and given in the group index list. The same group classification appears in the spare parts list thereby bringing the service and spare parts literature on a uniform basis for easy cross reference.

Group-00 deals with the technical specifications and maintenance frequency This is followed by repair procedures for various aggregates arrange groupwise.

The list of special tools and repair data are given in the begining of each group for ease of reference.

All data contained in this manual is based on the latest product information available at the time of publication.

For any further technical advice, please contact our nearest Zonal / Area Office or write to :

**Divisional Management (Vehicle Serive)**
Tata Motors Limited,
Jamshedpur - 831 010

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# General 00

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## Vehicle Identification





| Description | Wheel base | Chassis type | Sales designation |
|---|---|---|---|
| Semi-forward control chassis with cab and four wheel drive, 3 way tipper | 3225 mm | | SAK 1212TC/32 BS-III |
| Tipper with semi-forward control cab and Load body | 3225 mm | 424 093 | SAK 1212TC/32 BS III |
| Tipper with semi-forward control cab and Load body | 4225 mm | 424 010 | SA 1212 TC/42 BS III |
| Semi-forward control chassis with cab and four wheel drive, Box tipping body | 3225 mm | 424 088 | SAK 1212TC/32 BS-III |

## AGGREGATE NUMBERING SYSTEM

### CHASSIS NUMBERING SYSTEM
### (Vehicles manufactured on and after 1st April 2009)

Chassis number consists of 17 digits as given below

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| MAT | XXXXXX | X | X | X | XXXXX |

Barrel 1 : Indicates produced in Tata Motors, India

Barrel 2 : Chassis type No. (Model, execution, wheel base, etc.)

Barrel 3 : Indicates : Year of Production

| YEAR | CODE |
|---|---|
| 01-04-2009 to 31-12-2009 | 9 |
| 01-01-2010 to 31-12-2010 | A |
| 01-01-2011 to 31-12-2011 | B |
| 01-01-2012 to 31-12-2012 | C |
| 01-01-2013 to 31-12-2013 | D |
| 01-01-2014 to 31-12-2014 | E |
| 01-01-2015 to 31-12-2015 | F |

Barrel 4 : Plant Location

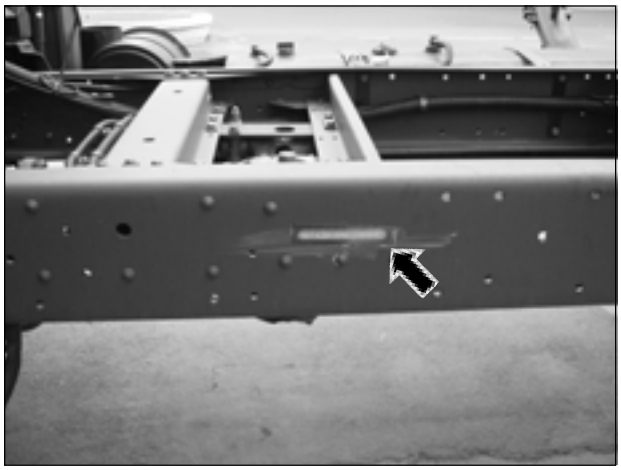
0 - Lucknow I
1 - Jamshedpur I
2 - Jamshedpur II
2 - Jamshedpur III
4 - Lucknow II
5 - Lucknow III
6 - Dharwad
7 - D Block, Pune
8 - H Block, Pune
9 - J Block, Pune, First Assy Line
A - Lucknow IV
B - Lucknow V
M - Lucknow - MASOP
N - J Block, Pune, Second Assy Line
P - K Block, Pune, First TCF Line
R - J14 - Block, Pune
S - J13 - Block, Pune
T - TML, Ranjangaon
U - E9 - Block, Pune
V - Uttarakhand - I
W - K Block, Pune, Second TCF Line
X - Singur
Y - Uttarakhand - II
Z - Uttarakhand - III

Barrel 5 : Month and year of manufacture

| | | | | | |
|---|---|---|---|---|---|
| JAN | - | A | FEB | - | B |
| MAR | - | C | APR | - | D |
| MAY | - | E | JUNE | - | F |
| JULY | - | G | AUG | - | H |
| SEPT | - | J | OCT | - | K |
| NOV | - | N | DEC | - | P |



*Location of chassis number plate*



*Chassis number on frame*

Barrel 6 : Serial No. to start every year with 00001 on FIRST JANUARY at each plant location. Running Sl Nos. to be punched as given in Table 4. Repeate after 3,29,999.

Notes : *1 Chassis type number to be punched in a single line without any gap.

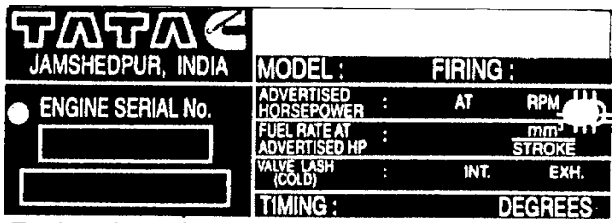
2 Minimum height of the chassis Serial No. punched on the long member should be 7mm.

**Engine Number :**

: The engine is produced at Tata Cummins Jamshedpur.
The data plate fitted on the left hand side of engine gives specific information about the engine. For details see sketch.



*Engine number plate*




*Engine data plate*

**FRAME :** Frame is numbered in 5 barrels each of 1,3,2,1, and 5 digits resp. as follows :

| B | 014 | QQ | 1 | 72154 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Barrel 1 : This indicates the basic model.

Barrel 2 : This indicates the variations in basic model.

Barrel 3 : This indicates year of production as given below :

2004 - VZ
2005 - UZ
2006 - TZ
2007 - SZ

Barrel 4 : This indicates the location of the plant. The allotment of this barrel between Jamshedpur, Pune and Lucknow is as follows :

0 - Lucknow

1, 2, 3 & 4 - Jamshedpur

5, 6,7, 8 & 9 - Pune

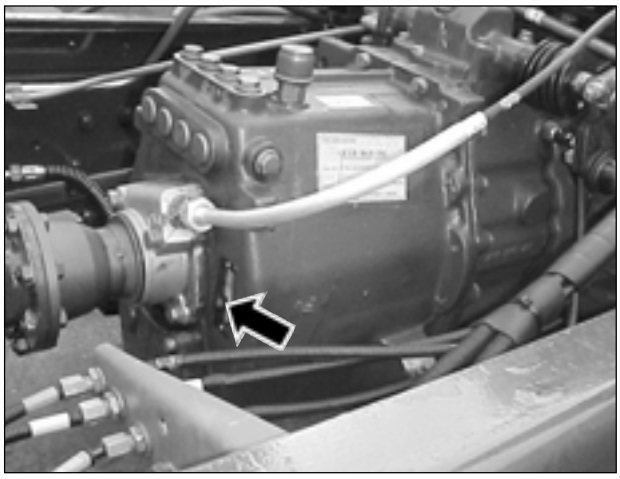
In Pune the allotment for frame is as below

D Block - 5 - All HCVs

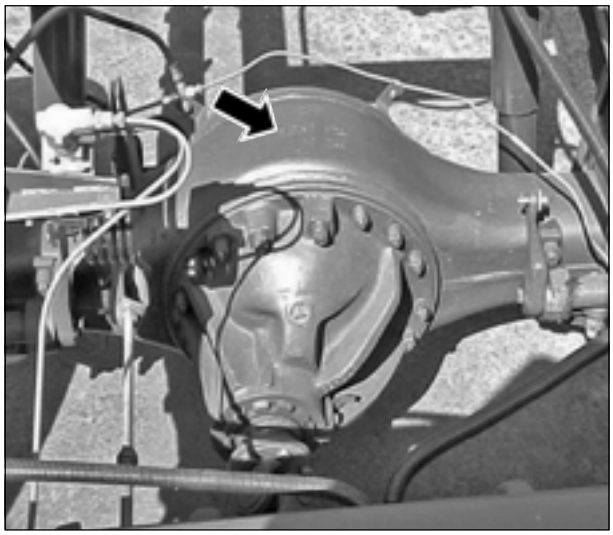
Barrel 5 : This indicates the Sr. No. of the particular aggregate. This commences from serial No. 00001 and will start every year on 1st January.

Location : Number is punched on RH long member at rear end.

for L.H.D. veh. : 'L' is punched after first two barrels.



*Gearbox G-600*



*Rear Axle*

**REAR AXLE :**

Rear axle is numbered in 5 barrels each of 3, 3, 2, 1 and 5 digits resp. as follows:

| 342 | 164 | SZ | 1 | 20198 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Barrel 1 : This indicates the basic model.

e. g. 342 or 348

Barrel 2 : This indicates vehicle models cab/cowl as 342 - for 1015 models

Barrel 3 : same as barrel 3 in frame

Barrel 4 : same as barrel 4 in frame

Barrel 5 : same as barrel 5 in frame

Location : To be punched on beam / rear axle housing

**GEAR BOX :** Gear box is numbered in 5 barrels each of 4, 3, 2, 1 & 5 digits as below.

| 2691 | 825 | SZ | 3 | 42292 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Barrel 1 : This indicates basic model.
e.g. 2691 for G600.

Barrel 2 : First digit indicates type of gear engagement and shift. e.g. 5 for synchromesh, conventional. 8 for synchromesh, full remote. 2nd digit indicates vehicle type. e.g. 3 for SFC type vehicle. 3rd digit indicates gear ratios e.g. for G600

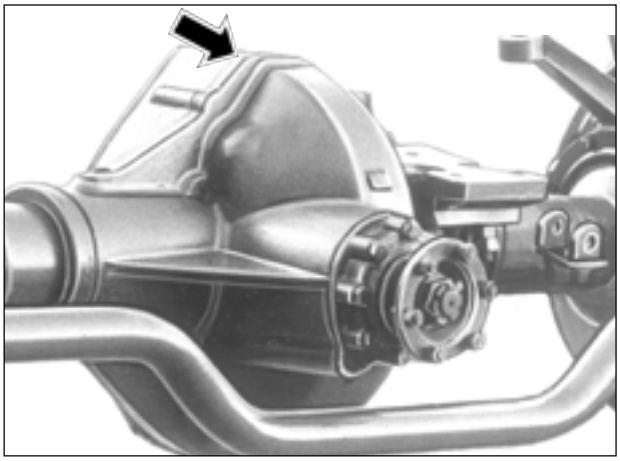
0 - for standard 1st gear ratio 7.83

Barrel 3 : Same as barrel 3 in frame.

Barrel 4 : Same as barrel 4 in frame.

Barrel 5 : Same as barrel 5 in frame.

Location : It is punched on the machined surface on the rear top side of the gear box.



*Front Axle*

**FRONT AXLE (LIVE) 1210 TYPE :**

: Front axle is numbered in 5 barrels each of 3, 3, 2, 1, 5 and digits as below.

| 342 | 512 | SZ | 2 | 04371 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Barrel 1 : This indicates the basic model.
e.g. 342 for 1210 type

Barrel 2 : This indicates the variation in basic model and crown wheel / pinion ratio.

Barrel 3 : Same as barrel 3 in frame.

Barrel 4 : Same as barrel 4 in frame.

Barrel 5 : Same as barrel 5 in frame.

Location : To be punched on the top of centre housing.

## TECHNICAL SPECIFICATION

### ENGINE

| | | |
|---|---|---|
| Model | : | Cummins B5.9 130 31 |
| Type | : | Water cooled, Turbocharged, after cooled Diesel Engine |
| No. of Cylinders | : | 6 Inline |
| Bore / Stroke | : | 102mm x 120mm |
| Capacity | : | 5883 CC |
| Max. engine output | : | 130 BHP at 2500 rpm as per ECE R 24 and CMVR 115 (9) |
| Max. torque | : | 490 Nm at 1500 rpm as per ECE R 24 and CMVR 115 (9) |
| Compression ratio | : | 18:1 |
| Firing order | : | 1-5-3-6-2-4 |
| Air filter | : | Dry type remote mounted |
| Oil filter | : | Spin-on full flow paper type |
| Fuel filters | : | Two stage Pre & fine filtration with water separator |
| Fuel injection pump | : | BOSCH Rotary VE 14 / VP 14 |
| Governor | : | All speed, Mechanical |
| Turbocharger | : | HOLSET HX 35W |
| Capacity of cooling system | : | 22 liters (Total) |
| Coolant | : | Water & Ethylene glycol, Ratio 1:1 premixed |
| Crankcase oil capacity | : | Max. 15.3 Litres, Min. 13.3 Litres |
| Weight of engine | : | 413 kg (Dry) with flywheel and alternator but without starter and air compressor |
| Radiator frontal area | : | 3007 sq.cm. |

### CLUTCH

| | | |
|---|---|---|
| Model | : | Single plate,Coil type with ceramic Lining (dry friction type) |
| Outside diameter of clutch lining | : | 352 mm |
| Type | : | Pull Type |
| Friction area | : | 464 sq. cm (approx.) |

### GEAR BOX

| | | |
|---|---|---|
| Model | : | TATA GBS-60 with PTO for APP-MK III (for SAK 1212)<br>TATA GBS-60 with PTO provision (for SA 1212) |
| Type | : | Synchromesh on all forward gears and constant mesh on reverse gear |
| No. of gears | : | 6 Forward 1 Reverse |
| Gear Ratios (GBS-60) | : | 1st - 8.47 2nd - 4.87<br>3rd - 2.95 4th - 1.92<br>5th - 1.29 6th - 1.00<br>Rev - 7.28 |

### AUXILIARY GEAR BOX (Transfer Case)

| | | |
|---|---|---|
| Type | : | Constant mesh helical gear |
| Ratios | : | High 1.05:1 for 4x2 drive Low 1.60:1 for 4x4 drive |

### REAR AXLE (RA - 108RR)

| | | |
|---|---|---|
| | | Single reduction hypoid gears, heavy duty fully floating axle shafts |
| Type | : | TATA RA - 108RR With differential lock (Optional) |
| Ratio | : | 5.857 : 1 (41/7) |

### FRONT AXLE

| | | |
|---|---|---|
| Model | : | FA 104 |
| Ratio | : | 5.857:1 (41/7) |

### STEERING

| | | |
|---|---|---|
| Type | : | Fixed column, Power assisted Hydraulic Steering |
| Steering Wheel Dia | : | 500 |
| Ratio | : | 20.2:1 |

### BRAKES

| | | |
|---|---|---|
| Service brakes | : | Full air S-cam brake |
| Brake drum diameter | : | Front - 410 mm.<br>Rear - 410 mm |
| Lining area | : | Front - 2180 sq. cm.<br>Rear - 2470 sq. cm.<br>Total - 4650 sq. cm. |
| Parking brake type | : | Graduated valve controlled spring brake chamber integral with rear brake |
| Engine exhaust brake | : | Pneumatically operated butterfly valve Type exhaust Brake |

### FRAME

| | | |
|---|---|---|
| Type | : | Ladder type heavy duty frame with riveted / bolted cross members. Side members are of |

channel section.
Depth : 223 mm (max.)
Width : 60 mm

**SUSPENSION**

| | | |
|---|---|---|
| Type | : | Semi elliptical leaf spring at front and rear |
| Spring span | : | Front - 1450 mm<br>Rear - 1600 mm (Main)<br>1100 mm (Auxiliary) |
| Leaf width | : | Front - 70 mm<br>Rear - 80 mm |
| Shock absorbers | : | Hydraulic double acting telescopic type at front, optional at rear. |

**WHEELS & TYRES**

| | | |
|---|---|---|
| Tyres | | |
| | : | Front RIB type 10.00x20*16PR*<br>Rear and Spare LUG type 10.00X20*16PR*<br>Optional<br>9.00-20, 12 PR Cross Country<br>9.00-20, 14 PR Cross Country |
| Wheel rims | : | 7.00 x 20 |
| No. of wheels | : | Front - 2, Rear - 4, Spare - 1 |

**Fuel Tank**

| | | |
|---|---|---|
| Capacity | : | 150 litres Rectangular tank for 32 WB (SAK 1212TC)<br>225 litres Circular tank for 42 WB (SA 1212TC) |

**CAB/COWL**

| | | |
|---|---|---|
| Type | : | All steel semi forward control Driver's cab or cowl |

**ELECTRICAL SYSTEM**

| | | |
|---|---|---|
| System Voltage | : | 24 Volts |
| Alternator Capacity<br>as per DIN:72311 &<br>BS:3911 | :<br>: | 45 Amps<br>12 Volts,150 Ah capacity (2 Nos) |
| **TIPPING GEAR** | : | Underbody tipping gear pivoted to the subframe at rear with heavy duty steel body. Tipper is provided with tail gate. |
| Struck capacity in Cu.Mtrs. | | 4.5(Box Tipper) |

**PERFORMANCE**

| | | |
|---|---|---|
| Maximum recommended speed kmph | : | 72 kmph in 4x2 on hard paved roads |
| Gradability on hard paved roads at sea level | : | 10 deg for 4X2 & 23 Deg for 4X4 Mode on hard paved roads in 4x4 mode (limited by slip) |
| Wheel Base, mm | : | 3225 (For SAK 1212)<br>4225 (For SA 1212) |
| Minimum Turning Circle Dia. in mm as per IS: 9435 (SAK) | : | 14900 |
| Minimum Turning Circle Dia. in mm as per IS: 9435 (SA) | : | 17600 |
| Minimum Turning Clearance Circle Dia. in mm as per IS:9435 (SAK) | : | 16400 |
| Minimum Turning Clearance Circle Dia. in mm as per IS:9435 (SA) | : | 19100 |

**MAIN CHASSIS DIMENSIONS AS PER IS 9435 IN mm**

| | | |
|---|---|---|
| Wheel base | : | 3225 (For SAK)<br>4225 (For SA) |
| Track front | : | 1988 |
| Track Rear | : | 1809 |
| Max. Width | : | 2434 |
| Front Overhang | : | 1185 (For SAK)<br>1185 (For SA) |
| Overall Length | : | 5370 (For SAK)<br>6970 (For SA) |

**WEIGHTS (kg)**

(Tolerance as per INTER EUROPE StVZ0)

| | | |
|---|---|---|
| Complete chassis | : | 4670 (For SAK) |
| kerb weight with cab without loadbody (With spare wheels and tools) as per IS 9211 | | 4890 (For SA) |
| Bare chassis kerb | : | 4440 (SAK) |
| weight with Cowl (With spare wheel and tools) as per IS 9211 | | 4700 (SA) |
| Max. permissible FAW: | | 4060 |
| Max. permissible RAW | : | 8120 |
| Max. permissible GVW | : | 12180 |

**TIGHTENING TORQUES**

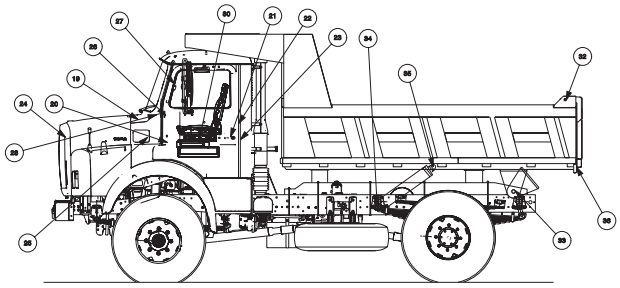
When choosing torque wrench remember that it should not be subjected to torque exceeding three-fourth of its capacity. Before tightening, clean the threads and apply a little oil.

| Sl. No. | Description | Torque |
|---|---|---|
| | **ENGINE** | |
| 1 | Cyl. Head Mtg. Cap Screw. (Follow the sequence) | |
| | Step 1 (ALL Cap Screws.) | 9.0 mkg. |
| | Step 2 Recheck (All Cap Screws.) | 9.0 mkg |
| | Step 3 (Long Cap Screws Only.) | 12.0 mkg |
| | Step 4 Recheck (Long Cap Screws Only) | 12.0 mkg |
| | Step 5 (All Cap Screws) | Rotate by 90 degrees |
| 2. | Rocker support bolts | 2.4 mkg |
| 3 | Valve lash adjusting screws nut | 2.4 mkg |
| 4 | Main bearing cap screws Step 1 | 8.0 mkg |
| | Main bearing cap screws Step 2 | Rotate by 60 degrees |
| 5 | Con. rod cap screws Step 1 | 6.0 mkg |
| | Con. rod cap screws Step 2 | Rotate by 60 degrees |
| 6 | Fly wheel housing mtg. screws | 7.7 mkg |
| 7 | Fly wheel mtg. screws | 13.5 mkg |
| 8 | Vibration damper mtg. screws | 12.5 mkg |
| 9 | Crank shaft rear oil seal mtg. screws | 0.9 mkg |
| 10 | Timing gear housing cover mtg. screws | 2.4 mkg |
| 11 | Timing gear housing mtg. screws | 2.4 mkg |
| 12 | Cam shaft thrust plate | 2.4 mkg |
| 13 | Cam shaft drive gear (Inline Pump “P” type) | 2.7 mkg<br>Rotate by 60 degrees. |
| 14 | Water pump | 2.4 mkg |
| 15 | Belt Tensioner | 4.3 mkg |
| 16 | Push rod, cover cap screws | 2.4 mkg |
| 17 | Oil cooler mtg. screws | 2.4 mkg |
| 18 | Oil pump mtg. screws | 2.4 mkg |
| 19 | Oil suction tube mtg. screws | 2.4 mkg |
| 20 | Oil pan mtg. screws | 2.4 mkg |
| 21 | Valve cover screws | 2.4 mkg |
| 22 | Intake manifold cover screws | 2.4 mkg |
| 23 | Oil filler tube | 4.5 mkg |
| 24 | Oil filter | 3/4 turn after contact |
| 25 | Oil drain plug | 6.0 mkg |
| 26 | Oil pressure regulator retainer plug | 8.0 mkg |

| | | | |
|---|---|---|---|
| 27 | FIP drive gear nut initial Torque (ROTARY TYPE) | 2.0 | mkg |
| 28 | FIP drive gear nut Final Torque (ROTARY TYPE) | 6.5 | mkg |
| 29 | FIP mounting nuts | 2.4 | mkg |
| 30 | FIP brace cap screw (ROTARY) | 2.4 | mkg |
| 31 | Fuel lift pump mtg. screws (Diaphragm type) | 2.4 | mkg |
| 32 | Fuel Lift Pump Mtg. Screws (Plunger type) | 3.2 | mkg |
| 33 | Fuel filter adopter nut | 2.4 | mkg |
| 34 | Fuel High Pressure pipes | 2.4 | mkg |
| 35 | Injector Holding nut | 6.0 | mkg |
| 36 | Fuel filter bracket mtg. screws. (Inline Pump) | 2.4 | mkg |
| 37 | Turbo Oil drain tube screws | 2.4 | mkg |
| 38 | Turbo Oil drain tube clamps | 2.4 | mkg |
| 39 | Turbo mtg. nuts | 4.3 | mkg |
| 40 | Turbo charger hose clamps | 0.5 | mkg |
| 41 | Turbo turbine housing screws | 2.0 | mkg |
| 42 | Exhaust manifold mtg. screws | 4.3 | mkg |
| 43 | Fan clutch bkt. mtg. screws (bkt. to eng. block) | 2.4 | mkg |
| 44 | Fan clutch mtg. screw | 27 | mkg |
| 45 | Fan mtg. screws | 5.0 | mkg |
| 46 | Air compressor drive gear nut | 12.5 | mkg |
| 47 | Air compressor mtg. nuts | 7.7 | mkg |
| 48 | Starter mtg. screws | 4.3 | mkg |
| 49 | Alternator mtg. nut | 5.5 | mkg |
| 50 | Clutch pressure plate mtg. screws | 6.0 | mkg |
| 51 | Transmission housing mtgs. screws | 9.5 | mkg |
| 52 | Rear engine mtg. {All bolts (8) and nuts (8)} | 8.0 | mkg |
| 53 | Engine front mounting centre bolt | 32 to 35 | mkg |
| 54 | Engine front mounting bracket to cross member | 5 to 6 | mkg |
| 55 | Engine front support mtg. screws | 7.7 | mkg |
| | **TRANSMISSION (G-600)** | | |
| 1. | Main Shaft Coupling Flange Nut (M32 Threads) | 36-40 | mkg |
| 2. | Coupling Flange / Propeller Shaft Nuts / Bolts | 7 | mkg |
| 3. | Centre Bearing Bracket mounting Bolts | 5 | mkg |
| 4. | Gear Shift Lever Bracket mounting bolts | 3 | mkg |
| 5. | Turning Tube / Connecting Flange mounting nuts / Bolts | 3 | mkg |
| 6. | Housing Interface Bolts | 6 | mkg |
| 7. | Top Cover bolts/screws | 2.5 | mkg |
| 8. | Front Cover bolts/screws | 2.5 | mkg |
| 9. | Rear cover bolts/screws | 2.5 | mkg |
| 10. | Rear cover lower (inner) bolts/screws | 6 | mkg |

| | | | | |
|---|---|---|---|---|
| 11. | Reverse Idler Cover bolts/screws | | 1.5 | mkg |
| 12. | Filler plug | | 1.5 | mkg |
| 13. | Drain plug | | 6 | mkg |
| | **POWER STEERING AND CHASSIS** | | | |
| 1 | Steering intermediate cover screw M 10 | | 3 | mkg |
| 2 | Steering intermediate cover screw M 12 x 1.5 | | 5.6 | mkg |
| 3 | Steering intermediate cover screw M 14 x 1.5 | | 9.2 | mkg |
| 4 | Sealing nut | | 4.3 | mkg |
| 5 | Oil drain plug | | 2.1 | mkg |
| 6 | Counter nut | | 1.7 | mkg |
| 7 | Ball joint of Pitman arm and drag link | | 13 to 17 | mkg |
| 8 | Pitman arm to cross shaft | | 40 to 45 | mkg |
| 9 | Shock absorber mounting bolts | | 10 | mkg |
| 10 | Brake anchor plate mounting bolts | | 12 | mkg |
| 11 | 'U' bolt nuts | Front axle | 22 | mkg |
| | | Rear axle | 22 | mkg |
| 12 | 'U' bolt check nuts | Front axle | 15 | mkg |
| | | Rear axle | 15 | mkg |
| 13 | Wheel nuts | | 50 to 60 | mkg |
| 14 | Bolts holding steering mounting bracket to long member | | 10 | mkg |
| 15 | Bolts holding steering gearbox to mounting bracket | | 10 | mkg |
| 16 | Steering arm mounting bolt / nut | | 20 | mkg |
| 17 | Rear spring hanger mounting bolts | | 12 | mkg |
| 18 | Tie rod end | | 13 to 17 | mkg |
| 19 | Drag link ends nuts on adjusting clamp | | 13 to 17 | mkg |

## LUBRICATING POINTS



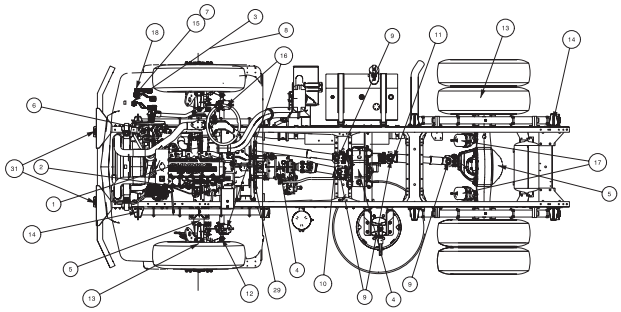
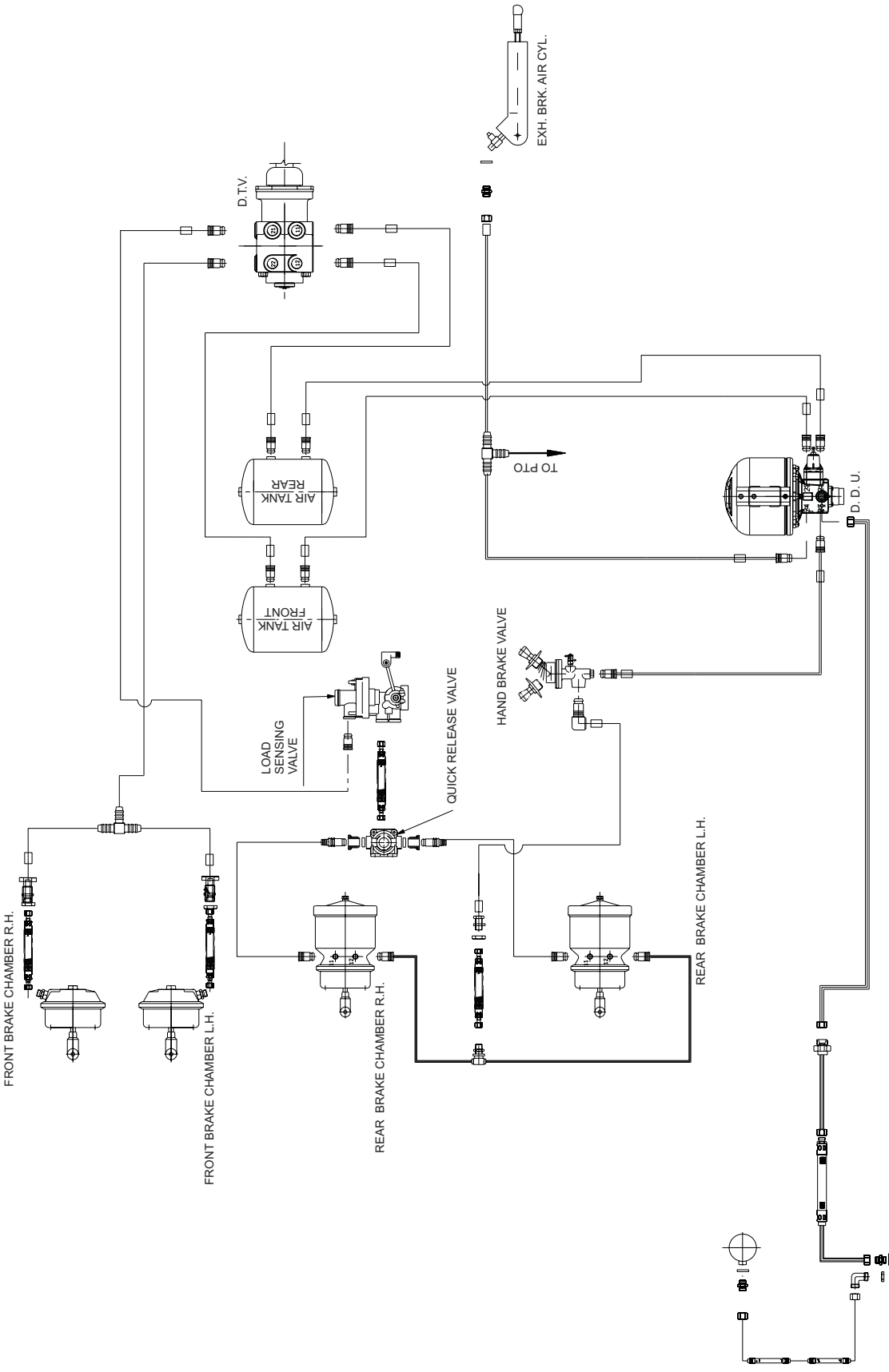


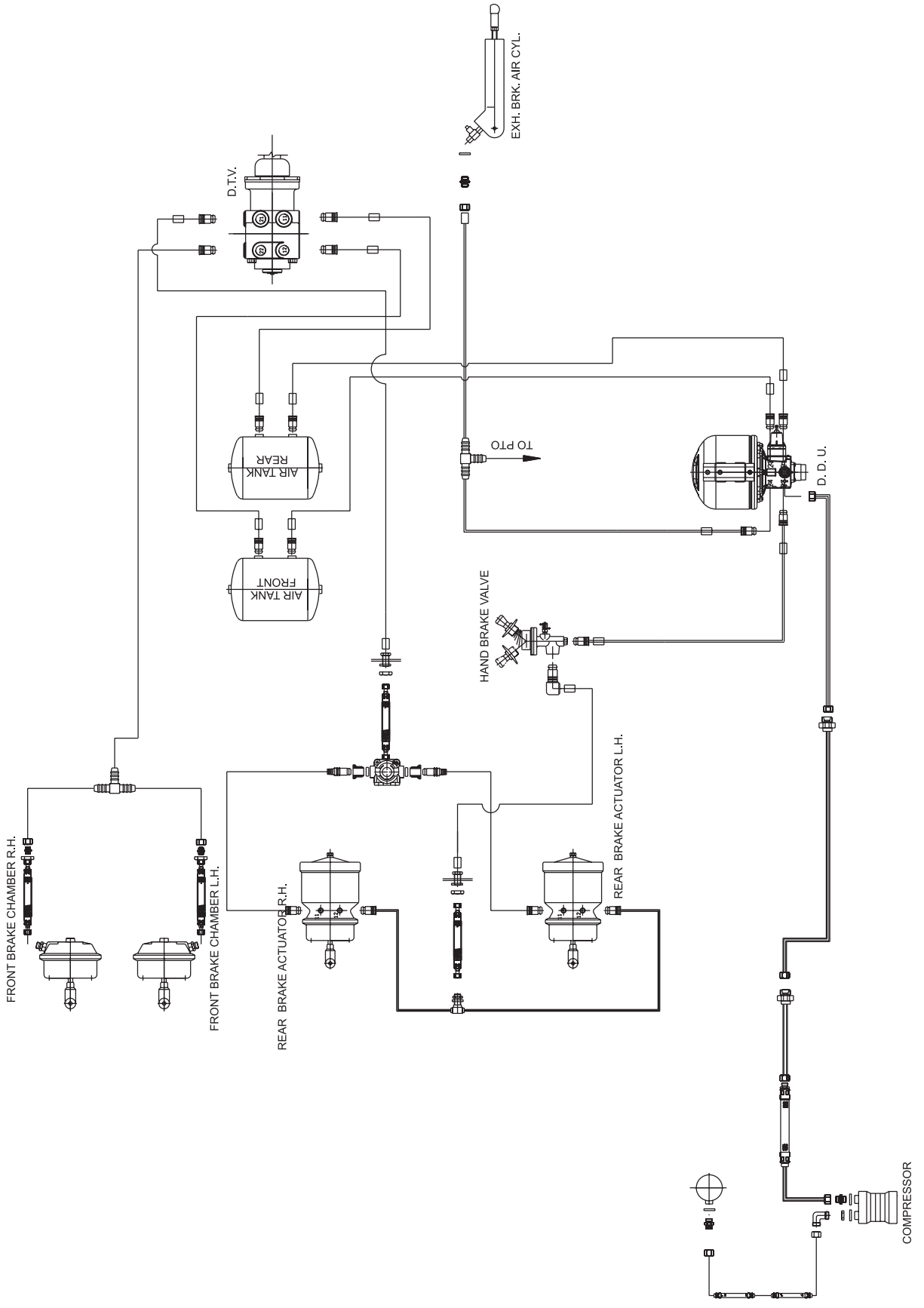
TABLE I OIL LUBRICATING POINT CHART

| | |
|---|---|
| 1.ENGINE OIL FILLING | OIL LEVEL |
| 2 CONTROLS TO INJECTION PUMP | 2 |
| 3 CLUTCH LINKAGE AND RELEASE BEARING | 2 |
| 4 GEAR BOX,TRANSFER CASE | OIL LEVEL |
| 5 REAR AXLE, FRONT AXLE | OIL LEVEL |
| 6 STEERING GEAR BOX | OIL LEVEL |
| 7 PINS FOR FOOT AND HAND BRAKE LINKAGES | 8 |
| 18 ACCELERATOR PEDAL LINKAGES | 5 |
| 19 BONNET HINGES | 4 |
| 20 DOOR HINGES | 4 |
| 21 OUTER DOOR HANDLES | 2 |
| 22 DOOR LATCHES | 2 |
| 23 DOOR DOVETAIL AND STRIKER PLATES | 4 |
| 24 BONNET STAY ROD PIVOT PIN | 2 |
| 25 SIDE FLAP HINGES | 2 |
| 26 GLOVE BOX,INSTRUMENT PANEL AND WIPER MOTOR COVER HINGES | 5 |
| 27 PIVOT OF QUARTER WINDOW | 4 |
| 28 AIR VENTILATOR CABLE | 2 |
| 31 HOOK | |

| TABLE II GREASE LUBRIACATING CHART | |
|---|---|
| 8 CLUTCH PEDAL BUSHING | 1 |
| 9 PROPELLER SHAFT UNIVERSAL JOINT | 6 |
| 10 FRONT PROPELLER SHAFT YOKES | 2 |
| 11 REAR PROPELLER SHAFT YOKES | 1 |
| 12 KING PIN (4),STEERING KNUCKLE JOINTS (4),DRAG LINK ENDS (2),TIE ROD ENDS (2) | 12 |
| 13 FRONT AND REAR HUB | 4 |
| 14 FRONT AND REAR SPRING PINS, SHACKLE PINS | 12 |
| 15 BRAKE PEDAL BUSHING | - |
| 16 FRONT BRAKE SLACK ADJUSTER (S-CAM BRAKE) LH/RH 2 NO. | 2 |
| 17 REAR BRAKE SLACK ADJUSTER (S-CAM BRAKE) LH/RH 2 NO. | 2 |
| 29 SLIDING END OF CAB SPRING BKT | 1 |
| 30 SLIDING RAILS OF DRIVER SEAT | - |
| 32 TAIL DOOR HINGE PIN | |
| 33 LOAD BODY MOUNTING REAR HINGE PIN | |
| 34 CYLINDER MOUNTING BRACKETS | |
| 35 BODY LIFTING BRACKET | |
| 36 TAIL DOOR LOCKING CROSS BAR | |

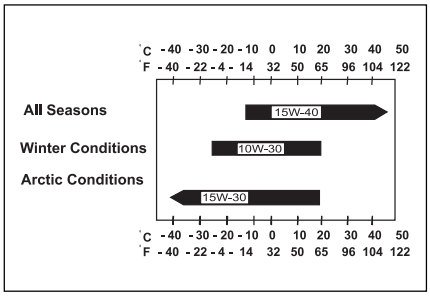



**BRAKE CIRCUIT SCHEMATIC SAK 1212TC**




**BRAKE CIRCUIT SCHEMATIC SA 1212TC**

## Fuel, Lubricants, Coolants




*Ambient temperature & oil viscosity*

**Lubricating Oil Recommendations/ Specifications**

**Oil Performance Recommendations**

The use of quality engine lubricating oils combined with appropriate oil drain and filter change intervals are critical factors in maintaining engine performance and durability.

The use of high quality SAE 15W40 heavy duty engine oil which meets the American Petroleum Institute (API) performance classification CH4/CI4+ and MB 228.1 specifications is recommended.

*Note : CC/CD or CD/SF engine oils can be used in areas where* API CH4/CI4+ *and MB 228.1 oil is not yet available, but the oil change interval must be reduced to one half the interval given in the maintenance schedule.*

A sulphated ash limit of 1.0 mass percent is suggested for optimum valve and piston deposit and oil consumption control. The sulphated ash must not exceed 1.85 mass percent.

**Oil Viscosity Recommendations**

The use of multi-viscosity lubricating oil has been found to improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures.

While 15W40 oil is recommended for most climates, refer to the accompanying table for oil viscosity recommendations for extreme climates.

***Note :*** *Limited use of low viscosity oils, such at 10W-30 may be used for easier starting and providing sufficient oil flow at ambient temperatures below - 5$^{O}$C. However, continuous use of low viscosity oils can decrease engine life due to wear*

**New Engine Brake-in Oils**

Do not use special "brake-in" lubricating oils for new or rebuilt Cummins engines. Use the same type of oil during the 'brake-in" as that which is used in normal operation.

**Coolant Recommendations/ Specifications**

- **Antifreeze is essential in any climate.**

It broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point. Do not use more than 50 percent antifreeze in the mixture unless additional freeze protection is required. **Never** use more than 68 percent antifreeze under any condition.

Use soft water in the Coolant mixture. Contaminants in hard water neutralise the corrosion inhibitor components. Water **must not** exceed 300 ppm hardness or contain more than 100 ppm of either chloride or sulphate.

- **Specifications - Use low silicate antifreeze which meets ASTM 4985 test (GM 6038 M spec.) criteria.**

  **Concentration -** Antifreeze must be used in any climate for both freeze and boiling point protection.

**Use a 50 percent concentration level of ethylene glycol or propylene glycol in most climates.** Antifreeze at 68 percent concentration provides the maximum freeze protection and must never be exceeded under nay condition. Antifreeze protection decreases above 68 percent.

| Ethylene Glycol | Propylene Glycol |
|---|---|
| 50% = -37 $^{0}$C | 50% = - 33 $^{0}$C |
| 60% = - 54 $^{0}$C | 60% = - 49 $^{0}$C |
| 68% = - 71 $^{0}$C | 68% = - 63 $^{0}$C |

**Concentration Testing - Antifreeze concentration must be checked using a refractometer (such as Fleetguard Part No. CC 2800).**

**Recommended antifreeze brands**

1. Servo Cool (IOC)
2. Long life coolant (CASTROL)
3. Golden Cruiser 1200 (Sunstar industries Ltd.)
4. Koolgard (HPCL)
5. Purocool (Ansysco)

**Fuel Recommendations/Specifications**

*Warning : Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.*

*Caution : Due to the precise tolerance of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the injection pump and the injection nozzles.*

Use ASTM No. 2D fuel with a minimum Cetane number of 40. No. 2 diesel fuel gives the best economy and performance under most operating conditions. Fuels with Cetane numbers higher than 40 may be needed in high altitudes or extremely low ambient temperatures to prevent misfires and excessive smoke.

At operating temperatures below $0^0$C, use a blend of No. 1D and No. 2D fuels, also known as "winterized" No. 2D

***Note :*** *No. 1 D fuel can be used, however, fuel economy will suffer.*

Use low sulphur content fuel having a cloud point that is at least 10 degrees below the lowest expected fuel temperature. Cloud point is the temperature at which wax crystals begin to form in diesel fuel.

The viscosity of the fuel must be kept above 1.0 centistokes to provide adequate fuel system lubrication at $40^0$C.

**Oil for live front axle and rear axle**

Recommended oil : Use multigrade oil conforming to SAE 85W90-140 grade and API-GL5 Specifications.

**Live front axle and rear axle**

Change the Multigrade oil at first 9,000 km, then at 36,000 km and thereafter at every 36, 000 km.

**Note :** Monograde oils conforming to SAE 90 grade and API GL5 specifications can be used in areas where above mentioned Multigrade oils are not yet available but the oil should be changed at first 9,000 km then at 18,000 km and there after at every 18,000 km.

| TO BE USED FOR | GRADE/ SPECIFICATION | Brand endorsed by Tata Motors | |
|---|---|---|---|
| | | CASTROL | TATA BP |
| **ENGINE** : Tata Cummins (Engine oils conforming to API CH4/ CI4+ & MB 228.1 specifications.) | SAE 15W-40 | Castrol RX Super plus 15W-40 | Vanellua CA Multigrade 15W 40 |

| TO BE USED FOR | GRADE/ SPECIFICATION | BHARAT PETROLEUM | HP | CASTROL | INDIAN OIL | TIDE WATER (VEEDOL) | CHEMOLEUMS | TATA BP | GULF OIL |
|---|---|---|---|---|---|---|---|---|---|
| **SYNCHROMESH GEAR BOX** | SAE 85W 90 | Bharat Spirol 80 W EP | HP gear oil EP 80 | Castrol Hypoy 80 EP Light | Servo Gear HP 80 W | Veedol Multigear 80 | Chemoleums Universal Thubol SAE 80 W | TATA BP Hyper Gear oil 80 W | Gulf EP Gear Oil 80 W |
| **REAR AXLE LIVE FRONT AXLE** (With Multigrade oil) ▲ | SAE 85W 140 | Bharat Spirol HD 85W 140 | HP Gear Oil XP 85W 140 | Castrol EPX Multigrade Oil 85W 140 | Servo Gear Super 85W 140T | Veedol Multigear 85W 140HD | TURBO GL5 SAE 85W 140 | | GULF MPGO 85W 140 |
| **REAR AXLE LIVE FRONT AXLE** (With Monograde oil) ◆ | SAE 85W 140 | Bharat Spirol HD 90 | HP Gear Oil XP 90 | Castrol Hypoy B | Servo Gear Super 90 | Veedol MG 90 HD | Chemoleums Multipurpose Thubol SAE 90 | TATA BP Hypo Gear oil 90 | GULF MP Gear oil 90 |
| **AUXILIARY GEAR BOX** | | Bharat Spirol 90 EP | HP Gear Oil EP 90 | | Servo Gear HP 90 | | Chemoleums Universal Thubol SAE 90 | | Gulf EP Gear oil 90 |
| **BRAKES AND CLUTCH HYDRAULIC SYSTEM** | RR3 Grease | | HP Super Duty brake fluid | Castrol Universal brake fluid (crimson) | Servo brake fluid Super HD | | | | |
| **WHEEL BEARINGS** | | Bharat Univex-A Grease | HP Multipurpose Grease 2 | Castrol AP Grease (Consistency No. 2) | Servo Grease MP | Veedol AP-2 Grease | | Energrease LS2 Multipurpose Grease | Gulf Multipurpose Grease 2 |

▲ = Oil change frequency is 36000 km for Multigrade oil.

◆ = Oil change frequency is 18000 km for monograde oil.

| TO BE USED FOR | GRADE/ SPECIFICATION | BHARAT PETROLEUM | HP | CASTROL | INDIAN OIL | TIDE WATER (VEEDOL) | CHEMOLEUMS | TATA BP | GULF OIL |
|---|---|---|---|---|---|---|---|---|---|
| **CHASSIS** Spring shackles and pivots. Propeller shaft U-joints and sliding yoke. Steering linkages. king pin bushes. Pedal bushes. Gear shift linkages. | Lithium MP | Bharat Univex-A Grease | HP Multipurpose Grease 2 | Castrol AP Grease (Consistency No. 2) | Servo Grease MP | Veedol AP-2 Grease | | Energrease LS 2 Multipurpose Grease | Gulf Multipurpose Grease 2 |
| **LEAF SPRINGS** | | | HP Graphite Grease-50 | | | | | | |
| **HYDRAULIC / EQUIPMENT JACK** | | Bharat Hydrol 46 or 68 | Turbinol 46 or 68 Enklo 46 or 68 | Hyspin VG 46 or 68 | Servo System 46 or 68 | Aturbio 46 or 68 | | TATA BP Hydraulic oil 46 | |
| **CLUTCH** (a) Clutch release bearing sleeve. Release fork Support bearing | RR3 Grease | | HPMP Grease 2 | | Servo Grease MP 2 | | | | |
| (b) Felt pad of clutch release bearing if fitted. | Lubricate with engine oil by using oil can. | | | | | | | | |
| **BRAKE PNEUMATIC EQUIPMENT** | | Bharat Univrex-A Grease | HP Multipurpose Grease 2 | Castrol AP Grease (Consistency No. 2) | Servo Grease MP | Veedol AP-2 Grease | | | |
| **POWER STEERING SYSTEM** | | Bharat Automatic Transmission Fluid A | HP Automatic Transmission Fluid A | Castrol TQ Automatic Transmission Fluid | Servo Transmission Fluid A | Veedol Multigear SM Oil | Chemoleums TQA Gear oil | TATA BP Autran GM-MP | |

## SERVICE SCHEDULE

P : Service to be performed once only at the time of delivery of vehicle (PDI)
D : Daily service to be performed by the driver / operator
O : Service to be performed at every 1000 kms by the driver / operator
W : Service to be performed weekly or at every 2000 kms whichever is earlier by driver / operator.
T : Service to be performed once only at 3000-3500 kms
● : Service to be performed regularly as per frequency given in the chart

| SR. No. | OPERATION | FREQUENCY IN km | PDI | DAILY | Every 1000 km | 3000-3500 | 9000-9500 | 18000-18500 | 27000-27500 | 36000-36500 | 45000-45500 | 54000-54500 | 63000-63500 | 72000-72500 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **GENERAL** | | | | | | | | | | | | | |
| 1. | Wash the Vehicle | 9,000 | P | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 2. | Road Test and Check Brake : i. Foot brake, ii. Hand brake. Steering, Clutch. Transmission and P.T.O (If fitted) for Gear shift and Noise. Rear axle for differential noise. Speedometer. Squeaks and rattles. For tippers : Check operation of tipping gear. | PDI only | P | | | | | | | | | | | |
| 3. | Start engine and check - Engine idling and running (watch for any unusual noise). Alternator operation (watch charging control lamp) Oil pressure at : a) Idling speed & maximum speed. Water temperature, compressed air pressure and operation of engine exhaust brake. | PDI only | P | | | | | | | | | | | |
| | **ENGINE** | | | | | | | | | | | | | |
| 1. | Check water trap in water separator. | DAILY | P | D | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 2. | Check fan and fan belt visually and replace, if damaged. | DAILY | P | D | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 3. | Check coolant level in radiator and top up, if necessary. Check coolant leakages and rectify, if any | DAILY | P | D | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 4. | Check air intake piping, hoses, clamps. Replace damaged hoses | 9,000 | P | | | | ● | ● | ● | ● | ● | ● | ● | ● |
| 5. | Check service indicator. Change primary filter, if red band is in raised position | 9,000 | P | | | | ● | ● | ● | ● | ● | ● | ● | ● |
| 6. | Check oil level in the sump and top up, if necessary. Check oil leaks and rectify, if any | 9,000 | P | D | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 7. | Lubricate with oil can : Controls to fuel injection pump and exhaust brake linkage ball joints | 9,000 | P | | O | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 8. | Check distance between release bearings and clutch; adjust if necessary | 9,000 | | | | | ● | ● | ● | ● | ● | ● | ● | ● |
| 9. | Check and if necessary, tighten the following :- (a) Injector pressure lines, (b) Leak off fuel line banjo bolts. (c) Heat exchanger bolts. (d) Oil sump screws. (e) Oil pressure transducer at heat exchanger (f) Exhaust manifold mounting bolt. (g) Turbocharger mounting fasteners. (h) Flywheel housing mounting bolts. (i) Air cleaner mounting bolts. (k) Muffler assembly bolt. | 9,000 | P | | O | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 10. | Check and tighten, if necessary the following :- (a) Push rod chamber cover. (b) Timing gear cover (c) Cylinder head cover (d) Radiator mountings (e) Radiator hose connections, (f) Fuel tank brackets. (g) Fuel filter bracket, (h) Fuel filter mounting bolts. (i) Air ducting hose connections, (j) Engine mounting bolts (k) Engine breather rubber hose clamp | 9,000 | P | | | T | ● | ● | ● | ● | ● | ● | ● | ● |

| SR. No. | OPERATION | FREQUENCY IN km | PDI | DAILY | Every 1000 km | 3000-3500 | 9000-9500 | 18000-18500 | 27000-27500 | 36000-36500 | 45000-45500 | 54000-54500 | 63000-63500 | 72000-72500 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11. | Change oil in sump. Drain off while hot. Clean drain plug. Change oil filter. (For city service, tippers & short route operation the filter & oil should be changed at 9000 kms. or 250 hrs., whichever is earlier.) | 18,000 | | | | | | • | | • | | • | | • |
| 12. | Check anti-freeze concentration | 18,000 | | | | | | • | | • | | • | | • |
| 13. | Change two fuel filters and 'O' rings. Bleed the fuel system. | 18,000 | | | | | | • | | • | | • | | • |
| 14 | Grease with grease gun : clutch release bearing | 18,000 | | | | | | • | | • | | • | | • |
| 15. | Remove strainer in fuel tank, clean and refit. | 36,000 | | | | | | | | • | | | | • |
| 16. | Drain cooling system - reverse flush. Check thermostat for proper operation. Refill system with fresh coolant. Use mixture of clean water & recommended anti freeze agent in specified ratio | 3,20,000 kms or 2 years whichever is earlier | | | | | | | | | | | | |
| 17. | Check drive belt tension and replace belt , if necessary. | 36,000 | | | | | | | | • | | | | • |
| 18. | Check fan hub and drive belt tensioner bearing | 36,000 | | | | | | | | • | | | | • |
| 19. | Check valve clearance and adjust, if necessary. | 36,000 | P | | | | | | | • | | | | • |
| 20. | Remove and clean exhaust outlet elbow, exhaust valve, shaft and refit. (Do not lubricate) | 72,000 | | | | | | | | | | | | • |
| 21. | Check end play of turbocharger shaft and radial clearance between turbine wheel & housing | 72,000 | | | | | | | | | | | | • |
| 22. | Check vibration damper and replace, if necessary | 72,000 | | | | | | | | | | | | • |
| 23. | Remove FIP injectors, check and reset the pressure | 72,000 | | | | | | | | | | | | • |
| | **CLUTCH AND TRANSMISSION** | | | | | | | | | | | | | |
| 1. | Check oil level in gear box and top up, if necessary | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 2. | Check clutch fluid level and top up, if necessary | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 3. | Check clutch pedal free play and adjust if necessary. (For off highway operation vehicles this check to be done more often) | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 4. | Grease with grease gun : (i) Accelerator pedal bush -LP (ii) Clutch pedal bushing, (iii) Remote gear shifting linkage where fitted, (v) Propeller shaft U joints, sliding yoke, & centre bearing where fitted. | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 5. | Remove grease cup for lubricating clutch release bearing. Repack 3/4 the full with grease and tighten by a few turns. | 9,000 | P | | | | • | • | • | • | • | • | • | • |
| 6. | Lubricate with oil can : Clutch linkages & felt pad of clutch release bearing sleeve. (few drops only) | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 7. | Change oil in gear box and transfer case. (At first 3000 km also) Drain while hot. Clean drain plug. | 36,000* | | | | T | | | | • | | | | • |
| 8. | Check and tighten, if necessary : (a) Gear box mounting bolts, (b) Propeller shaft coupling flange bolts, (c) Propeller shaft centre bearing support bracket bolts. | 18,000 | p | | | | | • | | • | | • | | • |
| 9. | Clean breather on gear box | 72,000 | | | | | | | | | | | | • |
| 10. | Overhaul clutch master and slave cylinder | 72,000 | | | | | | | | | | | | • |

* = Frequency is 36,000 km for multigrade oil and 18,000 km for monograde oil

| SR. No. | OPERATION | FREQUENCY IN km | PDI | DAILY | Every 1000 km | 3000-3500 | 9000-9500 | 18000-18500 | 27000-27500 | 36000-36500 | 45000-45500 | 54000-54500 | 63000-63500 | 72000-72500 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **FRONT AXLE AND REAR AXLE** | | | | | | | | | | | | | |
| 1. | Grease with grease gun : (a) Kingpins, (b) Tie rod ends, (c) Drag link ends | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 2. | Check oil level in front live axle and rear axle and top up, if necessary | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 3. | Change oil in front live axle and rear axle, (At first 3000 km also) drain while hot, clean drain plug and breather | 36,000 * | | | | T | | | | • | | | | • |
| 4. | Check crown wheel thrust pad clearance and adjust, if necessary | 18,000 | P | | | T | | • | | • | | • | | • |
| 5. | Check and tighten, if necessary, carrier and rear cover mounting nuts. Also tighten axle shaft cover mounting bolts, rear axle (Banjo type) carrier mounting studs | 18,000 | P | | | T | | • | | • | | • | | • |
| 6. | Remove front hub cap, fill 3/4 the full with wheel bearing grease and refit | 18,000 | P | | | | | • | | • | | • | | • |
| 7. | Check front and rear wheel bearing adjustment and correct, if necessary | | P | | | T | | | | | | | | |
| 8. | Check wheel alignment and if necessary, adjust | 18,000 | P | | | | | • | | • | | • | | • |
| 9. | Remove front and rear wheel hubs. Dismantle and clean bearing and other components. Replace damaged/worn-out parts. Repack with fresh wheel bearing grease, and refit, Adjust Wheel hub bearing play. | 36,000 | | | | | | | | • | | | | • |
| | **STEERING AND SUSPENSION** | | | | | | | | | | | | | |
| 1. | Check steering wheel free play. Adjust if necessary | 9,000 | P | | | | • | • | • | • | • | • | • | • |
| 2. | Check oil level in steering gear housing (where fitted). Top up, if necessary | 9,000 | P | | | T | • | • | • | • | • | • | • | • |
| 3. | Check oil level in power steering hydraulic tank and top up, if necessary, Check hydraulic piping connections for leakages and rectify, if any. | 9,000 | P | | | | • | • | • | • | • | • | • | • |
| 4. | Grease with grease gun : (a) Front spring pins, (b) Rear spring pins. Apply grease on helper spring brackets and free end of cab spring. | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 5. | Check and tighten, if necessary : (a) U bolts of front and rear springs, (b) Nuts of spring pin wedge bolts, box mounting bracket bolts and, (c) Anti roll bar bracket mounting bolts, Spare wheel carrier. | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 6. | Check and tighten, if necessary : (a) Pitman arm, (b) Drag link rod, (c) Tie rod, (d) Steering gear box mounting bracket bolts and, (e) Steering gear box mounting bolts. | 9,000 | P | | | T | • | • | • | • | • | • | • | • |
| 7. | Check and tighten, if necessary, mounting of shock absorber | 9,000 | P | | | T | • | • | • | • | • | • | • | • |
| 8. | Check mountings of spare wheel carrier and tighten, if necessary | 18,000 | | | | T | | • | | • | | • | | • |
| 9. | Check condition of shock absorber rubber bushes and replace, if necessary | 18,000 | | | | | | • | | • | | • | | • |
| 10. | Dismantle front and rear springs and cab mounting spring. Clean and inspect leaves. Check and replace eye bushes, if necessary. Apply graphite grease on leaves and reassemble. | 72,000 | | | | | | | | | | | | • |

| SR. No. | OPERATION | FREQUENCY IN km | PDI | DAILY | Every 1000 km | 3000-3500 | 9000-9500 | 18000-18500 | 27000-27500 | 36000-36500 | 45000-45500 | 54000-54500 | 63000-63500 | 72000-72500 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11. | Drain off hydraulic oil of power steering. Replace filter cartridge & fill in fresh oil. Test the system with test equipment | 72,000 | | | | | | | | | | | | • |
| | **BRAKES ( 'S' CAM )** | | | | | | | | | | | | | |
| 1. | Check for effective operation of brakes. | 9000 | | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 2. | Check for condensed water in air tanks. If water found, replace air dryer cartridge. | 18000 | | | | | | ● | | ● | | ● | | ● |
| 3. | Check and if necessary, tighten : (1) Mounting of air tanks, (2) Air line clamps. | 54,000 | | | | | | | | | | ● | | |
| 4. | Check brake system for leaks and rectify, if necessary. | 9000 | | | O | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 5. | Check for proper functioning of engine exhaust brake, free movement of plunger of exhaust brake valve, mounting bolts for loosening and slackness in linkages. | 9000 | | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 6. | Check brake rubber hoses / air pipes for damages / leaks and replace if necessary. | 18000 | | | | T | | ● | | ● | | ● | | ● |
| 7. | Dismantle pneumatic aggregates of brake system, clean, inspect and replace parts if necessary. | 2,00,000 km or 2 years whichever is earlier | | | | | | | | | | | | |
| 8. | Grease with grease gun - brake lever, and camshaft bushes (AAL). | 9000 | | | O | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 9. | Lubricate with oil can : brake chamber fork & pin, linkages of foot brake, ball joints of exhaust brake linkages - hand & foot brake linkages. | 18000 | | | | | | ● | | ● | | ● | | ● |
| 10. | For manual slack adjuster, check travel of brake chamber's push rod/brake lining wear and clearance with drum. Adjust service brakes, if necessary. Change lining when worn up to indicator slot. | | | | | | | | | | | | | |
| | a. Long route operation. | 9,000 | | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| | b. City/Hill/Cross country application. | 4,500 | | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 11. | For automatic slack adjuster, check lining thickness. Change lining if worn up to 1 mm above indicator slot. | | | | | | | | | | | | | |
| | a. Long route operation. | 9,000 | | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| | b. City/Hill/Cross country application. | 4,500 | | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 12. | Overhaul the automatic slack adjuster | 3,00,000 km or 3 years whichever is earlier | | | | | | | | | | | | |
| 13. | Check brake torque plate mounting bolts and tighten if necessary. | At every lining change | | | | | | | | | | | | |
| 14. | Check condition of gaiter in different brake valves, exhaust flap in dual brake valve, exhaust check diaphragm in valve, nylon breather tube and inspect spring brake actuator for external damage. Replace if found damaged. | 36,000 | | | | | | | | ● | | | | ● |
| 15. | Check mounting bolts of brake chambers, different valve mountings, air tank mounting, air cylinders mounting, master cylinders mountings, air line clamps hydraulic pipes & tighten if necessary. | 54,000 | | | | | | | | | | ● | | |
| 16. | Conduct brake system routine checks | 36000 | | | | | | | | | ● | | | ● |
| 17. | Remove brake drums, inspect brake drums. Rectify defects if any. | At every lining change | | | | | | | | | | | | |
| 18. | Grease fulcrum pin bushes and roller ends of S-Cam Brake. | At every lining change | | | | | | | | | | | | |

| SR. No. | OPERATION | FREQUENCY IN km | PDI | DAILY | Every 1000 km | 3000-3500 | 9000-9500 | 18000-18500 | 27000-27500 | 36000-36500 | 45000-45500 | 54000-54500 | 63000-63500 | 72000-72500 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19. | Overhaul foundation brakes. Remove brake drum. Inspect brake drums camshaft etc. Rectify defect, if any. | Every second brake shoe relining or as required | | | | | | | | | | | | |
| 20. | Replace desiccant cartridge and filter of Air Dryer / DDU. | Every two years | | | | | | | | | | | | |
| 21. | Check for excessive play of hand brake shaft in bushes. Replace bushes, if necessary. | 18000 | | | | | | | • | | • | | • | • |
| | **ELECTRICALS** | | | | | | | | | | | | | |
| 1. | Check lights, switches, gauges, blinkers, wiper motor, horn, speedometer for proper functioning and if necessary rectify. | DAILY | P | D | | T | • | • | • | • | • | • | • | • |
| 2. | (a) Check battery mountings, (b) Clean battery posts and terminals. Tighten terminals & smear vaseline/petroleum jelly. | 9,000 | P | O | T | | • | • | • | • | • | • | • | • |
| 3. | Check electrolyte level in battery and if necessary, add distilled water. | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 4. | Check head lamp focusing. Adjust if necessary. (this should be done after every bulb change) | 9,000 | P | | | T | • | • | • | • | • | • | • | • |
| 5. | Check and if necessary tighten connections of (a) Starter motor, (b) Alternator (c) Switches and gauges, (d) Tail lamp, (e) Head lamp, (f) Blinker lamp. Check speedometer cable for proper clamping | 9,000 | P | | | T | • | • | • | • | • | • | • | • |
| 6. | Check mountings of (a) Alternator, (b) Starter motor and tighten, if necessary, | 18,000 | P | | | T | | • | | • | | • | | • |
| 7. | Lubricate with oil can (a) Pinion bushing of starter motor and (b) Wiper motor linkages. | 18,000 | | | | | | • | | • | | • | | • |
| 8. | Check battery cells with cell tester. Also check specific gravity of electrolyte & if necessary attend to it | 18,000 | P | | | | | • | | • | | • | | • |
| 9. | Check alternator carbon brushes and if necessary replace. | 36,000 | | | | | | | | • | | | | • |
| | **CAB AND BODY** | | | | | | | | | | | | | |
| 1. | Grease with grease gun : (1) trailer coupling where fitted, (2) free end of cab spring, (3) sliding rails of driving seat. | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |
| 2. | Check condition of driver seat, rubber stops, buffers, shock absorbers & bushes, replace if necessary | 9,000 | | | | | • | • | • | • | • | • | • | • |
| 3. | Lubricate with oil can : Door hinges, door handle, outer door latches, dove tails & striker plates hinges & locking levers of drop side bodies, hinges, bonnet stay rod, pivot pins & cables of air scoop flap, side flap hinges (if provided), hinges on glove boxes, instrument panel, wiper motor cover & quarter window pivot. | 9,000 | P | | | | • | • | • | • | • | • | • | • |
| 4. | Lubricate with oil can : Pivot of driver's seat | 9,000 | P | | | | • | • | • | • | • | • | • | • |
| 5. | Check and if necessary tighten mounting of driver's cab, load body and spare wheel carrier, bonnet, hinges, tie member mounting, dove tail bottom, dove tail bracket stop, door hinges, door locks, dove tail striker plates, mounting of driver seat, wiper motor & front bumper. | 9,000 | P | | | | • | • | • | • | • | • | • | • |
| | **WHEELS & TYRES** | | | | | | | | | | | | | |
| 1. | Check tyre pressure | DAILY | P | D | | T | • | • | • | • | • | • | • | • |
| 2. | Check and tighten wheel nuts, if necessary (Wheel nuts to be checked 100 km after every wheel change) | 9,000 | P | | O | T | • | • | • | • | • | • | • | • |

# Engine - General Operating and Maintenance Instructions

# Shop Manual

# Tata Cummins
# B Series Engine BS-III (Mechanical)

(Supplement to Shop Manual Tata Cummins B Series Engine - Edition XLI/B2006)

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# About the Manual

This manual contains information exclusively for TATA CUMMINS B Series engines (BS III Mechanical) as supplement to Shop Manual TATA Cummins B Series Engines.

The booklet covers dismantling / assembly inspection and repairs/ for components/ assemblies which are exclusive to Tata Cummins B Series Engines (BS-III Mechanical). For other components / assemblies which are common to Tata CUMMINS B Series engine please refer Shop Manual TATA CUMMINS B Series Engines, Edition : XLI / B-2006.

# General Engine Specifications

## General Engine Data

Basic Engine model ..... B 5.9 - 13031

Horse Power ..... 130 HP @ 2500 rpm

Bore ..... 102 mm

Stroke ..... 120 mm

Aspiration ..... Turbocharged and after cooled

Displacement
- 6B ..... 5.88 liters

Engine idle rpm ..... 800

Rated rpm ..... 2500

Maximum no load governed speed ..... 2850

Compression ratio

B5.9 Automotive, charge air cooled ..... 18:1

Firing order 6 cylinder ..... 1-5-3-6-2-4

Valve Settings
- Intake Valve Adjustment ..... 0.25 mm
- Exhaust Valve Adjustment ..... 0.51 mm

Engine rotation (viewed from front of engine) ..... Clockwise

Engine weight (with standard accessories)
- 6 cylinder engines ..... 413 to 437 kg

## Lubrication System

Oil pressure
- At Idle (minimum allowable) ..... 69kPa [10 Psi]
- At rated speed (minimum allowable) ..... 207 kPa [30 Psi]

Regulating valve opening pressure ..... 517 kPa [65 Psi]

Differential pressure to open oil filter by pass valve ..... 172 kPa [20 Psi]

Oil capacity of standard engine
- 6 cylinder engines (oil sump capacity) ..... 15.3 liters

Total system capacity
- 6 cylinder engines ..... 17.4 liters

## Cooling System

Thermostat

Begins to open ..... 81$^0$C [180$^0$F]

Fully open ..... 95$^0$C [203$^0$-F]

Pressure cap for 99$^0$ C [210$^0$ F] system ..... 50 kPa [7 Psi]

Pressure cap for 104$^0$ C [220$^0$ F] system ..... 103 kPa [15 Psi]

## Intake Air and Exhaust System

Maximum allowable intake restriction at rated speed and load (wit dirty air filter element)

Turbocharged ..... 63.5 cm $H_2O$ [25 in $H_2O$]

Maximum turbocharger outlet restriction at rated speed and load ..... 76.2 mm Hg [3 in Hg]

Automotive ..... 114.3 mm Hg [4.5 in Hg]

## Fuel System

Fuel transfer pump maximum inlet restriction ..... 100 mm Hg [4 in Hg]

Fuel transfer pump output pressure at rated speed

Distributor fuel injection pumps (maximum) ..... 70 kPa [10 PSi]

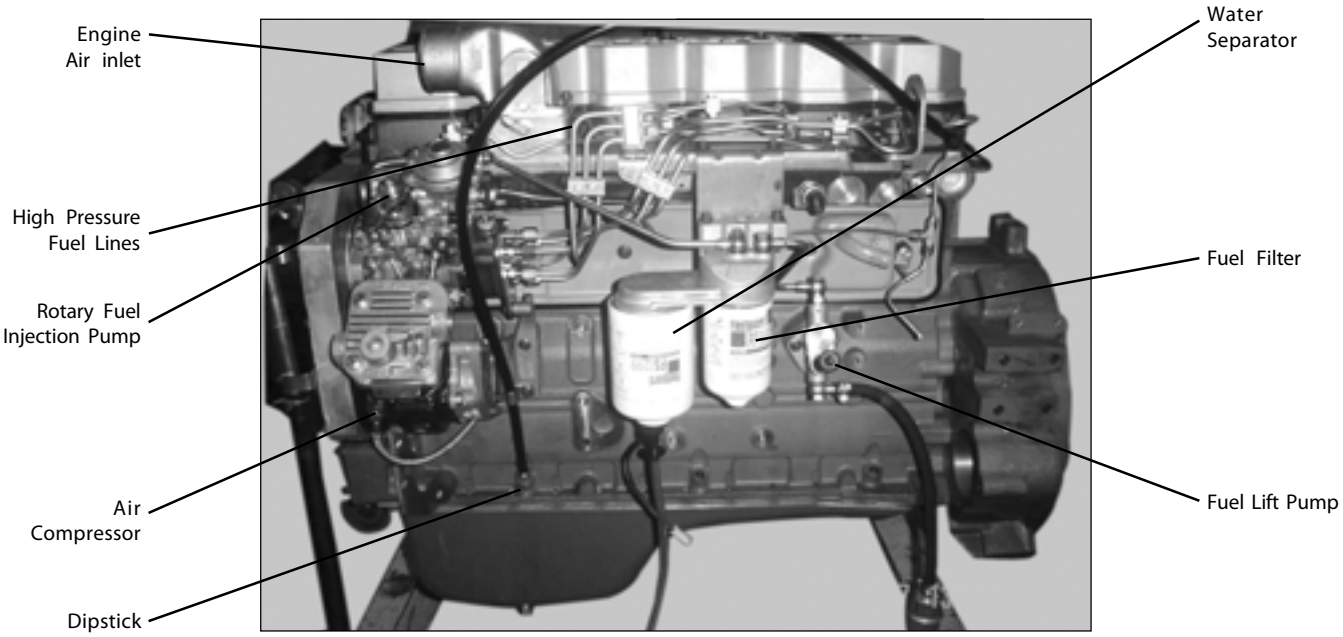
Mico Rotary VP 14 mechanical injection pump (minimum) ..... 172 kPa [25 Psi]

Fuel filter restriction (maximum pressure drop across filters) ..... 35 kPa [5 Psi]

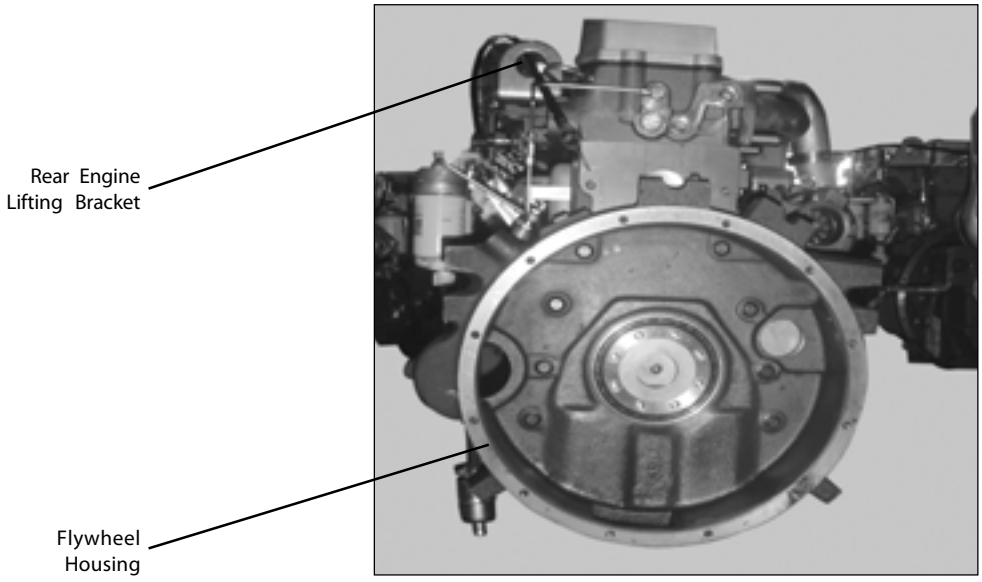
Fuel return restriction (maximum) ..... 518 mm Hg [20.4 in Hg]

# BS-III Engine Introduction

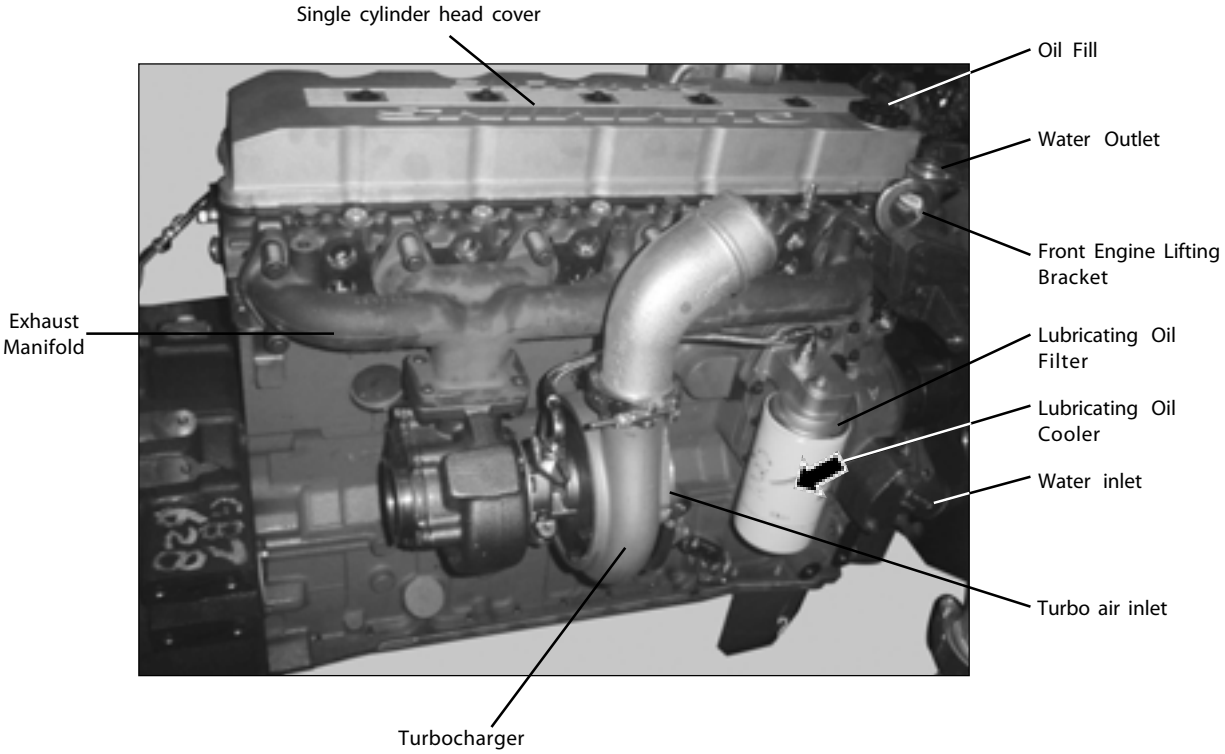
The illustrations which follow show the locations of the major external engine components, the filters, and other service and maintenance points.



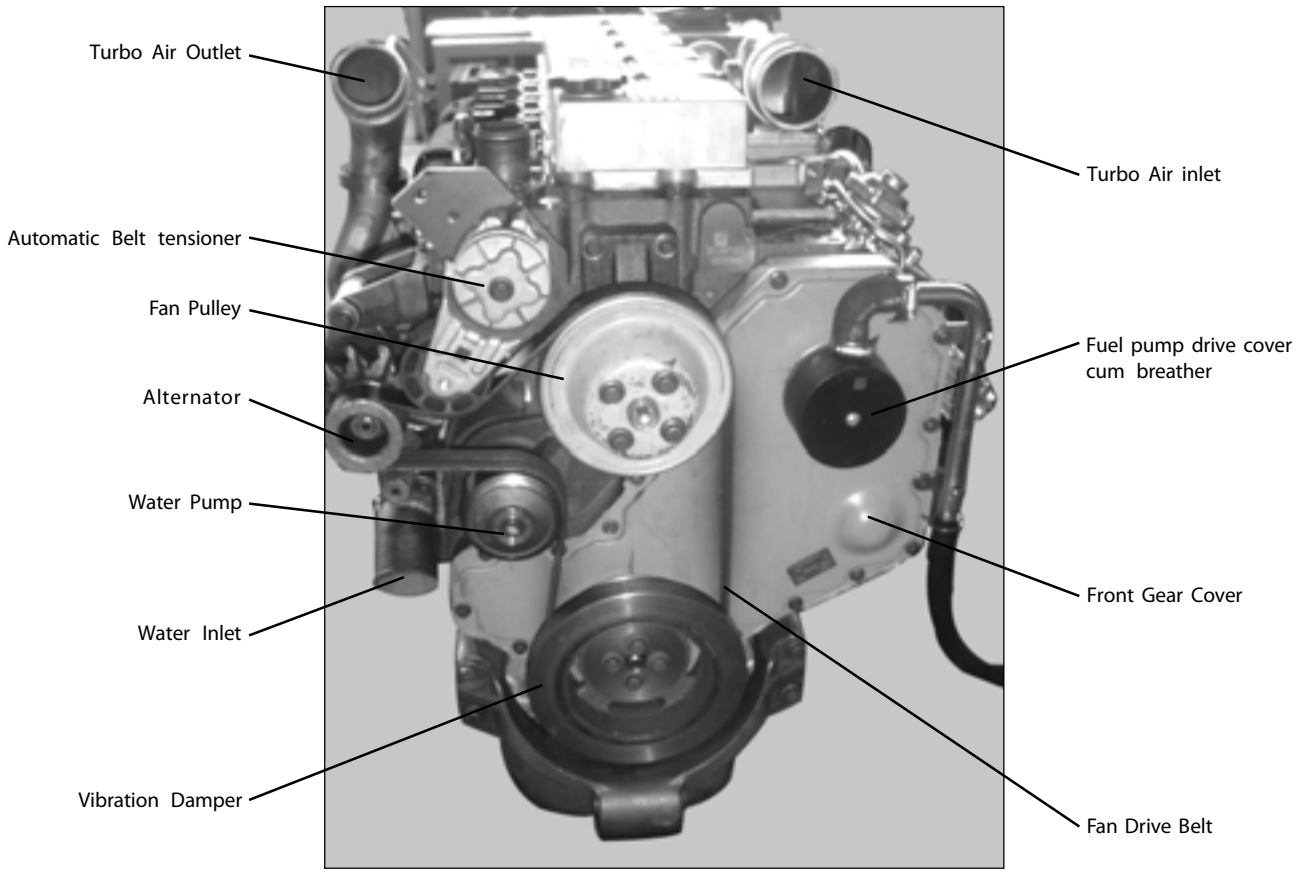

**FIP Side view**




**Rear View**




**Turbocharger Side View**




**Front View**

## MAJOR DIFFERENCES IN 6BT BS –III (MECHANICAL) Compared to 6BT BS-II ENGINE

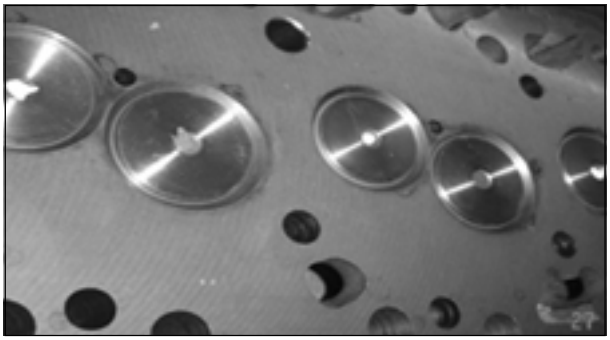
| | | | | | |
|---|---|---|---|---|---|
| 1 | Cylinder Head | 7 | Exhaust Manifold | 13 | Cylinder head Gasket |
| 2 | Valve (Inlet / Exhaust) | 8 | Camshaft | 14 | Valve Cover |
| 3 | Piston | 9 | Thermostat | 15 | Fuel Adapter |
| 4 | Rocker assembly | 10 | Valve (Inlet / Exhaust) | 16 | Fuel Return |
| 5 | Push Rod | 11 | Piston Ring | | |
| 6 | Injector | 12 | Valve Tappet | | |

### CYLINDER HEAD ASSEMBLY

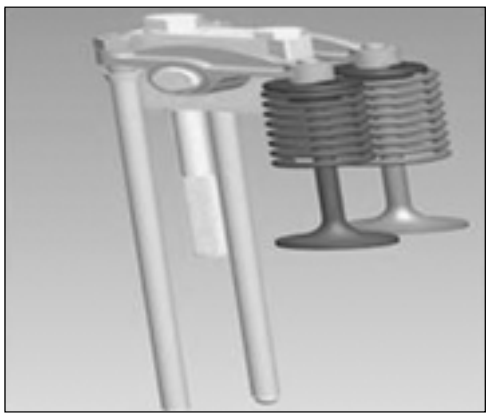
**BSII**



- 2 Valves Per Cylinders
- Cylinder head bolts - 3 Different lengths



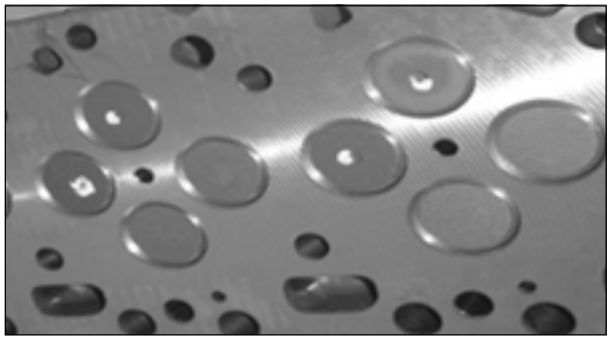
- Two valve per cylinder valve train



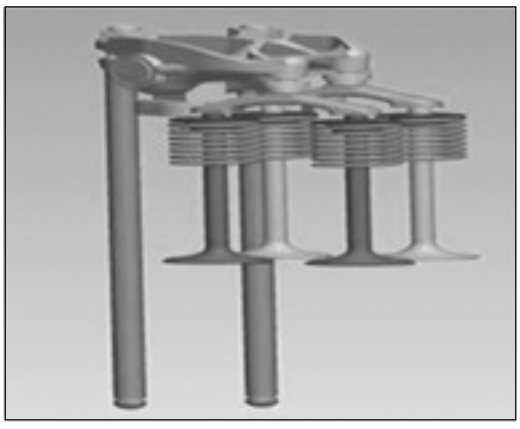
**BSIII**



- 4 Valves Per Cylinders
- All Cylinder head bolts are of same length.



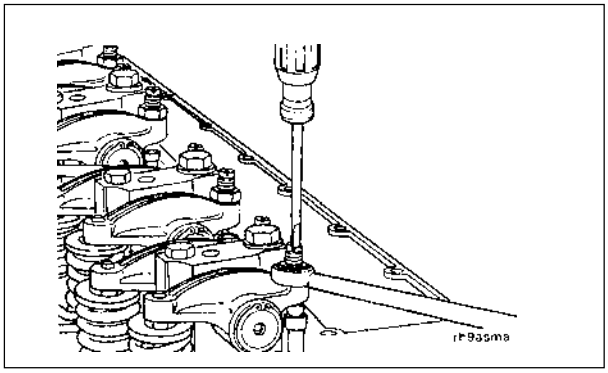
- Four valve per cylinder Valve train



## BSII

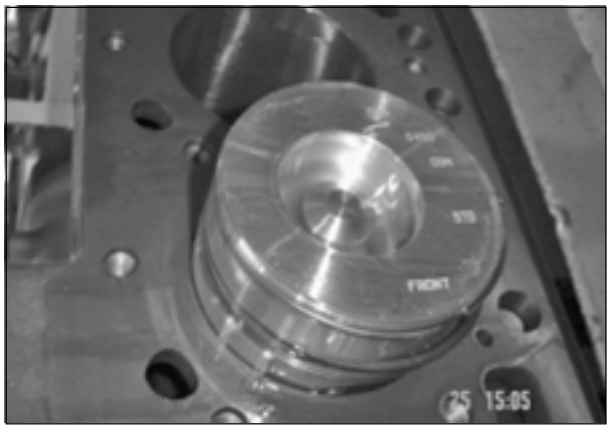
## BSIII

### ROCKER ASSEMBLY

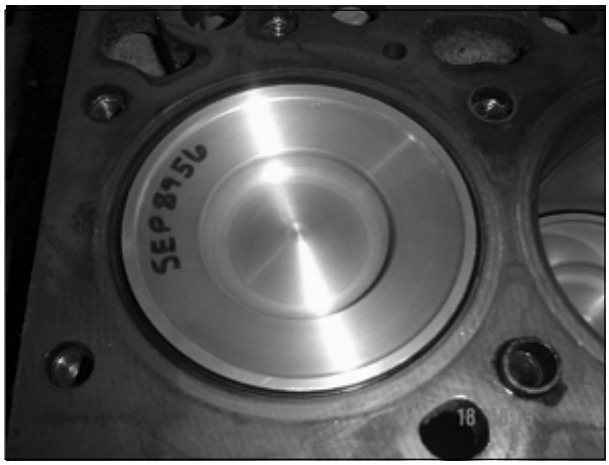




### PISTON



- Offset Piston Bowl




- Central Bowl Piston

### HIGH PRESSURE LINES AND INJECTORS



- High Pressure lines and injectors on Exhaust side of Cylinder head



- High Pressure Lines on Intake side of cylinder head

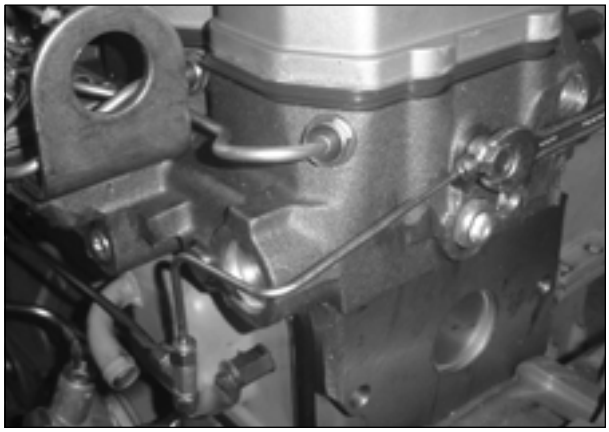
## BSII

## BSIII

### FUEL RETURN LINE

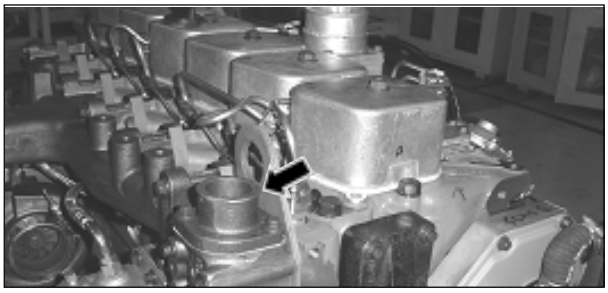



- External Injector Fuel Return line

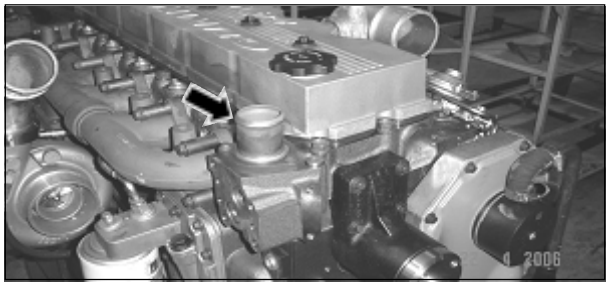


- No External Fuel return line
- Integral Fuel Return Line

### THERMOSTAT HOUSING

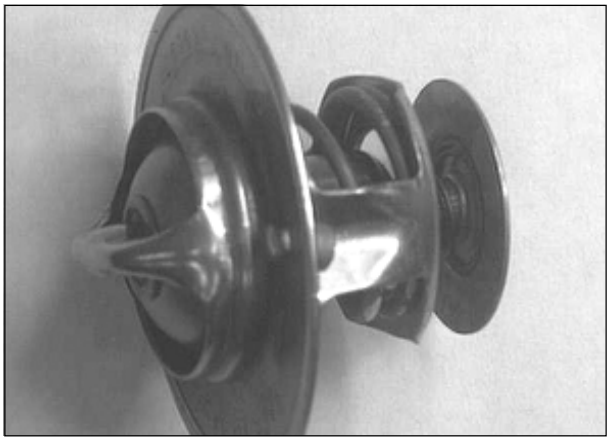


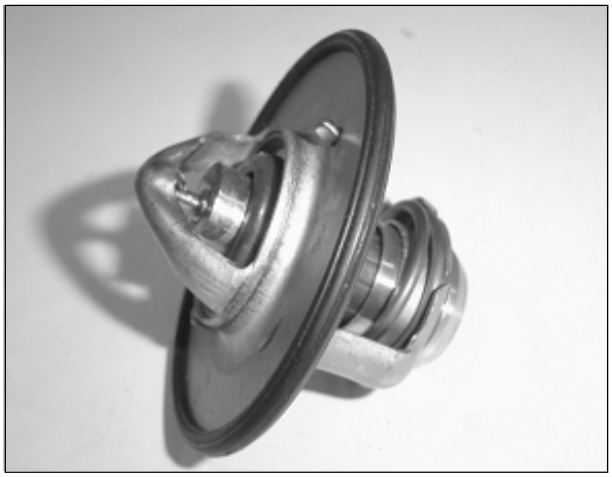
- Separate thermostat Housing




- Vertical and integral Thermostat housing in cylinder head itself.

### THERMOSTAT



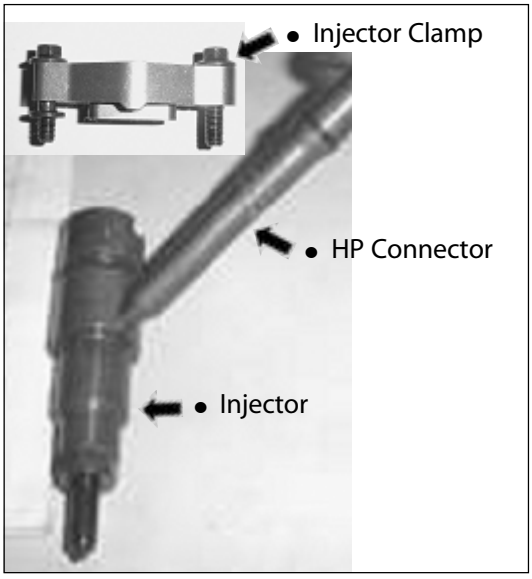


## BSII

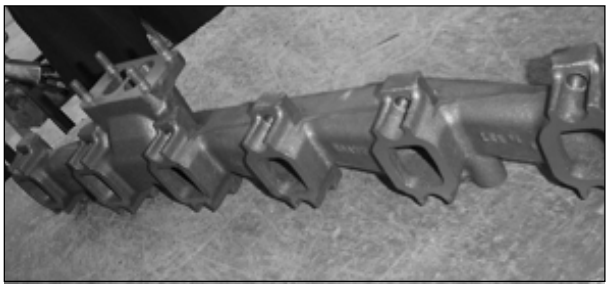
## BSIII

### INJECTOR

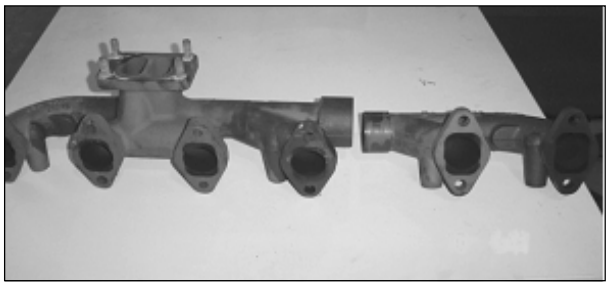





### EXHAUST MANIFOLD



- Single Piece Pulse type exhaust manifold

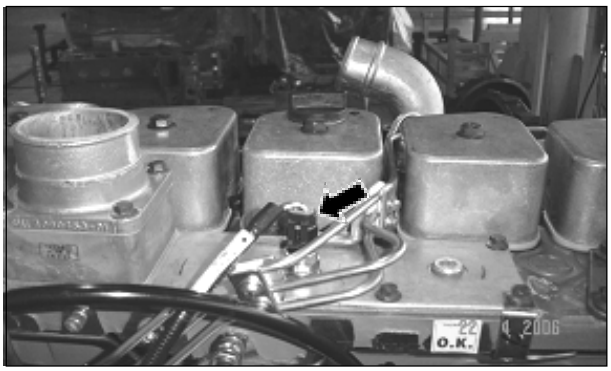


- Two Piece Pulse type exhaust manifold

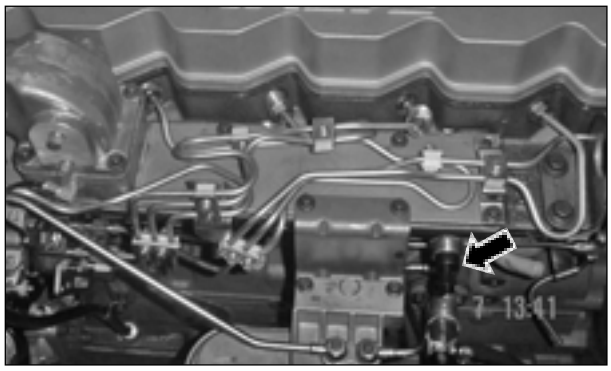
## BSII

## BSIII

### THERMO SWITCH LOCATION

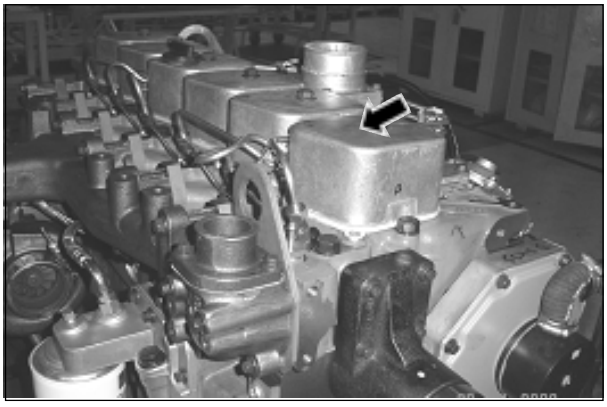


- Intake cover mounted Thermo switch connecting KSB

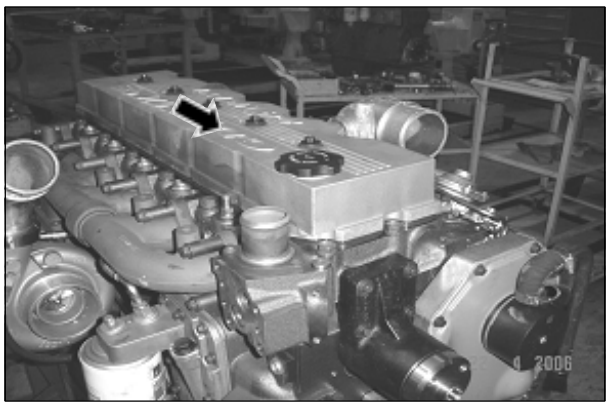


- Cylinder head mounted Thermo switch connecting KSB

### VALVE COVER



- Individual Valve cover and valve cover gasket for each cylinder (6 pieces)



- Single and integral Valve cover assembly and gasket (one piece)

## Thermostat- Removal

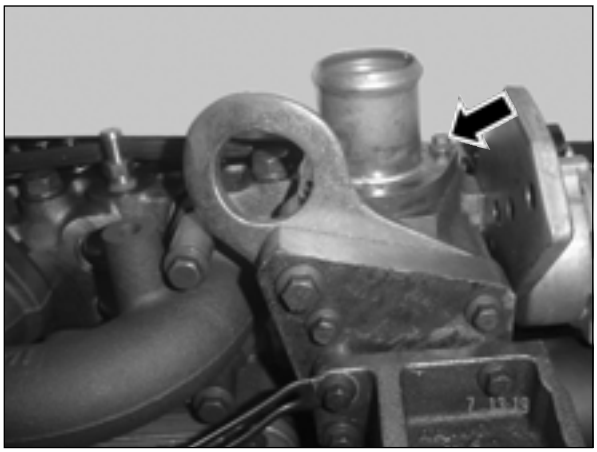




**10 mm Scew driver**

Drain coolant and disconnect water lines.

Remove the capscrews from the thermostat housing.



## Thermostat - Inspection

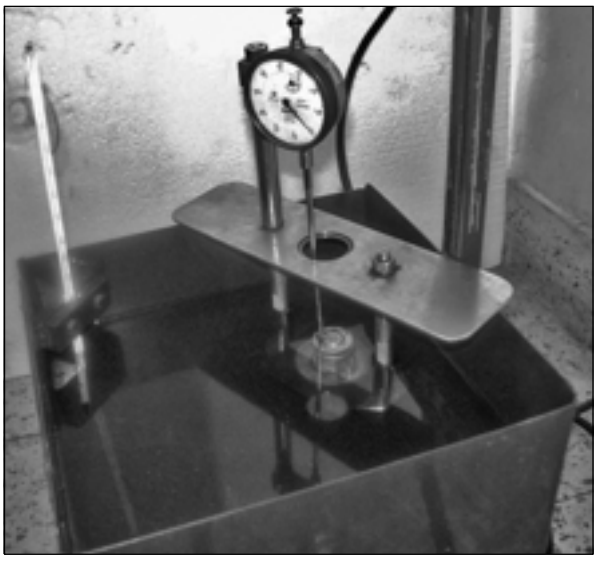


Visually inspect the thermostat for obvious damage such as obstructions caused by debris, broken springs, or stuck or missing vent pins.





The thermostat can be checked for correct operation.



**Requirements**

**Start to open** at $83^0$ C [$181^0$ F].

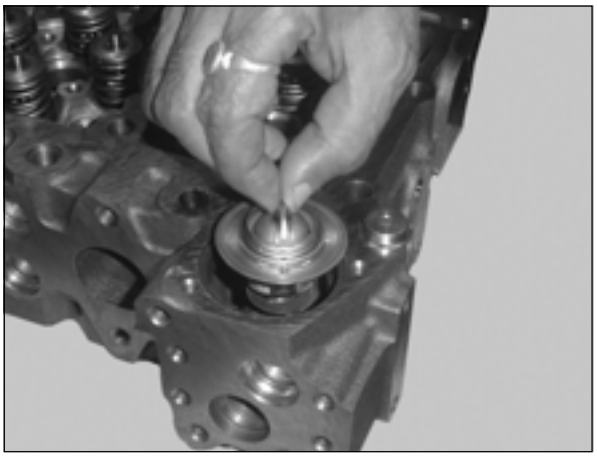
**Fully open at** $95^0$ C [$203^0$ F].

Max. Valve lift 6.6 mm

## Thermostat - Installation



Position the thermostat as shown.





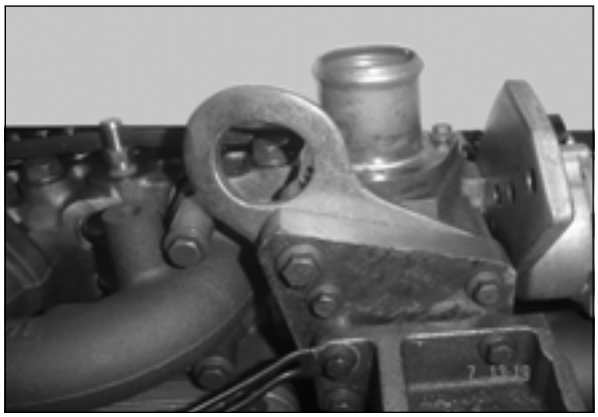
**10 mm**

Install Thermostat cover and tighten.

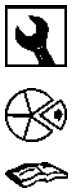


**Torque Value :** 24 N•m



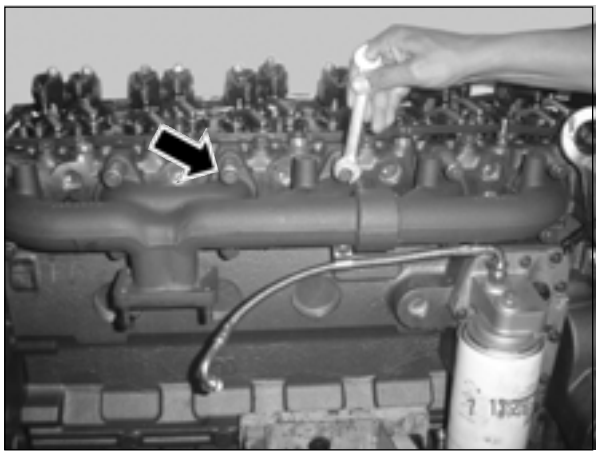


## Exhaust Manifold - Removal



**13 mm**

Remove the capscrews, exhaust manifold and gaskets.

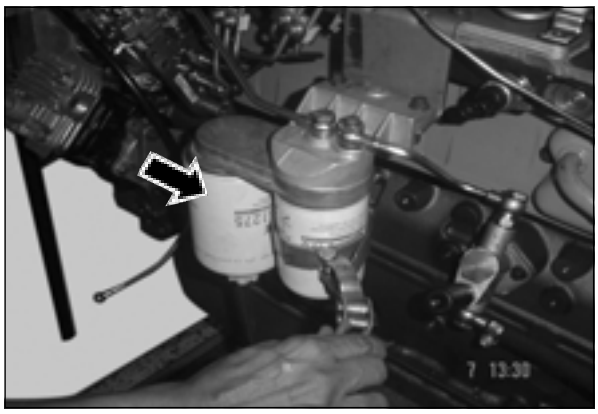


## Fuel Filter - Removal



**75-80 mm, 90-95 mm Strap Wrenches**

Remove the fuel filter(s).

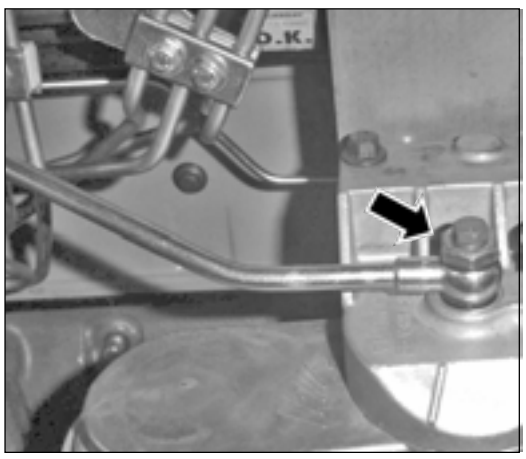


## Fuel Filter Head - Removal



**24 mm**

If equipped with a dual filter head, remove the nut, dual filter head and O-ring.



**Screwdriver**

Remove fuel filter adapter and O-ring.



## KSB Connections (Remote mounted) - Removal

Remove the KSB wiring harness connections.



*FIP KSB Unit*

# Fuel Lines - Removal

## High Pressure Fuel Line - Removal



**17 mm Crowsfoot Wrench**



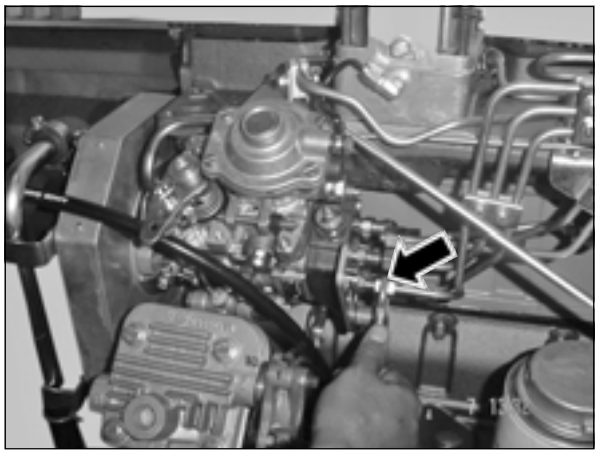
**19 mm Crowsfoot Wrench**



**Caution: Hold the fuel pump delivery valves securely when loosening the high pressure lines on the rotary pumps.**

Remove the high pressure line fittings from the injection pump.

**19 mm**

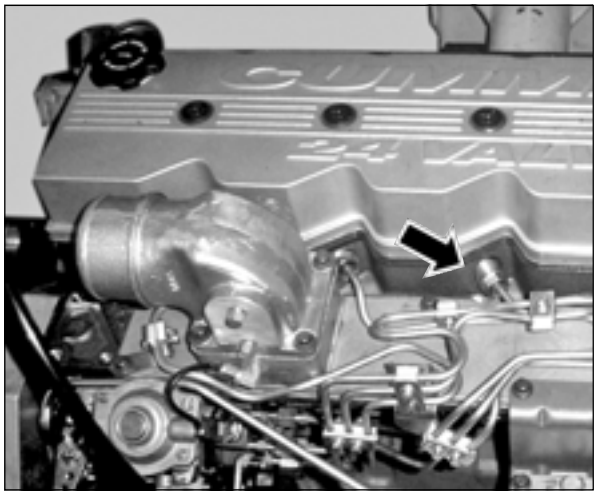


Remove the high pressure lines form the injectors.









**10 mm**



Remove the manifold cover capscrews that secure the high pressure line support brackets.



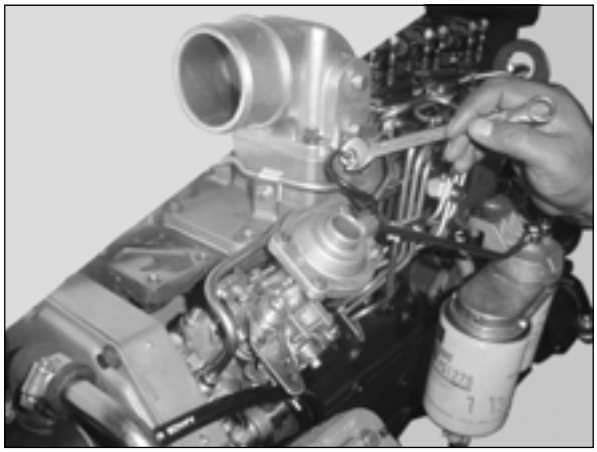
Remove the high pressure lines as an assembly. Cap or cover the injector openings.





**12 mm and 13 mm**

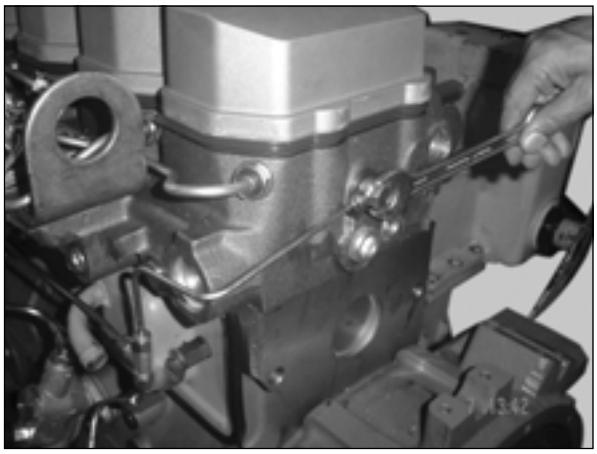
If so equipped, remove the air/fuel control tube and turbocharger wastegate line.



## Fuel Drain Manifold - Removal

**16 mm**

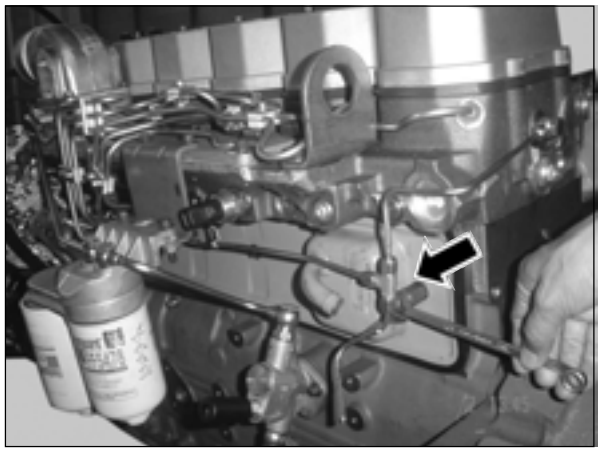
Remove the fuel drain manifold banjo fittings and sealing washers.



**17 mm and 10 mm**

**Rotary Fuel Pump**

Remove the fuel drain manifold support brackets and banjo fitting.

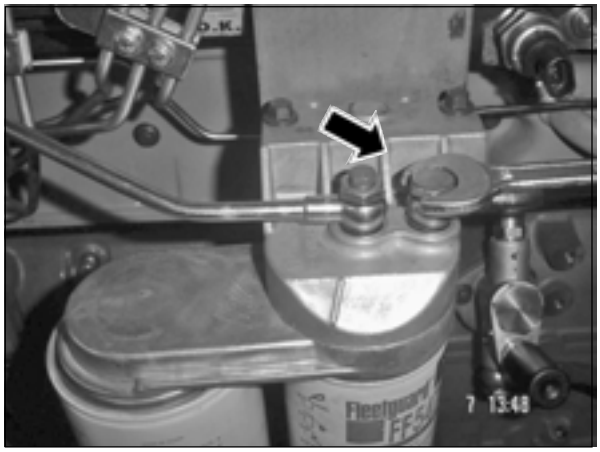


## Low Pressure Fuel Lines - Removal



**17 mm**

Disconnect the two banjo fittings at the filter head.

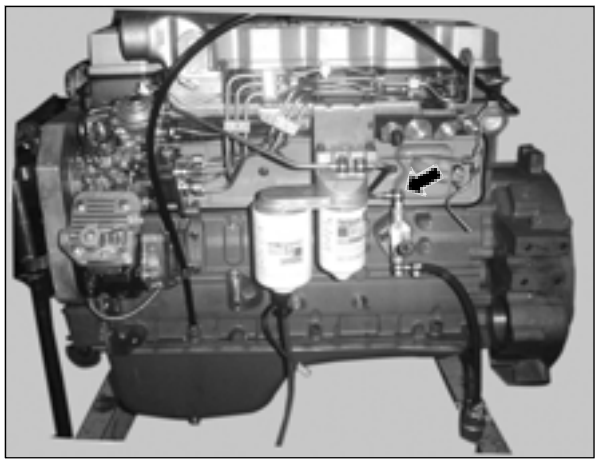


**14 mm and 17 mm**



**Caution: Be sure the fuel transfer pump connection is held securely when loosening the fuel line.**

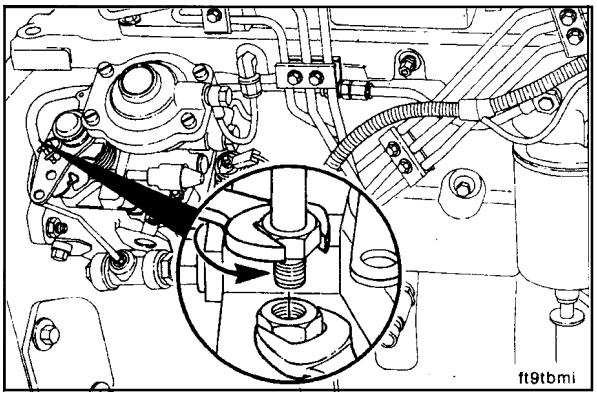
Loosen the nut and remove the fuel line from the lift pump.



**14 mm and 17 mm**



**Caution: Be sure the fuel pump connection is held securely when loosening the supply line.**



## Fuel Lines - Installation

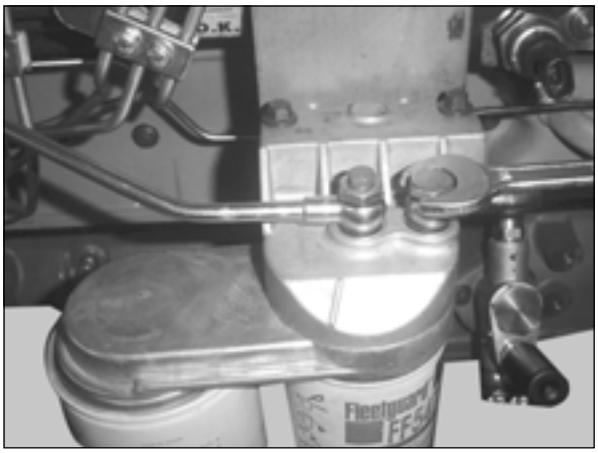


**17 mm**

Install the fuel filter supply line.

The banjo fittings at the filter head require sealing washers on each side of the line. The banjo fitting with the vent screw is used to install the pump supply line.





## Injection Pump Supply Line - Installation

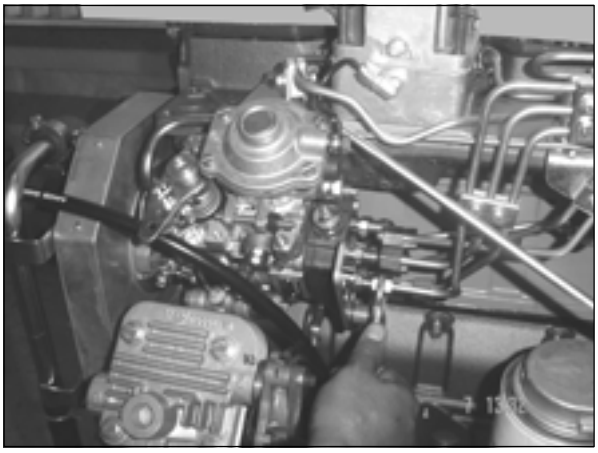




**17 and 14 mm**

Install the MICO Bosch injection pump fuel supply line.

**Torque Value :** 32 N•m



## Fuel Drain Manifold - Installation





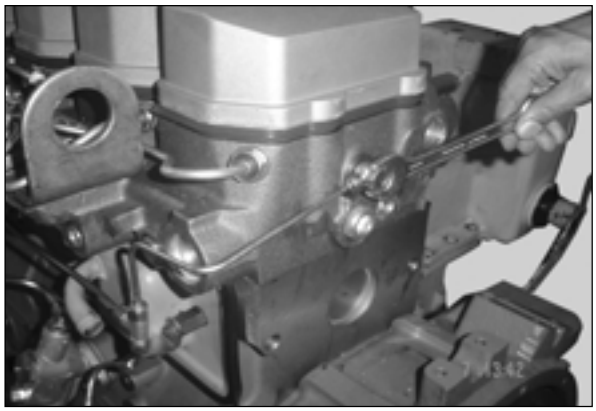


**10 mm**

Use new sealing washer for the new fuel drain manifold.

Intall the fuel drain manifold.

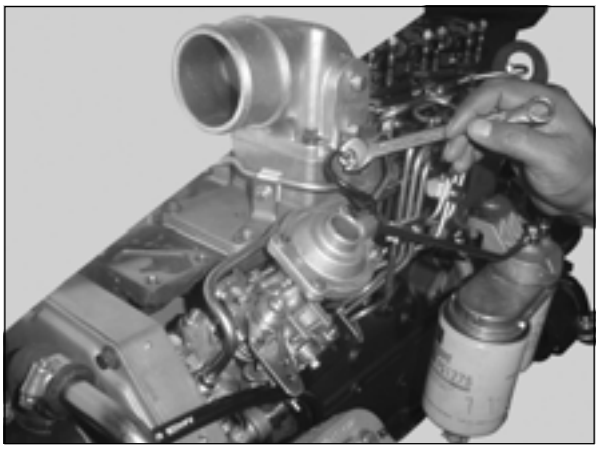
**Torque Value :** 9 N•m



## Injection Pump Vent Line - Installation

**10 and 19 mm**

Connect the Bosch injection pump vent.



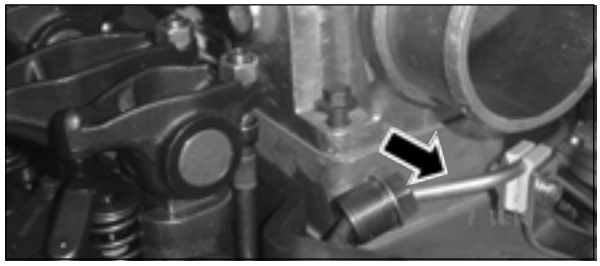
## High Pressure Fuel Lines - Installation





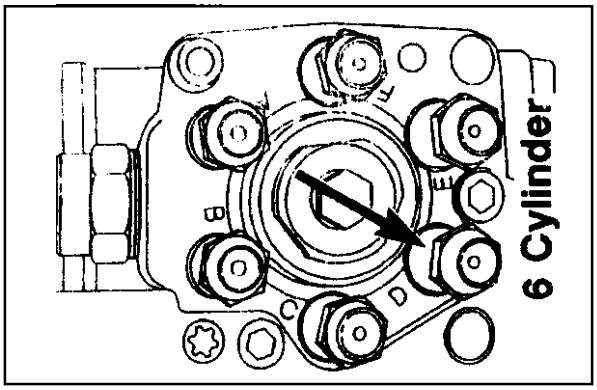
Assemble the high pressure fuel lines.

The number one cylinder delivery valve is marked on the pump as illustrated.



6 cylinder= D

Firing Order
6 Cylinder
D= 1 A= 6
E= 5 B= 2
F= 3 C= 4




**13 mm**

Tighten all of the manifold cover capscrews.

**Torque Value:** 24 N•m [18 ft.-lb]

**14 mm, 17 mm**





Make sure that the high pressure lines will not rub against other engine components.

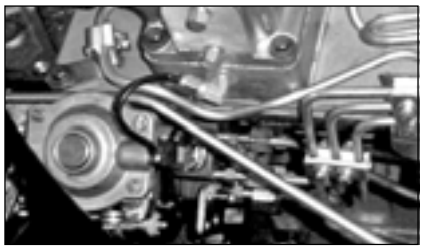
Tighten the high pressure lines at the injection pump and injectors securely.



**Torque Value :** 24 N•m



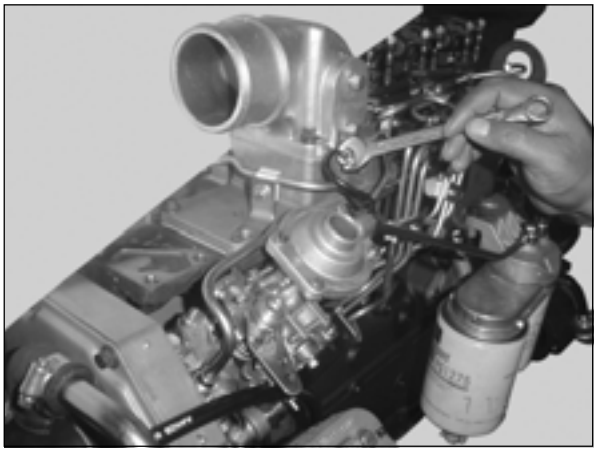




**12 mm and 13 mm**

Install the air fuel control tube.

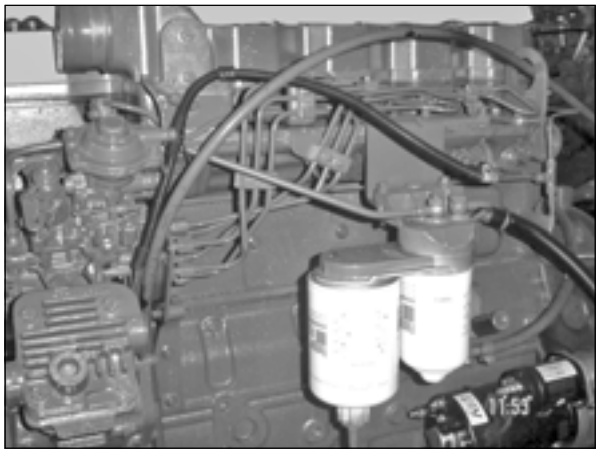
Use new sealing washers when installing the tube.



**KSB Installation**
**13 mm and 10 mm**

Install the remote mounted KSB valve.

**Torque Value:** 24 N•m



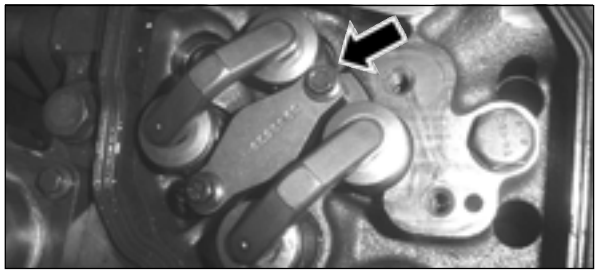
## Injector - Removal



After removing manifold cover gasket and diconnecting high pressure fuel lines remove HP connector to injector nozzle.



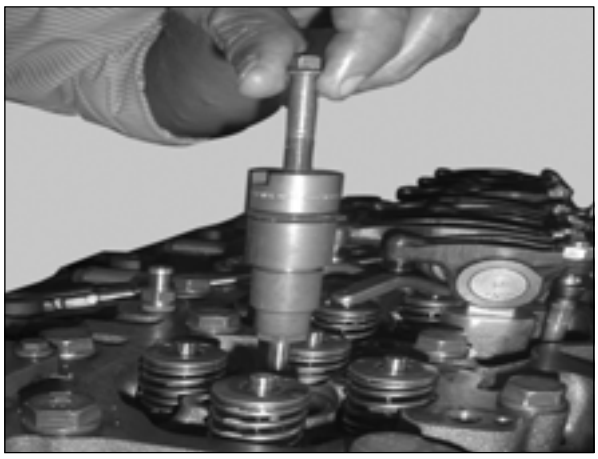
Remove screw hex flange head cap and injector clamp.



**Injector Puller**

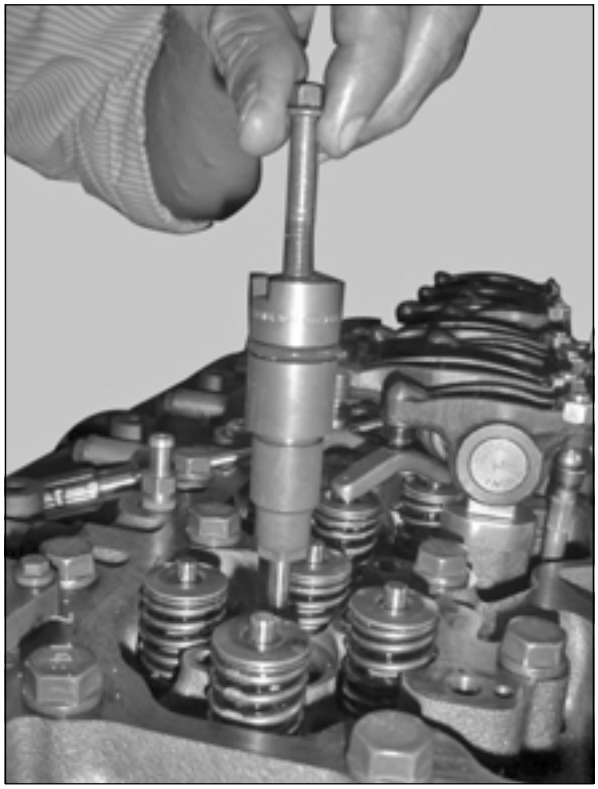


Remove the injectors



## Injector - Installation



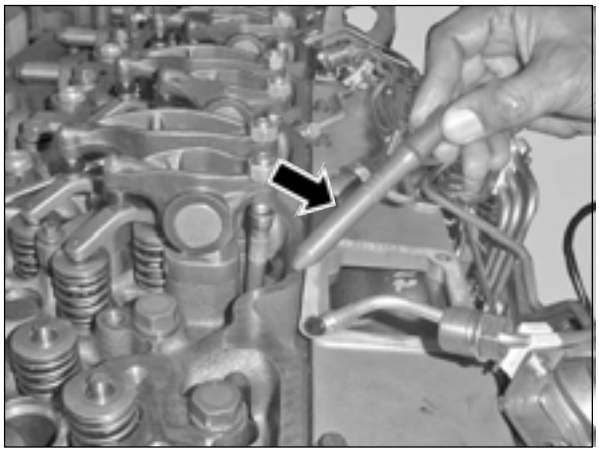


Apply a coat of anti-seize compound to the injector.

**NOTE :** Avoid getting anti-seize compound in the fuel drain hole.

Press injector nozzle into the nozzle hole in such a way that it aligns fitment of male connector.

Assemble HP male connector properly to match with injector nozzle hole.



**Note** : Orientation of inlet features of injector should be towards the HP connector.

Always replace HP connector when installing a new injector.

**Caution: Some sockets can damage the sealing surface of the fuel drain outlet.**









**10 mm deep well socket**

Place injector clamp so that clamp is centred on the injector.

Fit clamp injector and tighten M6 screw hex flange head.

**Torque Value :** 60 N•m

**Note** : Place injector completely using holding clamp to index injector.

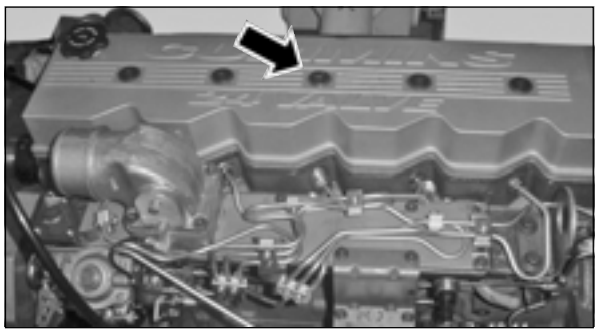
## Valve Cover - Removal





**10 mm**

Remove the special capscrews, isolator & valve covers.



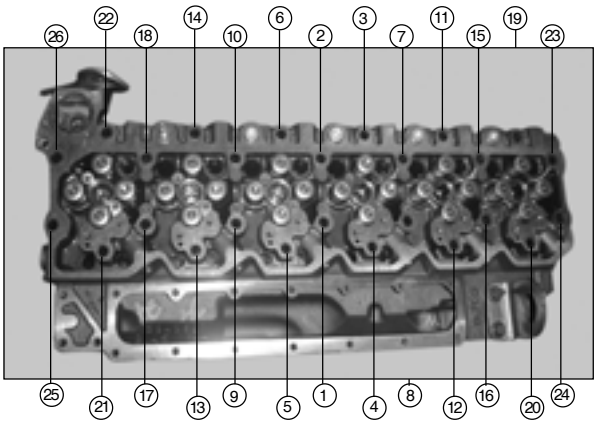
## Cylinder Head - Removal





**18 mm**

Remove the remaining cylinder head capscrews in the sequence shown.




Remove the cylinder head and gasket from the block.





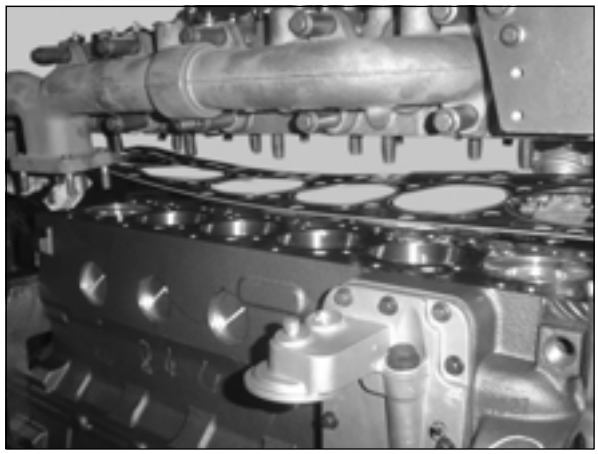


### Cylinder Head Torque

6 Cylinder- 9 Kg + 90 Deg.

**10 mm**

Remove the front cover and gasket.



**Note:** Tata Cummins BSII and BSIII Engine cylinder head gasket is different.

## Push Rods - Removal



Remove the push rods.



## Push Rods - Installation

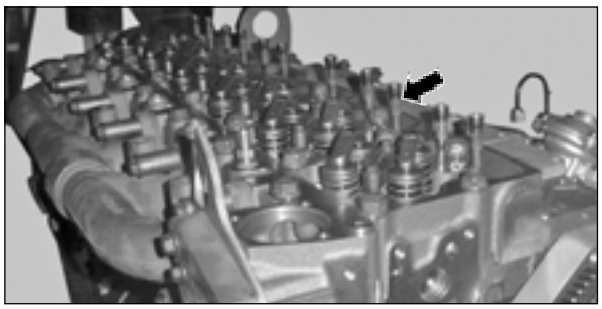


Position the push rods into the valve tappets.



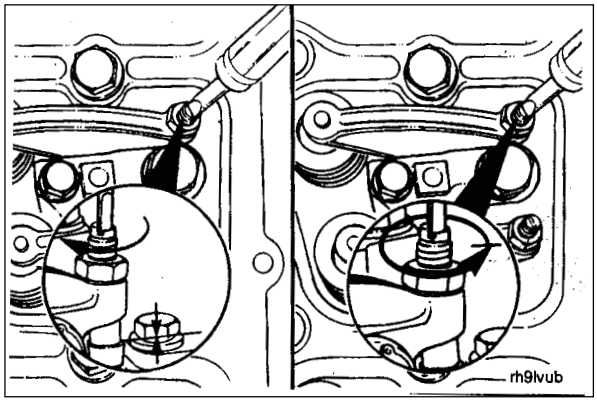
Lubricate the push rod sockets with engine oil.

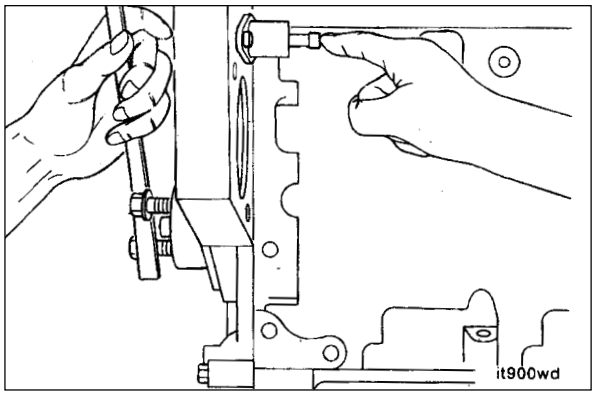




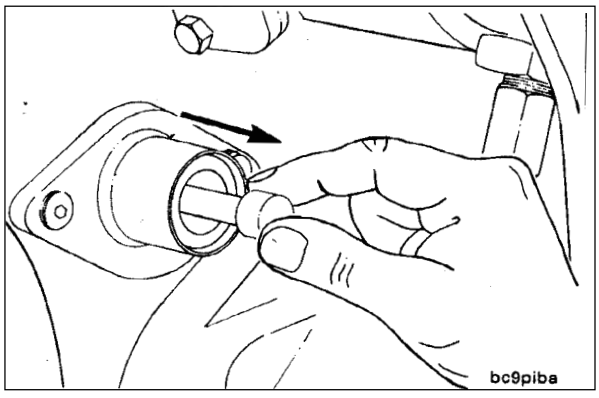
## Valve Clearance - Adjustment

Turn the valve adjustment screws in until they touch the push rod sockets. Loosen them one full turn.
Locate TDC for Cylinder Number 1.




Disengage the timing pin.



## Feeler Gauge

**Valve Stem to Rocker Lever Clearance**

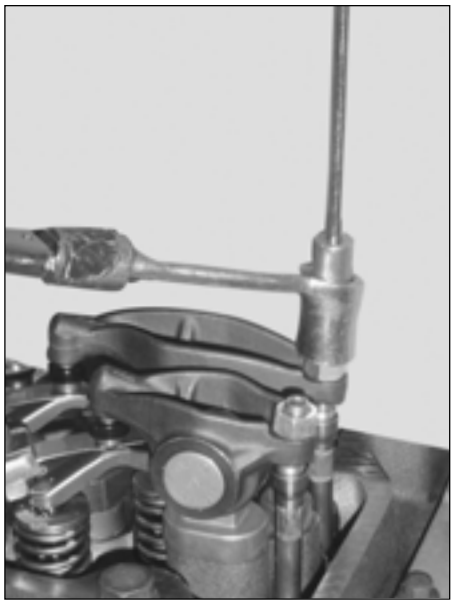
| Intake Valve | Exhaust Valve |
|---|---|
| 0.254 mm | 0.508 |

The clearance is correct when some resistance can be "felt" when the feeler gauge is pulled through the space between the valve stem and rocker lever.

Adjust the valves as indicated in the following illustrations. Tighten the locknuts and check the clearance again.

**Torque Value :** 24 N•m

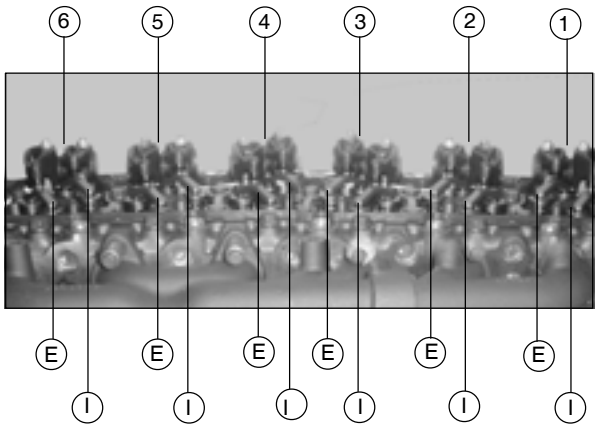
**Caution : Perform step A of the valve set procedure with Cylinder No. 1 at TDC compression stroke (timing pin will engage).**

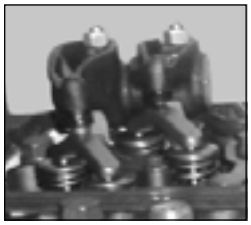


**Step A - Six Cylinder**

| | Valve | |
|---|---|---|
| Cylinder | I = Intake | E = Exhaust |
| 1 | * | * |
| 2 | * | # |
| 3 | # | * |
| 4 | * | # |
| 5 | # | * |
| 6 | # | # |

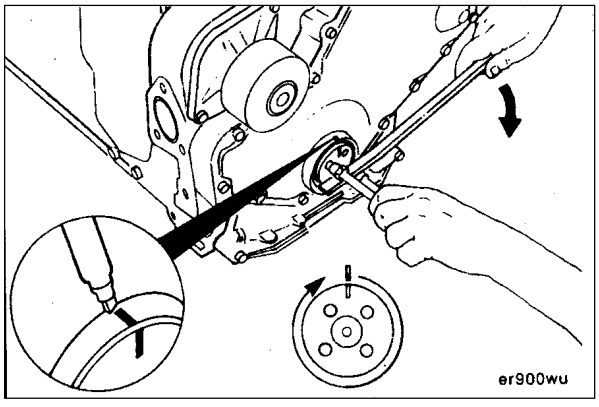
* = Set
# = Do not Set



**Perform Step B of the valve set procedure with Cylinder Number 1 at TDC plus 360 degrees (timing pin will not engage).**

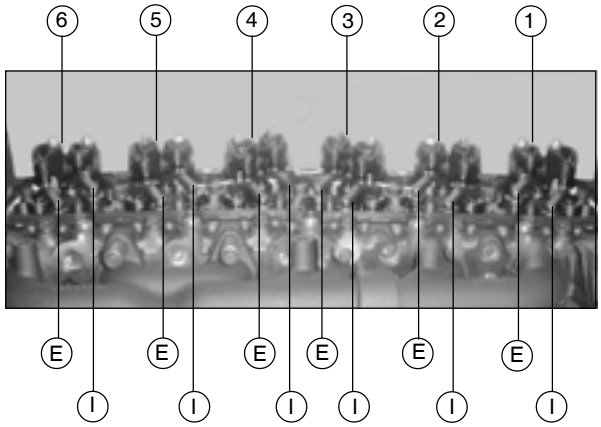
Mark the crankshaft and front cover. Rotate the Crankshaft one full turn.



**Step B - Six Cylinder**

| Cylinder | Valve I = Intake | E = Exhaust |
|---|---|---|
| 1 | # | # |
| 2 | # | * |
| 3 | * | # |
| 4 | # | * |
| 5 | * | # |
| 6 | * | * |

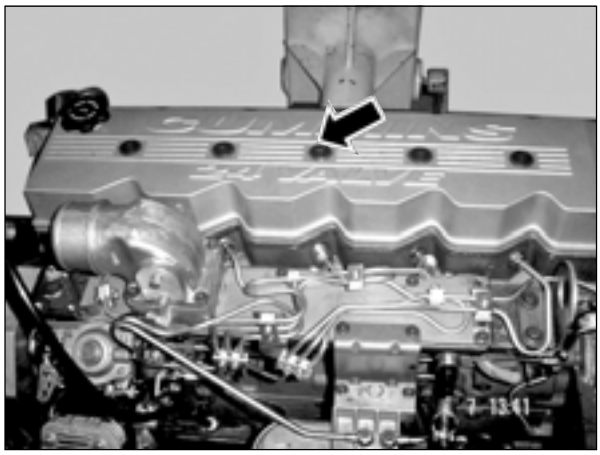
* = Set
# = Do not Set




## Valve Covers - Installation

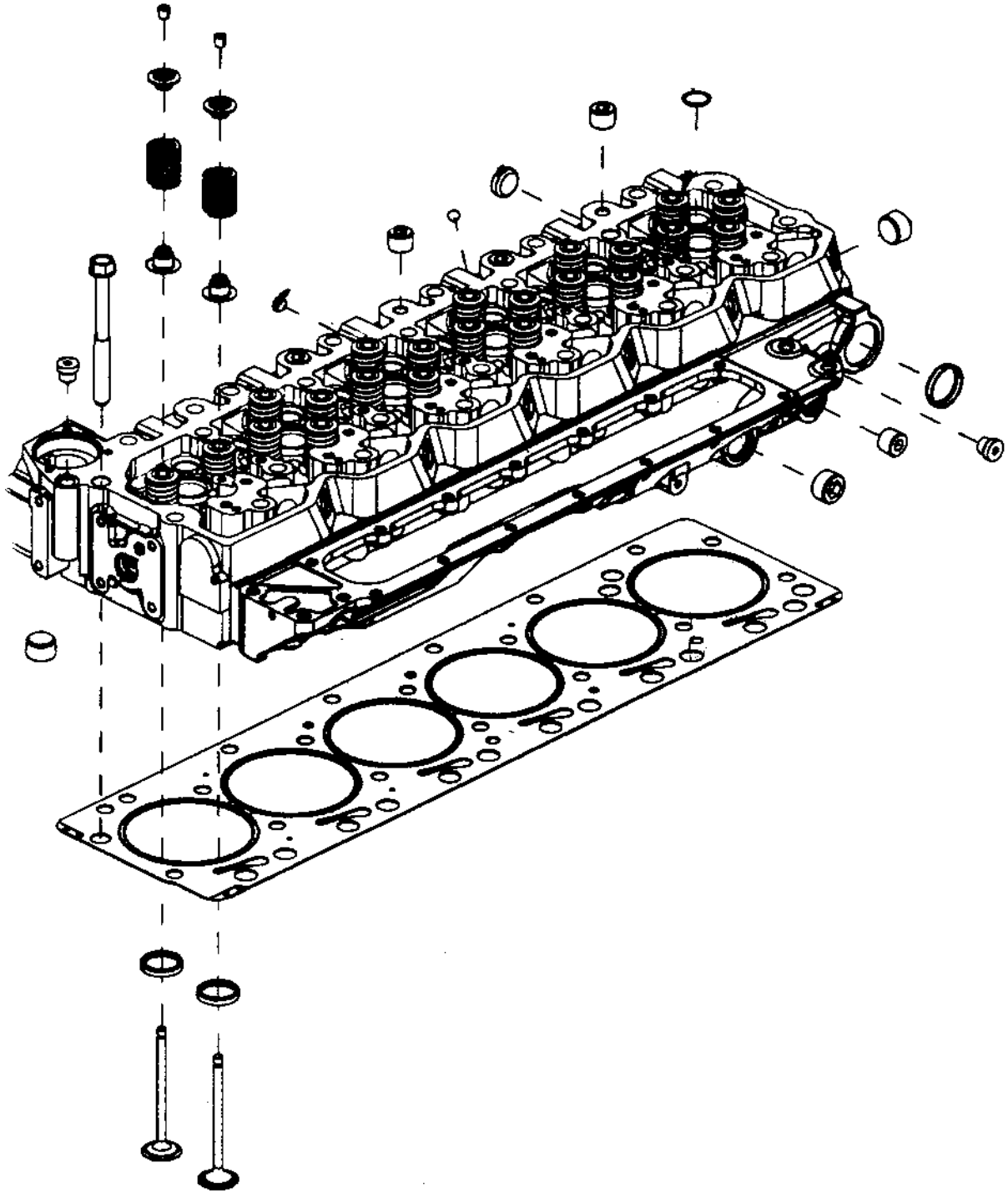
**16 mm**

Assemble the gaskets, valve covers, Isolator vibration, Plain washer and special, capscrews.



# Cylinder Head

## Exploded View

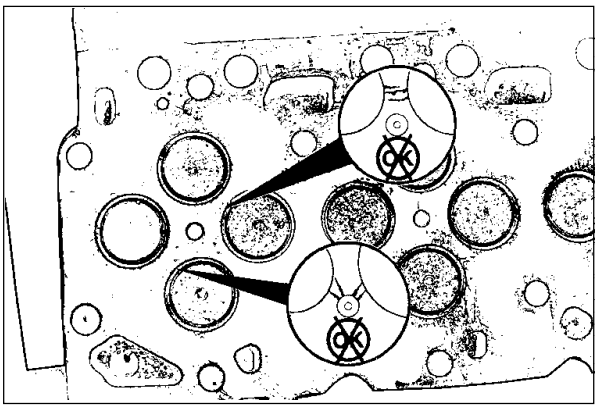


## Cylinder Head - Pre-check Before Disassembly

Clean the cylinder head with solvent.

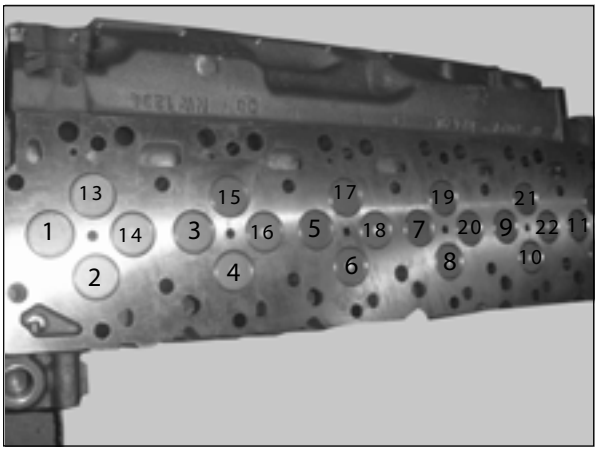


Visually inspect the cylinder head for obvious damage that would prohibit reuse. Check for cracks and damage to the combustion face that would result in loss of sealing.

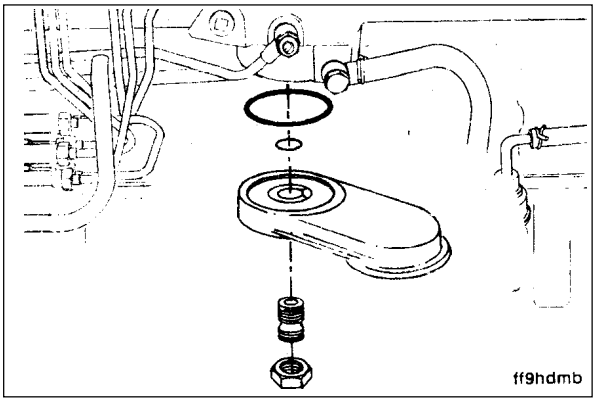


## Cylinder Head - Disassembly

Mark the valves to identify their position.




Compress the valve spring and remove the valve stem collets.

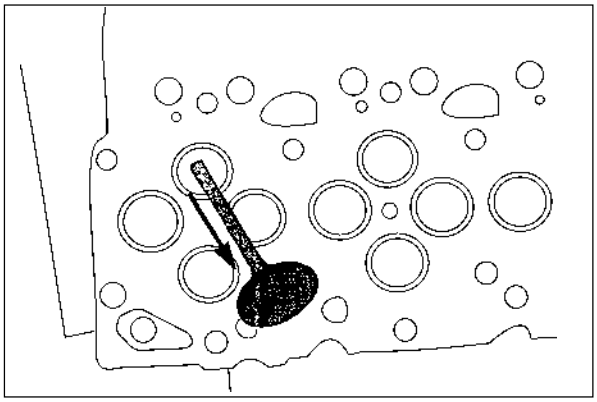


Release valve spring and remove the retainer and spring.

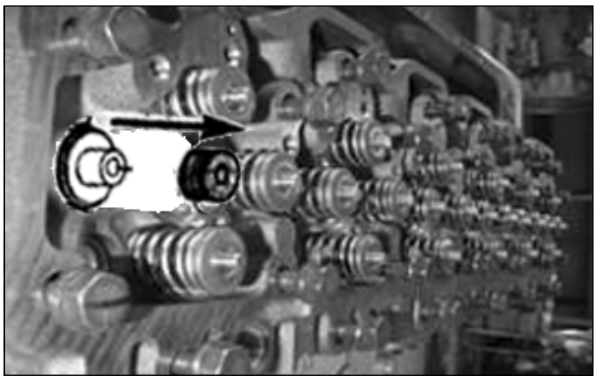


Remove the remaining collets, retainers, springs and valves.

**Keep the valves in a labeled rack for a correct match, with companion seats while making measurements.**

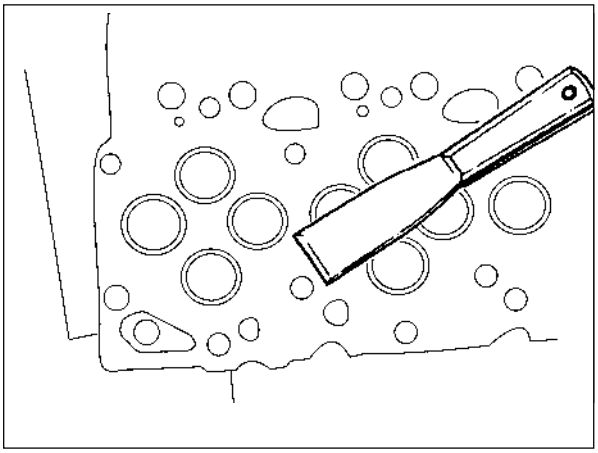


Remove the valve stem seals.



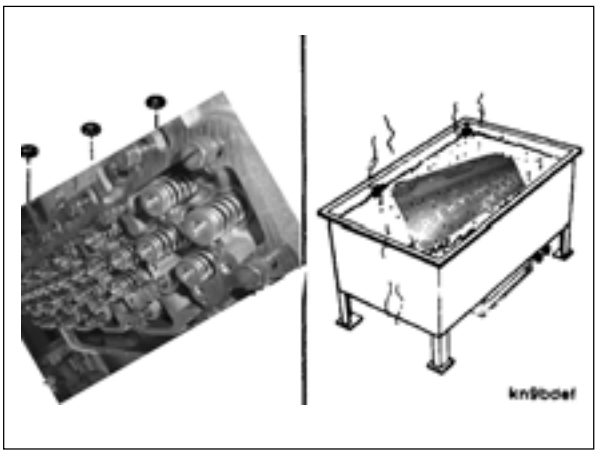
## Cylinder Head Cleaning

Clean the carbon from the injector nozzle seat.

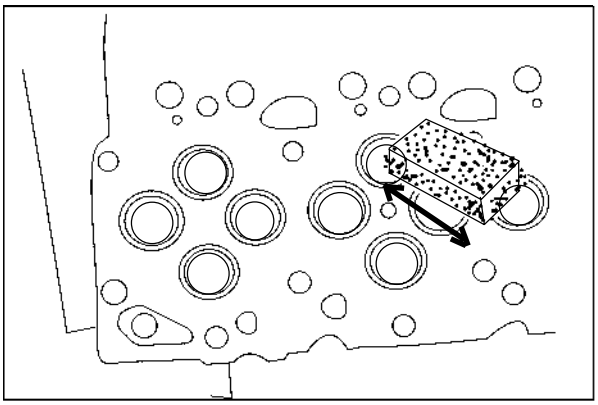


Scrape the gasket material from all gasket surfaces.

Clean the build-up of deposits from the coolant



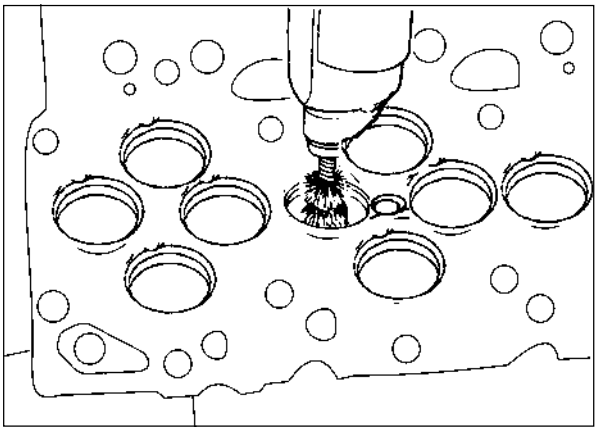
passages. Excessive deposits may be cleaned in an acid tank but the cup plugs must first be removed. Refer to Cup Plug Replacement procedure (2-10).



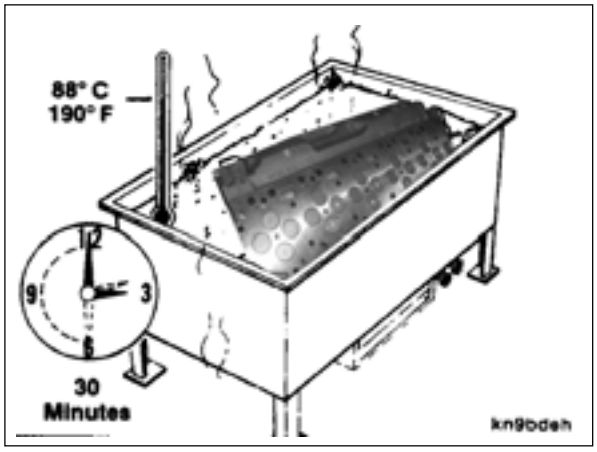
Clean the combustion face with a Scotch-Brite® pad or an equivalent cleaning pad and diesel fuel or solvent.

**Warning: Wear protective eye covering.**

Clean carbon deposits from the valve pockets with a high quality steel wire wheel installed in a drill or a die grinder.

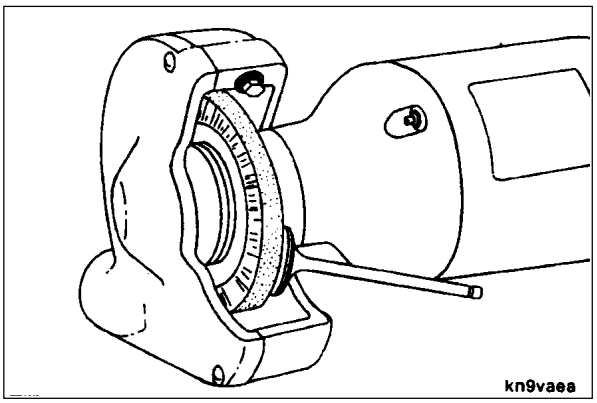


**NOTE :** An inferior quality wire wheel will loose steel bristles during operation, thus causing additional contamination.



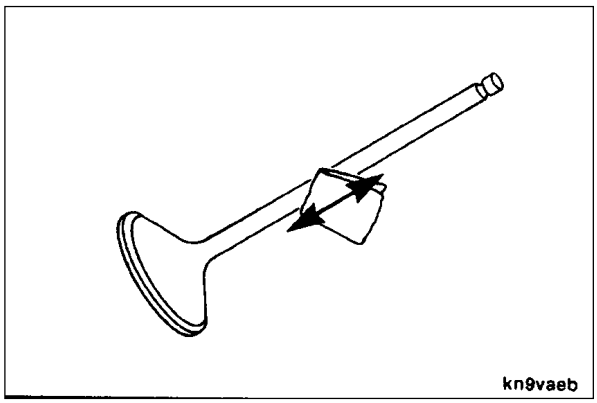

Wash the cylinder head in hot soapy water solution.

After rinsing, use compressed air to dry the cylinder head.




**Warning: Wear protective eye covering.**

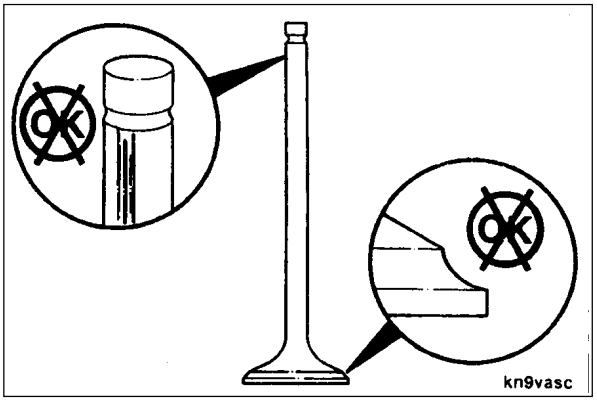
Clean the valve heads with a soft wire wheel.




## Valve - Inspection

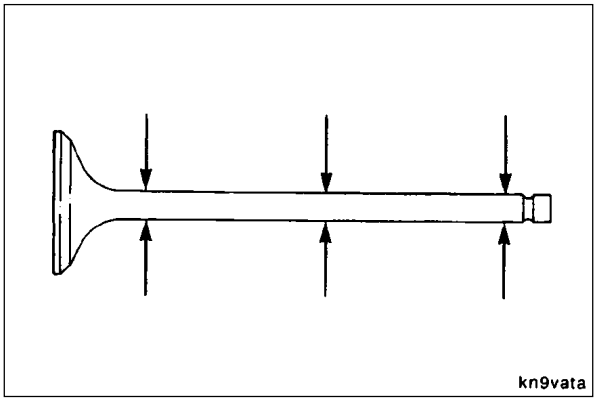
Inspect for abnormal wear on the heads and stems.

**Keep the valves in a labeled rack to prevent mixing prior to making measurements.**



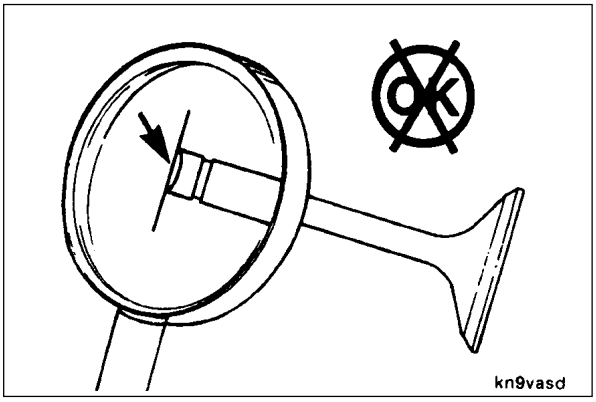
**Measure the valve stem diameter.**

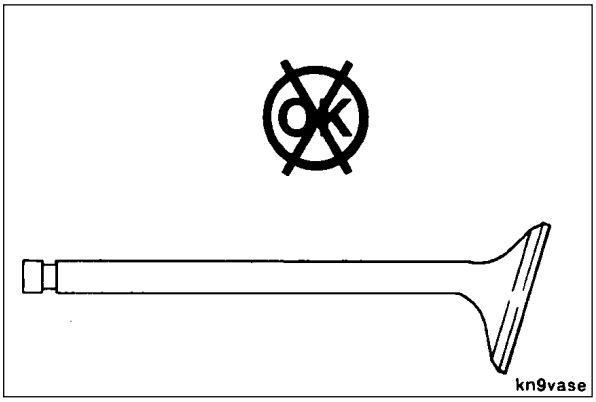
| Valve Stem Diameter | |
|---|---|
| **mm** | |
| 6.97 | MIN |
| 7.01 | MAX |




Check the valve stem tip for flatness.
Visually inspect for bent valves.

Polish the valve stem with a Scotch-Brites pad or equivalent cleaning pad and diesel fuel or solvent.



## Valve Guide Inspection

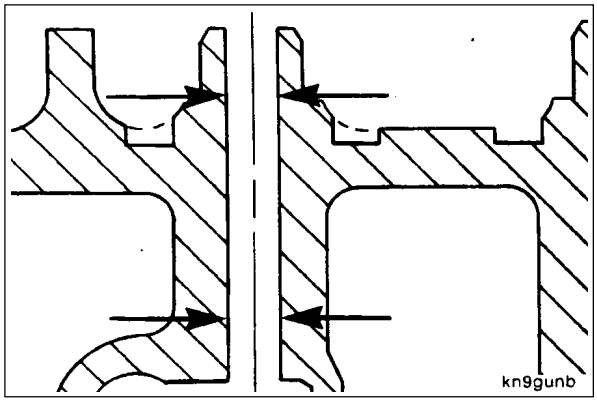
Inspect the valve guides for scuffing or scoring.

Measure the valve guide bore.

**Valve Guide Bore Diameter**

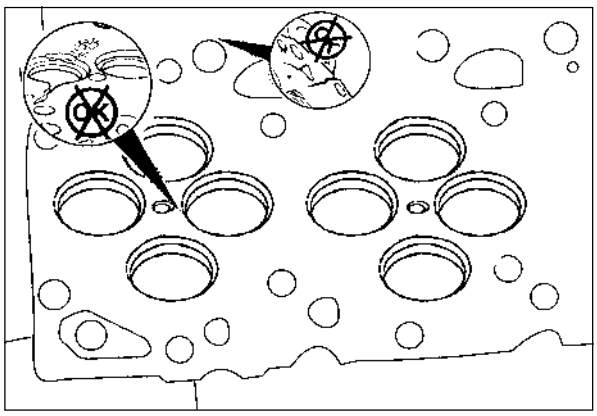
| **mm** | |
|---|---|
| 7.042 | MIN |
| 7.062 | MAX |

If the inspection reveals damaged valve guides, refer to the Alternative Repair Manual Bulletin No. 1150110003.




## Cylinder Head Combustion Face Inspection

Visually inspect the cylinder head combustion surfaces for any irregularities (dents, guttering, fire ring embedment, etc.). If any of these conditions exist, the surface must be machined in accordance with the appropriate procedure from the Alternative Repair Manual, Bulletin No. 115011 0003.

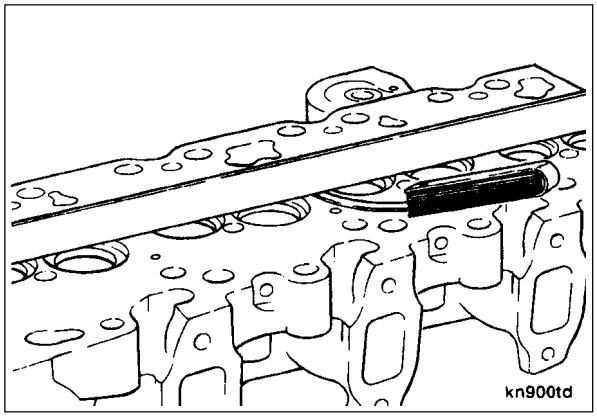


Measure the cylinder head overall flatness:

End-to-End 0.20 mm (6B)

Side-to-Side 0.076 mm

Visually inspect for any localized dips or imperfections. If present, the cylinder head deck must be reground.




## Repair Tools

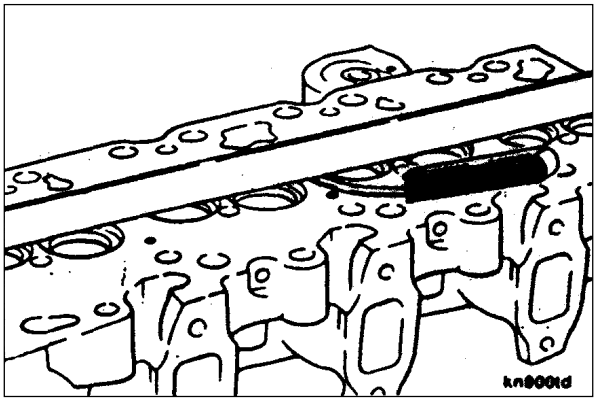
Valve Refacer

Valve Seat Grinder

Valve Guide Installation Tool

**NOTE :** The repairs can be performed with standard gasoline automotive tooling at engine repair shops

## Combustion Deck Inspection and Refacing



Inspect the head surface for nicks erosion etc.

Check for head distortion as illustrated

**Limit**

**Variation :** .010 mm in any given 50.8 mm diameter area. The overall end to end or side to side variation limit is :

0.30 mm - 6 cylinder

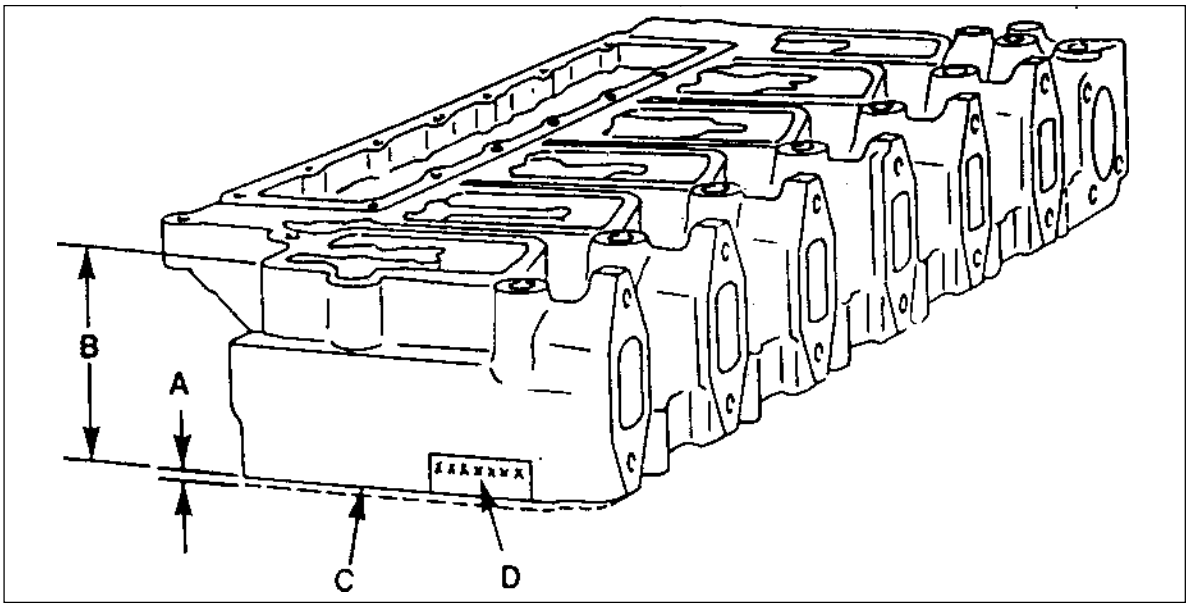
The combustion deck may be refaced in whatever increments necessary to clean up surface and maintain surface finish and flatness tolerancing as long as combined total of stock removal on all clean ups do not exceed 1.00 mm. Each amount of stock removed must be steel stamped just above edge of combustion deck on lower right and corner of rear face.

A = 1.00 mm total

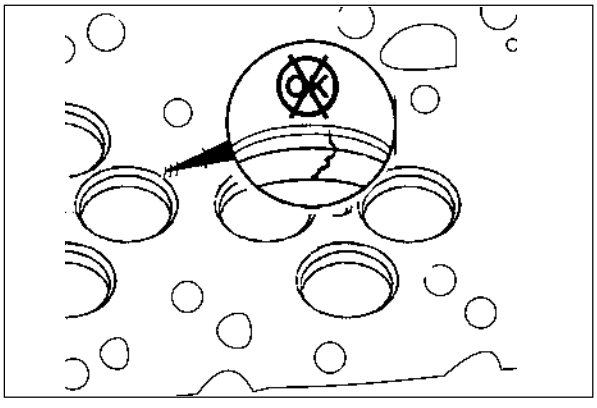
B = 94.00 ± 0.25 mm Minimum (reference only)

C = Surface finish 1.5 to 3.2 micrometers

D = Identification area for stamping amounts of stock removed




## Valve Seat Inspection

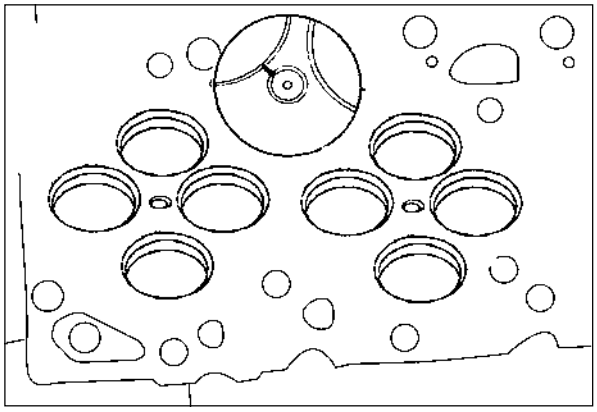


Inspect the valve seats for cracks or burned spots.

Refer to the following reuse guidelines for any cracks discovered. Service valve seats are available for seats with burned spots that will require more than 0.254 mm grinding to clean up.

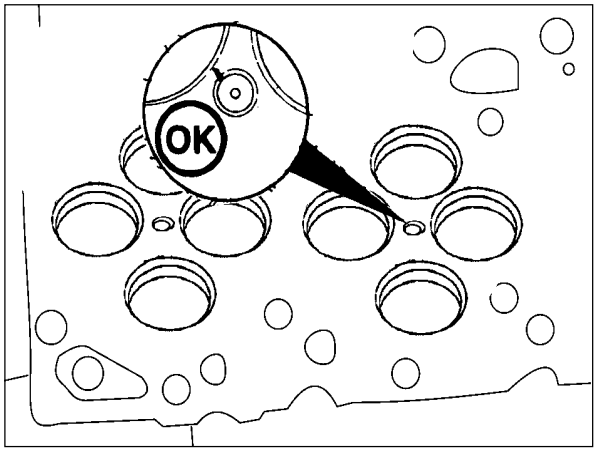
## Cylinder Head Cracks - Reuse Guidelines

These guidelines apply **only** to cracks extending through the valve seats.

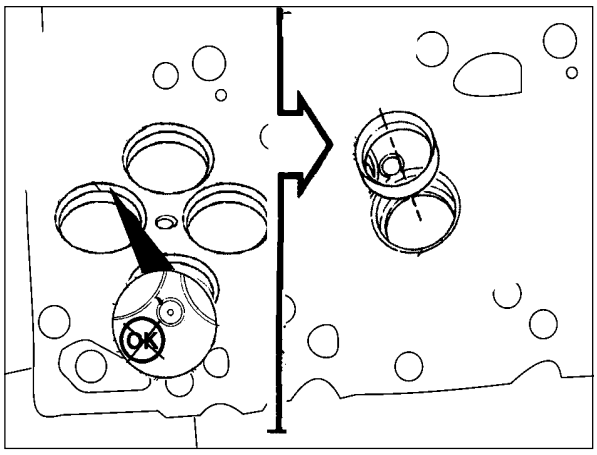


The reuse guidelines for a cylinder head with a crack extending from the injector bore to the valve seat is as follows:

If the cracks does not extend into the valve seat, the head is reusable.




If the crack extends into or through the valve seat, the head must be repaired by installing a valve seat insert as per the Alternative Repair Manual, Bulletin No. 1 5011 0003.




## Valve Spring Inspection

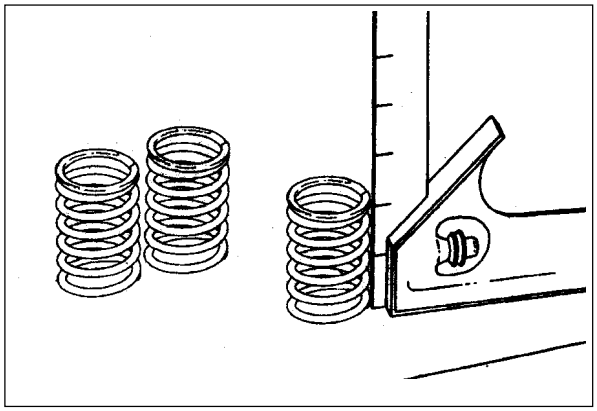
Inspect the Valve Springs.

Measure the valve spring.

**Limits**

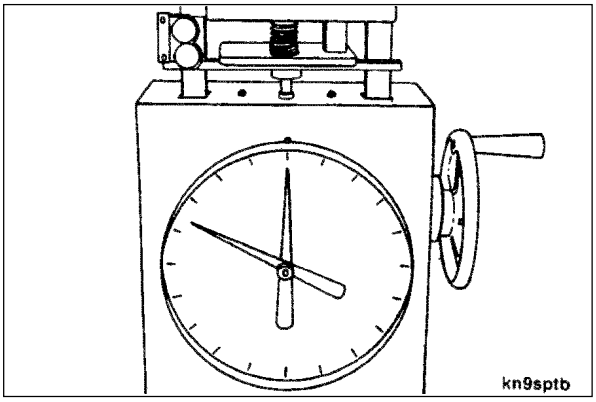
Approx. Free Length (L): 55.63 mm

Maximum Inclination : 1.0 mm



**Spring Specifications**

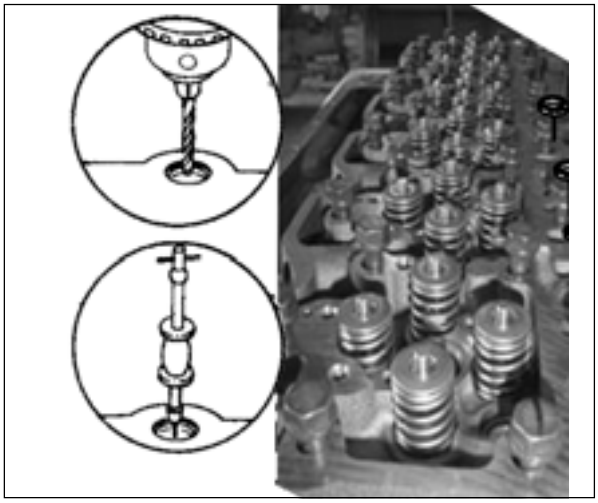
| Spring Color | Approximate Free Length | Load at 49.25 mm Height |
|---|---|---|
| Blue 55.63mm | | 289.13 to 321.16 N |
| White | 70.64mm | 643.2 to 691.2 N |




## Cup Plug Replacement

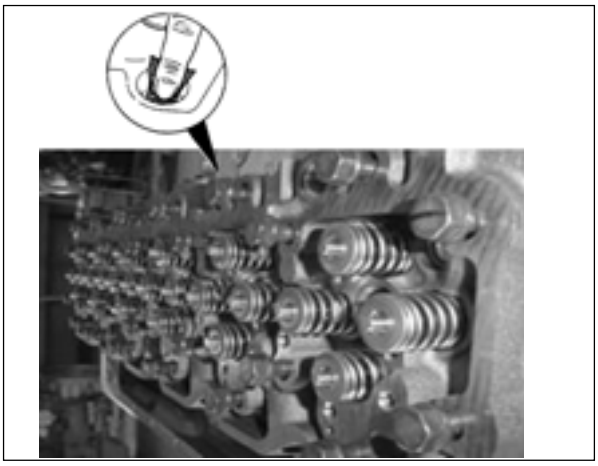
**Drill Motor, 3 mm [1/8 inch drill bit, slide hammer, #10 metal screw**

Remove the cup plugs from the cylinder head.



**400 grit sandpaper, Diesel Fuel**

Thoroughly clean the cup plug holes.

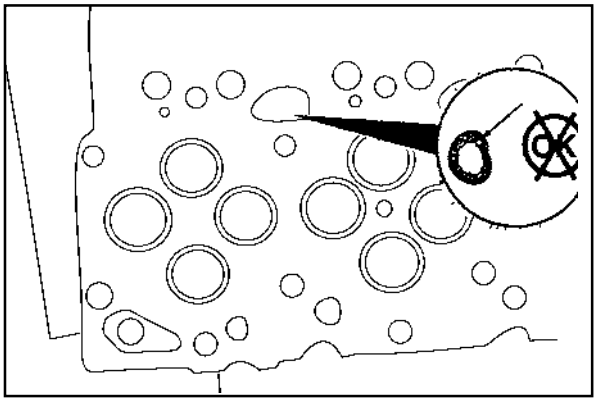


**Caution: Use protective clothing to prevent personal injury.**

Inspect for build-up of deposits in the coolant passages which can cause engine overheating.

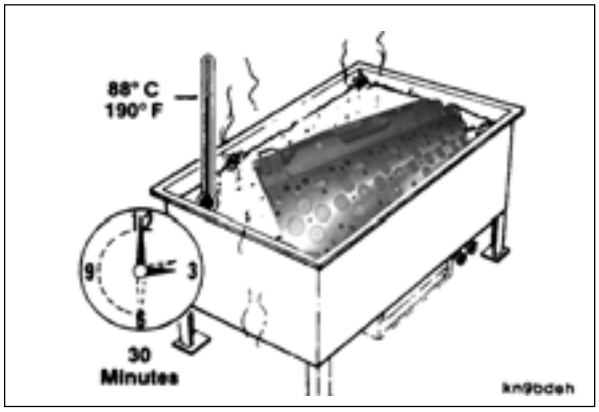
Be sure the coolant passages are clean.

Excessive deposits may be cleaned in an acid tank, but the cylinder head must be disassembled first.



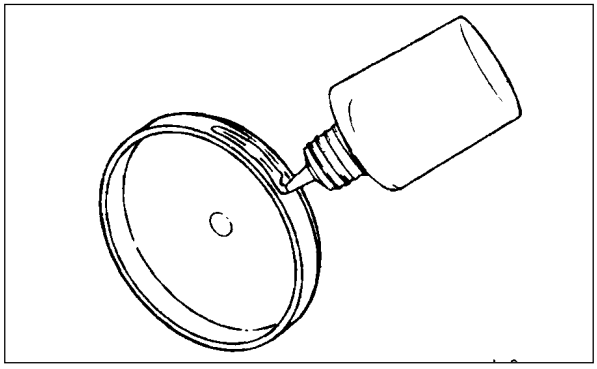
**Caution: Use protective clothing to prevent personal injury.**

The cylinder head may be cleaned in a hot tank using a soap and water solution.



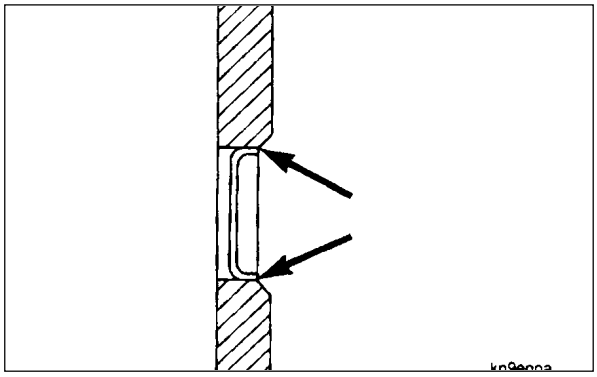

**NOTE:** The cup plugs and cup plug holes must be clean and free of oil before installing the cup plugs.

Apply a bead of Locate™ 277 around the outside diameter of all cup plugs before installing.



**Cup Plug Driver**

Drive all cup plugs in until the outer edge is flush with the counter sink.



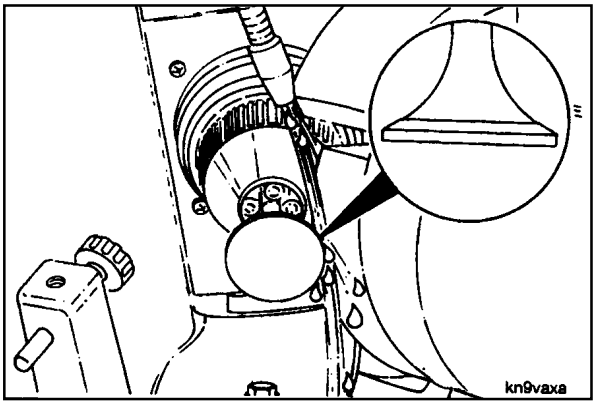


**Cup Plug Locations**

1. 13/16 inch

## Valves - Grinding

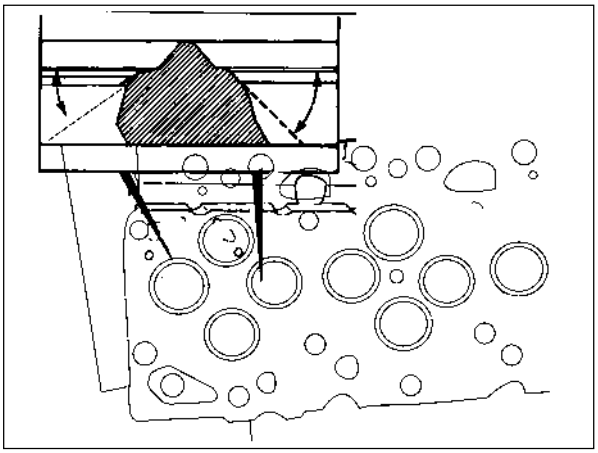
Re-face all reused valves. Check/replace bent valves.




**Seat Angle**

**Intake :** 30 Degrees

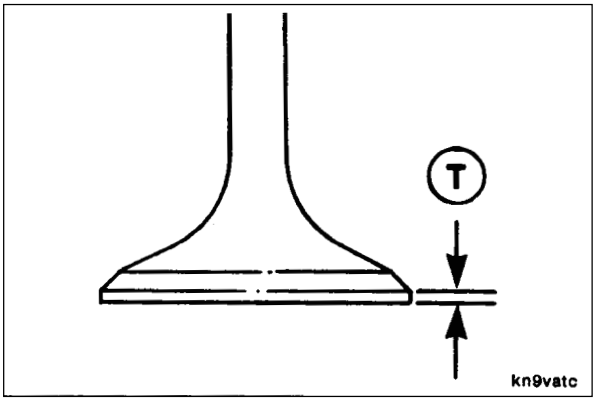
**Exhaust :** 45 Degrees



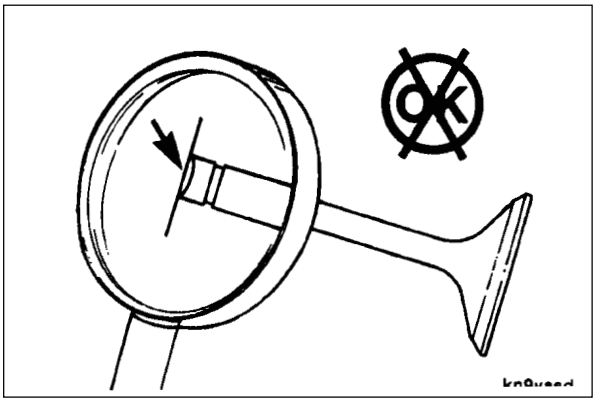
Measure rim thickness.

**Valve Rim Thickness**

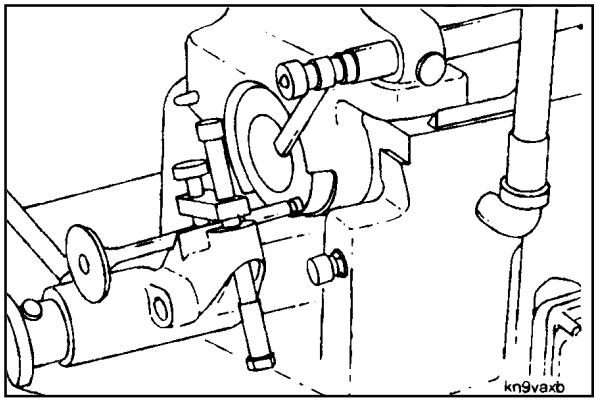
**Minimum (T) :** 0.79 mm




Check the valve stem tip for flatness.



If required, re-surface the tip.

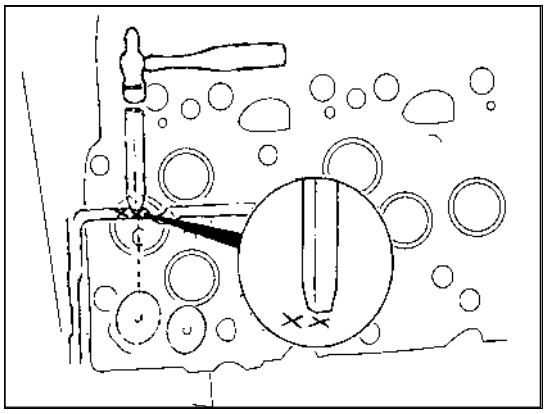



## Valve Seats - Grinding

The illustrated marks indicate valve seats have been ground previously. Additional grinding will result in grinding past the induction hardened area.

Replace previously re-ground seats will with service seats.

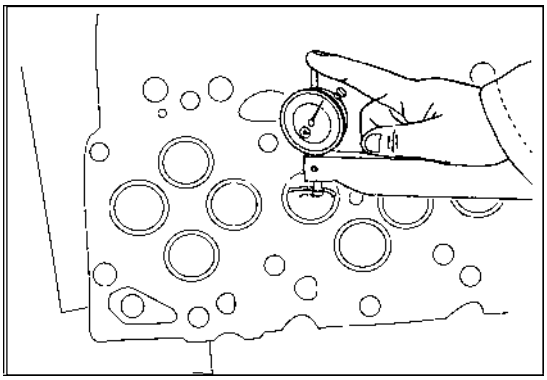
Refer to the Alternative Repair Manual, Bulletin No. 115011 0003.



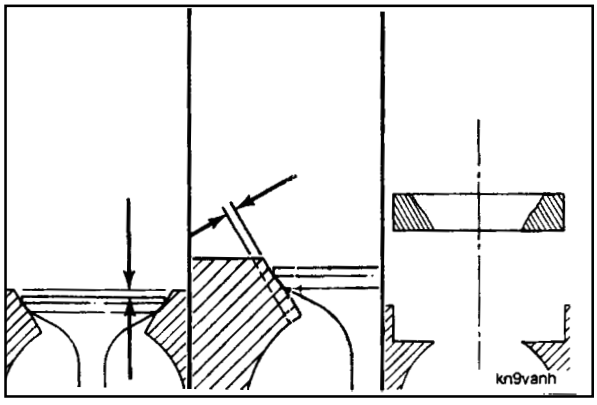
### Calculating the Grinding Depth

#### Measuring the Valve Depth

install the valves in their designated location and measure the valve depth.



There are two valve seat parameters that are critical to the valve grinding process. The first is to comply with the valve depth limits and the second is to not grind through the hardened layer of the valve seat by observing the grind depth limit. If either of these parameters are out of specification, refer to the 'alternative Repair Manual," Bulletin No. 1150110003.

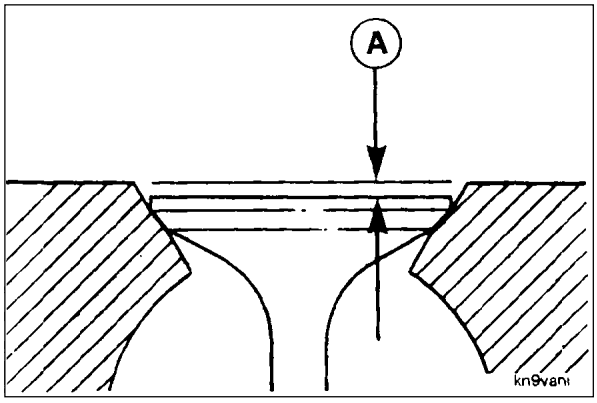


The valve depth is the distance from the valve face to the head deck.

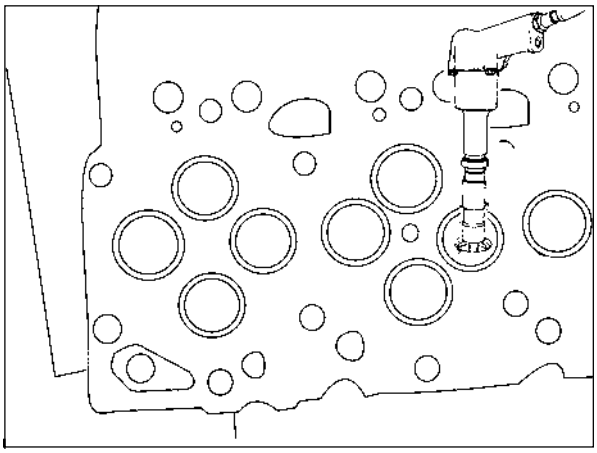
Record the depth of each valve as (A).

| Valve Depth | |
|---|---|
| 0.99 mm | MIN |
| 1.52 mm | MAX |

If valve depth does not meet specification the valve seat must be replaced.



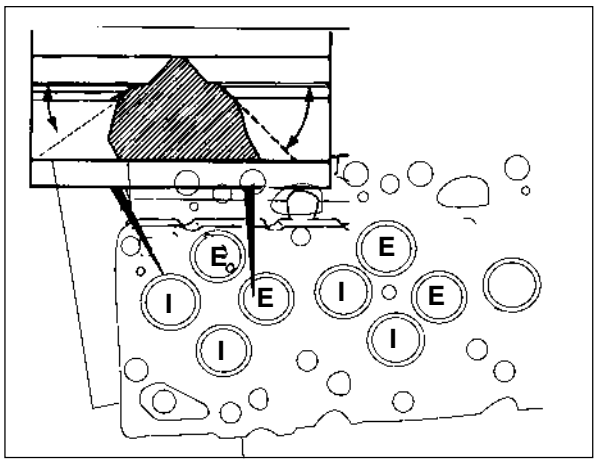

After valves meet initial valve depth criteria, grind the valve seats to remove all scores, scratches and burns.



**Seat Angle**

**Intake :** 30 Degrees

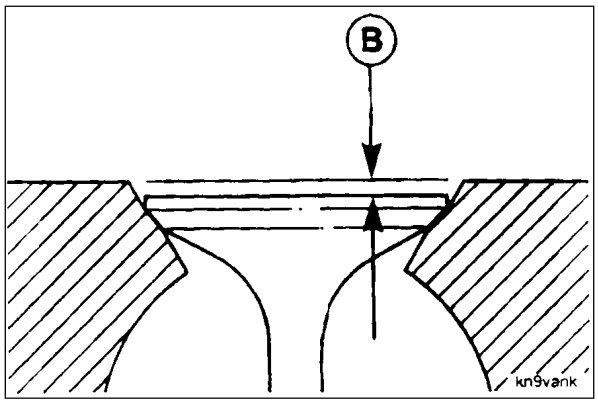
**Exhaust :** 45 Degrees




Since the seats have been ground, it is necessary to re-measure the valve depth and to calculate the grinding depth.

Install the valves in their respective bores and measure the depth. Record the depth of each valve as (B).

**Make sure the seats are clean before you measure the depth.**



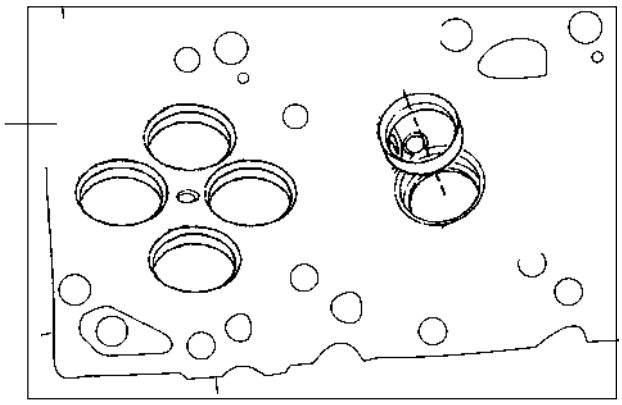
Calculate grinding depth (GD) as follows:

G D = (B) -(A)

**Seat Grinding Depth Limit**

GD: 0.254 mm

Service valve seats are available for over the limit seats.

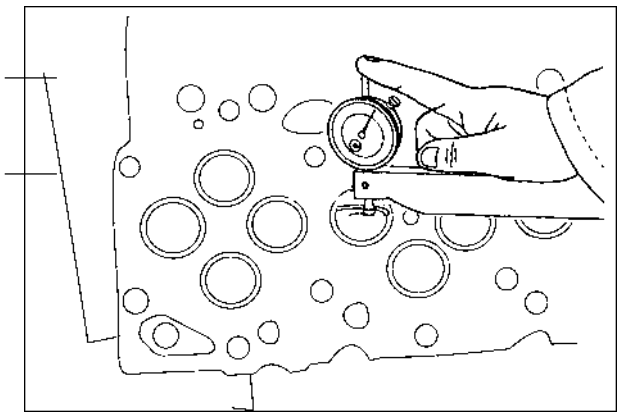


Confirm that the valve depth after grind (B) is still within the original specification.

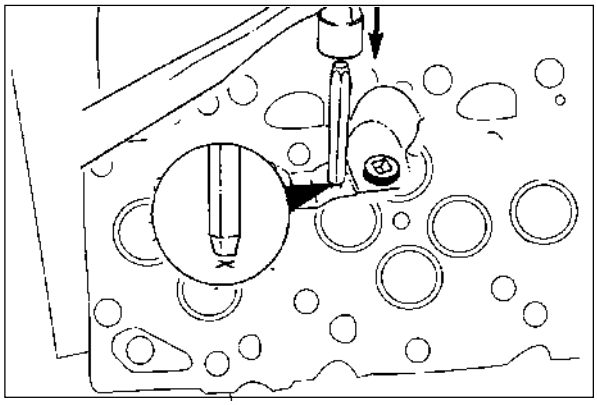
**Valve Depth**

Compress the valve spring after assembling the spring and retainer.

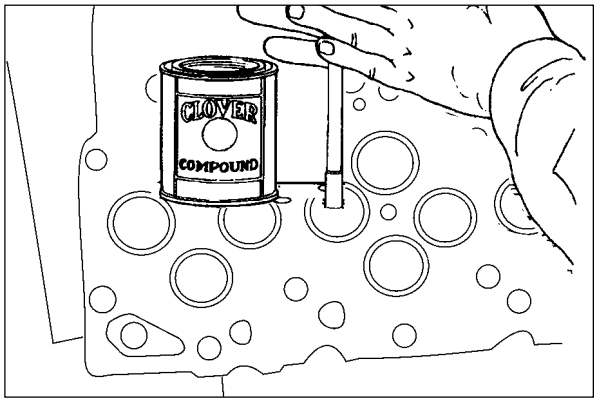
Install new valve collates and release the spring tension.



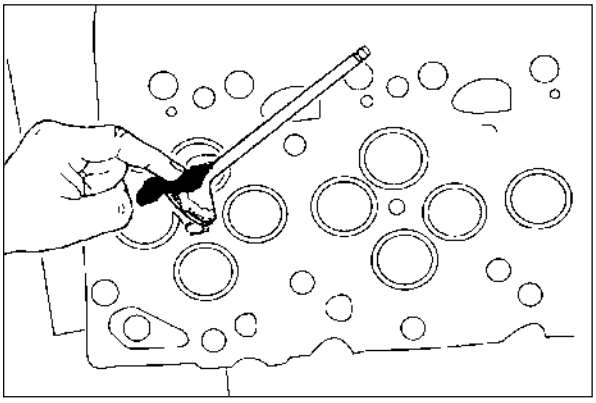
Mark the cylinder head with an (X) to identify each reground valve seat.




Apply a light coat of valve lapping compound to each valve and lap each valve to its companion seat.

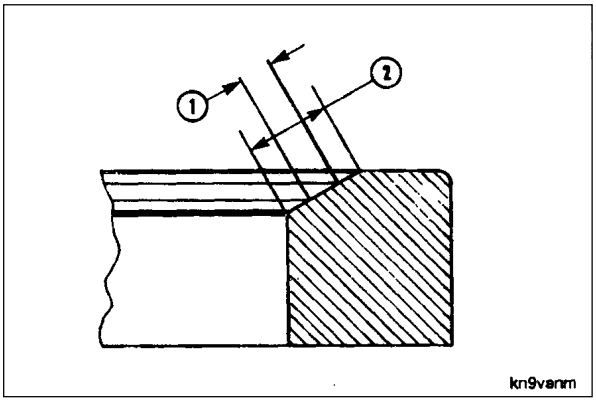


Remove the valves and clean the lapping compound from the valves and seats.



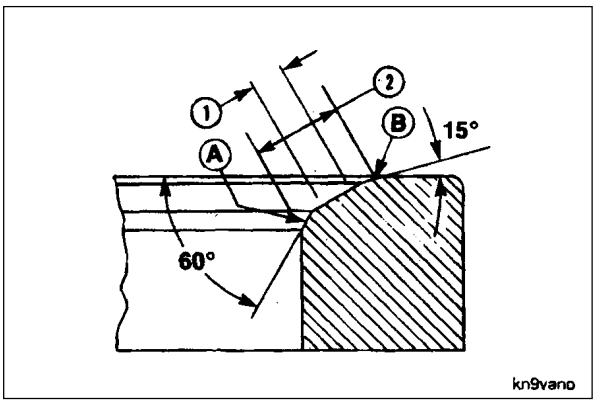
The valve should seat in the center of the valve face. Measure the valve seat width indicated by the lapped surface.

| Valve Seat Width Limit | |
|---|---|
| 1.5 mm | MIN (1 ) |
| 2.0 mm | MAX (2) |



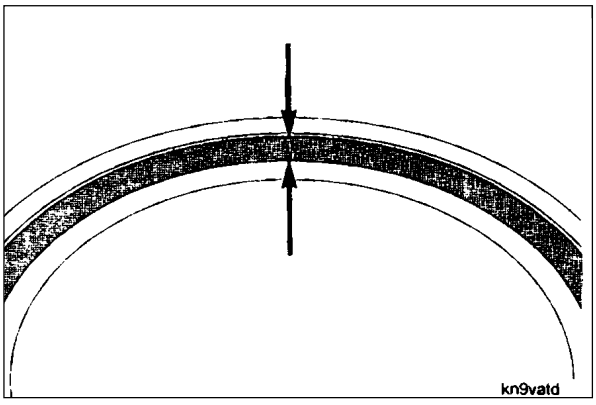

Grind area (A) with a 60 degree stone and (B) with a 15 degree stone to center the seat on the valve face and obtain the valve seat width limits.

| Valve Seat Width Limit | |
|---|---|
| 1.5 mm | MIN |
| 2.0 mm | MAX |

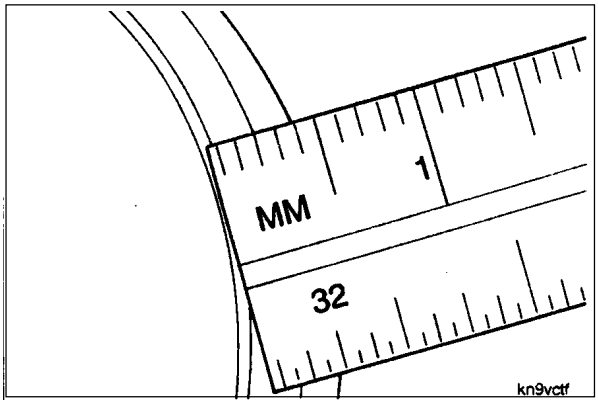



The lapped surface on the valve face is the key to determining how much of each angle to grind.

If the lapped surface is at the bottom of the valve face, the seat will require more grinding with the 60 degree stone than with the 15 degree stone.



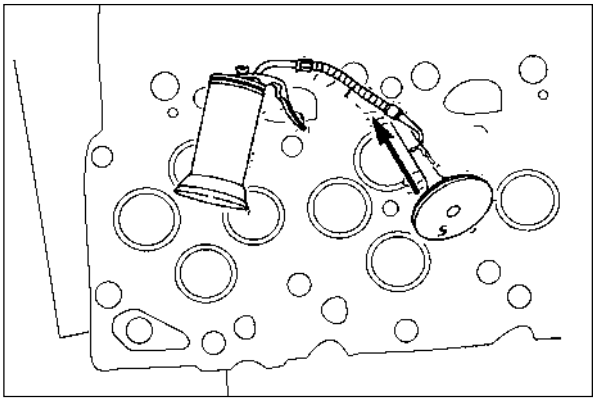
If the lapped surface is at the top of the valve face, the seat will require more grinding with the 15 degree stone than with the 60 degree stone.



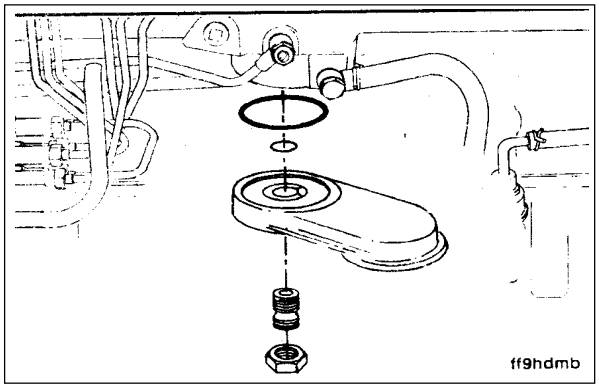

After centering the seat on the valve face, coat the valve face with Dykem™ Steel Blue™ and allow to dry.



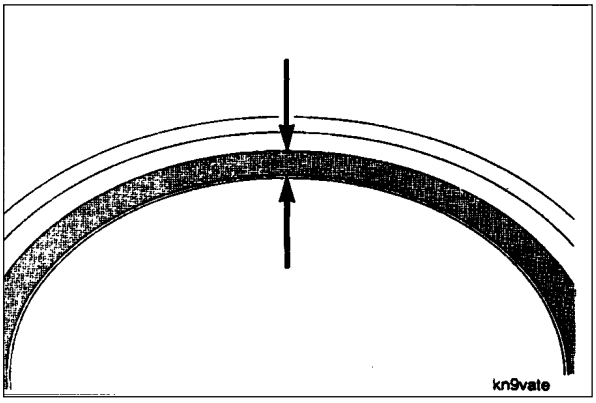
Apply a coat of valve lapping compound to the valve and lap the valve to its companion seat.



Remove the valve and clean the lapping compound from the valve face and seat.



Inspect the valve face for seat width and centering.




| Valve Seat Width | | |
|---|---|---|
| Intake | 1.79 ± 0.30 mm | MIN |
| Exhaust | 2.1 ± 0.30 mm | MAX |

## Installing Service Valve Seat (s)

If it is necessary to install guides, install the valve guides before installing the service seats.

**Intake valve insert pocket machining. (Valve Insert Part No. 3906854)**

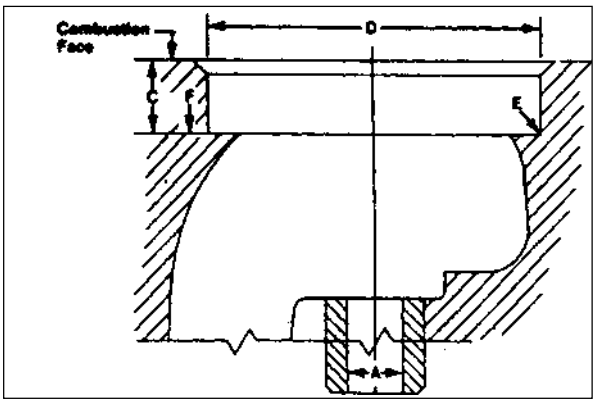
A = 7.052 ± 0.010 mm

C = 8.2 ± 0.0.90 mm

D = 34.85 ± 0.013 mm diameter

E = 0.79 ± 0.1 mm radius maximum

F = 3.2 micrometers surface finish




## Exhaust Valve Insert Pocket Machining (Valve Insert Part No. 3904105)

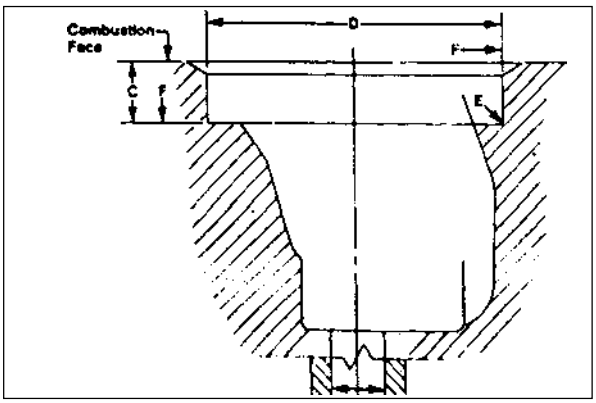
A = 7.052 ± 0.010 mm diameter

C = 8.2 ± 0.09 mm

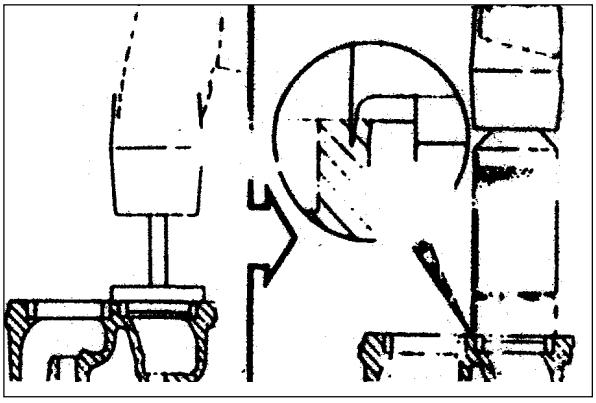
D = 34.85 ± 0.013 mm diameter

E = 0.79 ± 0.10 mm radius maximum

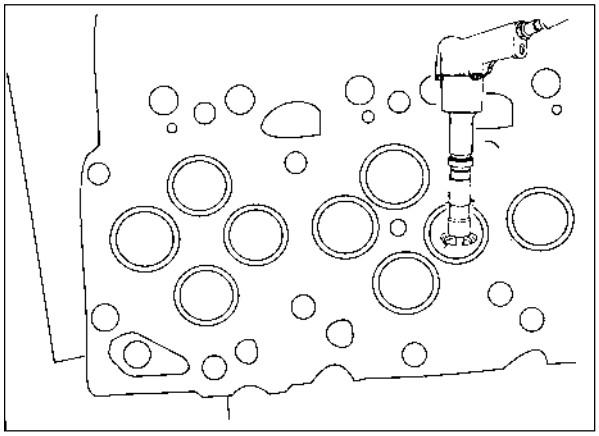
F = 3.2 micrometers surface finish



Press Service seals into machined pockets
Take the valve seats into the pockets.



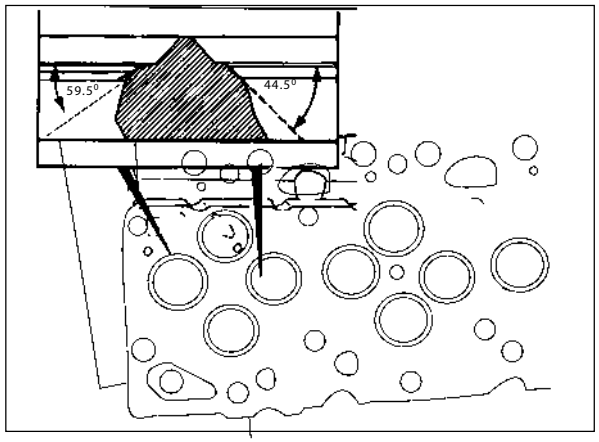
Grind the valve seats lightly to ensure proper seat angle.



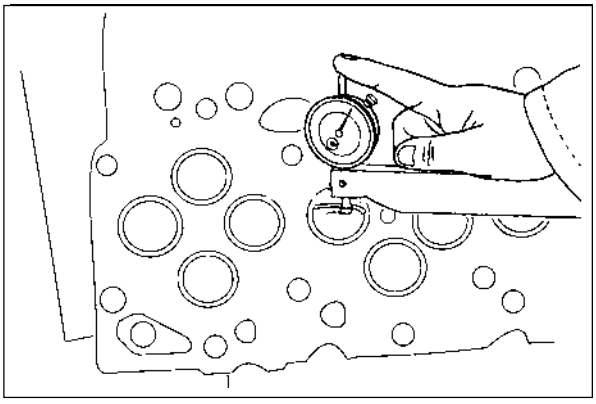
**Seat Angle**

**Intake :** 59.5$^0$ Degrees

**Exhaust :** 44.5$^0$ Degrees

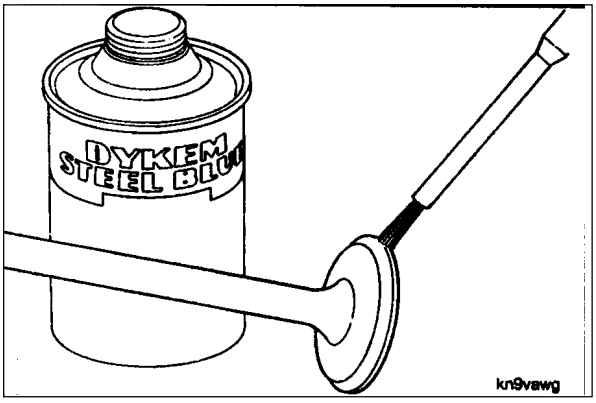



Install the valves in their designated location and ensure the depth



## Cylinder Head - Assembly





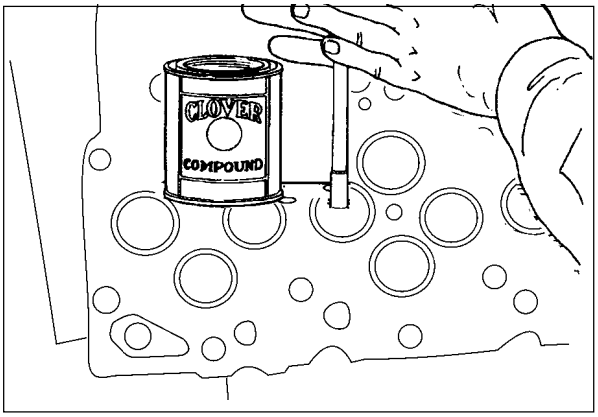

**NOTE :** Clean all cylinder head components before assembling.

Install the valve stem seals.

The intake and exhaust seals are the same.



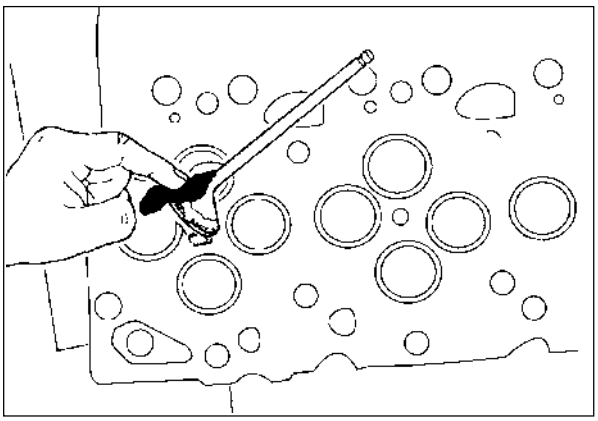





Lubricate the stems with SAE $90^0$ engine oil before Installing the valves.

**Valve Spring Compressor**

Compress the valve spring after assembling the spring and retainer.



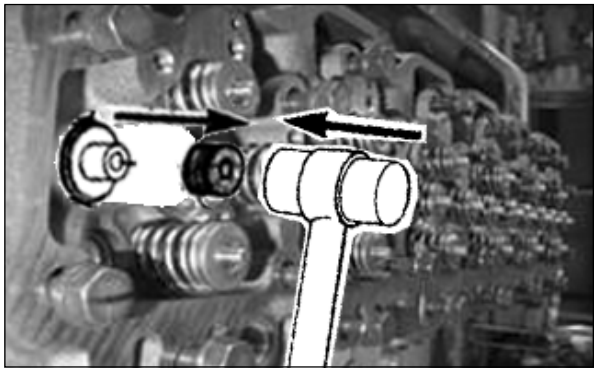
Install new valve collates and release the spring tension.



**Plastic Hammer**

**Warning: Wear eye protection. If the collets are not correctly installed, they can fly out when the stems are hit with a hammer**

After assembly, hit the valve stems with a plastic hammer to make sure that the collets are seated.



## Cylinder Head - Installation

**Caution : Make sure the cylinder head and block surface are clean and not nicked or gouged.**

**Mallet**

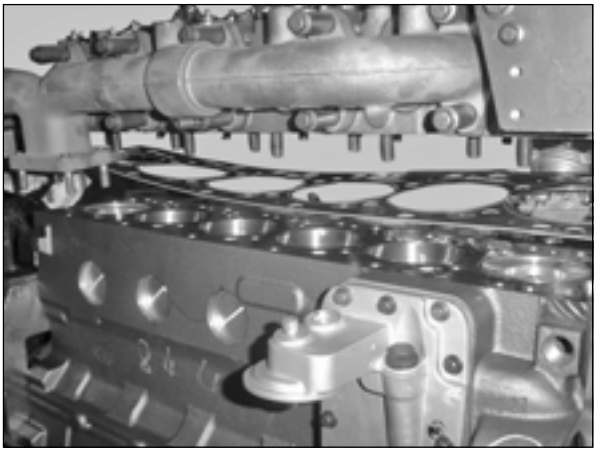
If removed, install the two cylinder head dowels. Drive the dowels to the bottom of the dowel bore.

**Caution: Make sure the gasket is correctly aligned with holes in the block.**

Position the head gasket over the dowels.



Carefully put the cylinder head on the block and seat it onto the dowels.

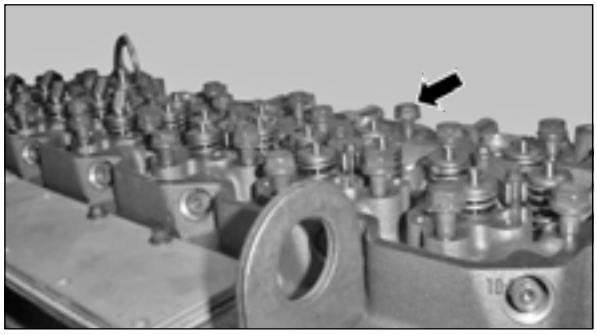


## Cylinder Head - Tightening

Lubricate the 12 mm pedestal/head capscrew bolt threads and under the capscrew heads with engine oil.

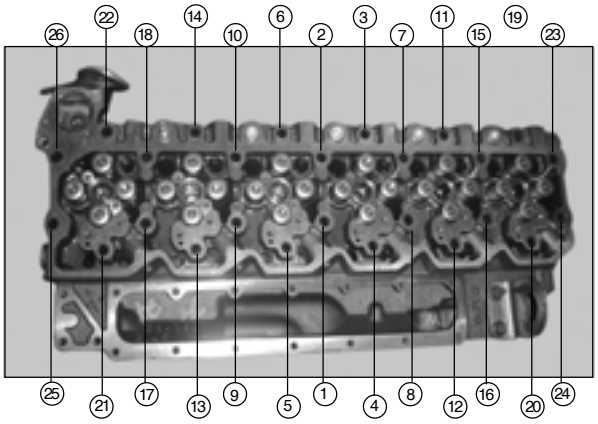
Install the capscrews finger tight.
Lubricate the threads and under the heads on the remaining head capscrews with engine oil.

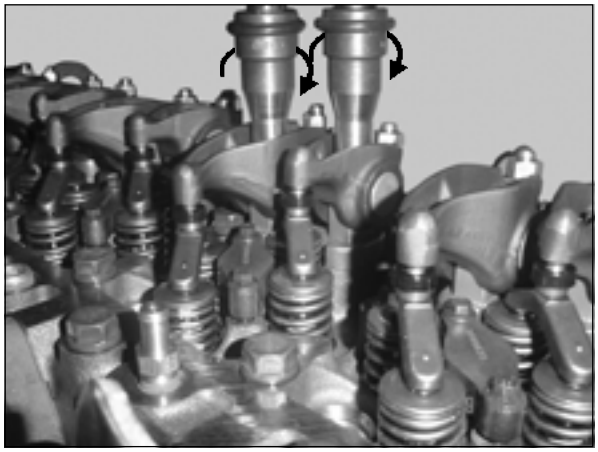
Install the capscrews finger tight.



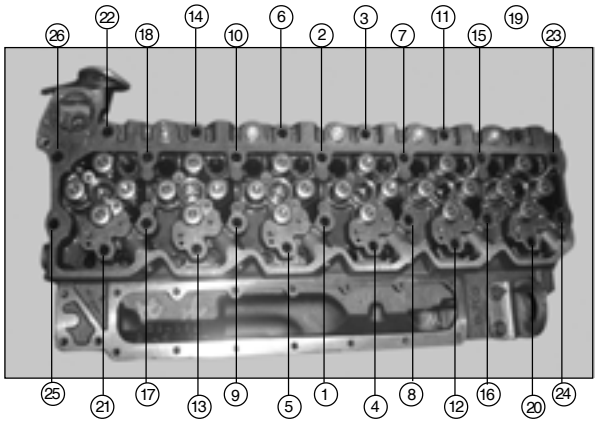
Use the illustrated sequence to tighten the cylinder head capscrews.

Follow the numbered sequence as shown above and tighten all capscrews to 90 Nm.

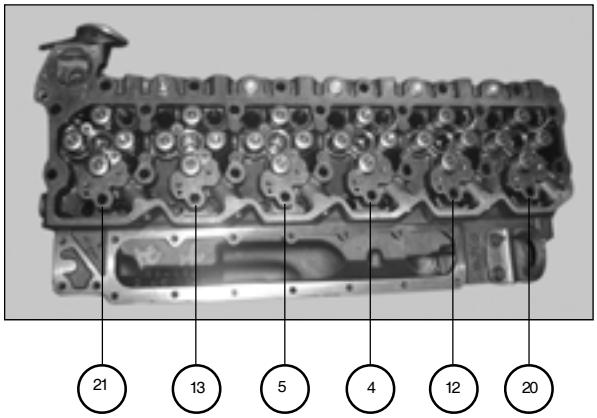


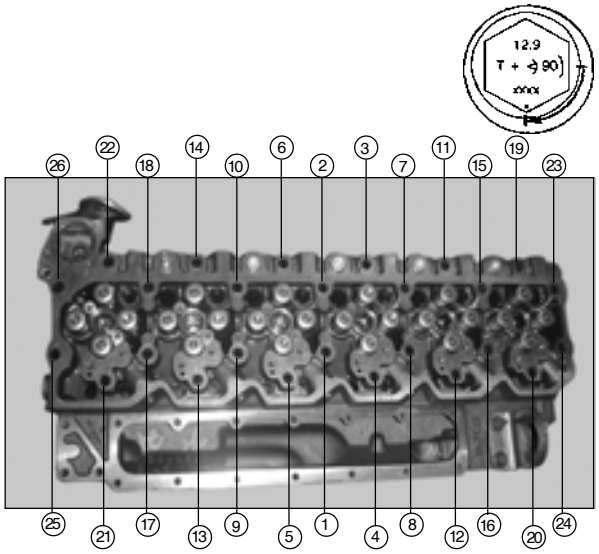
Follow the numbered sequence and recheck the torque on all capscrews to 90 Nm.



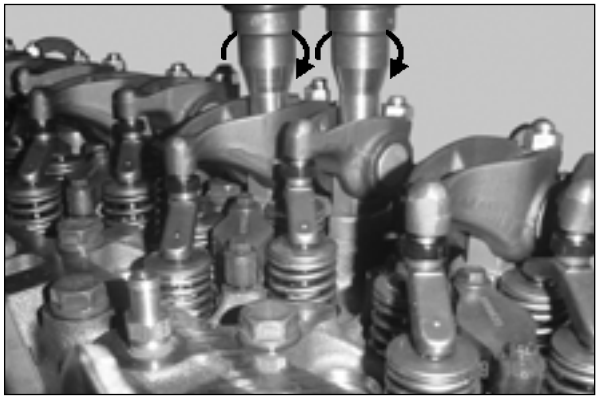
Follow the numbered sequence and tighten ONLY THE SIX CAPSCREWS (No. 4, 5, 12, 13, 20, 21) to 120 Nm.



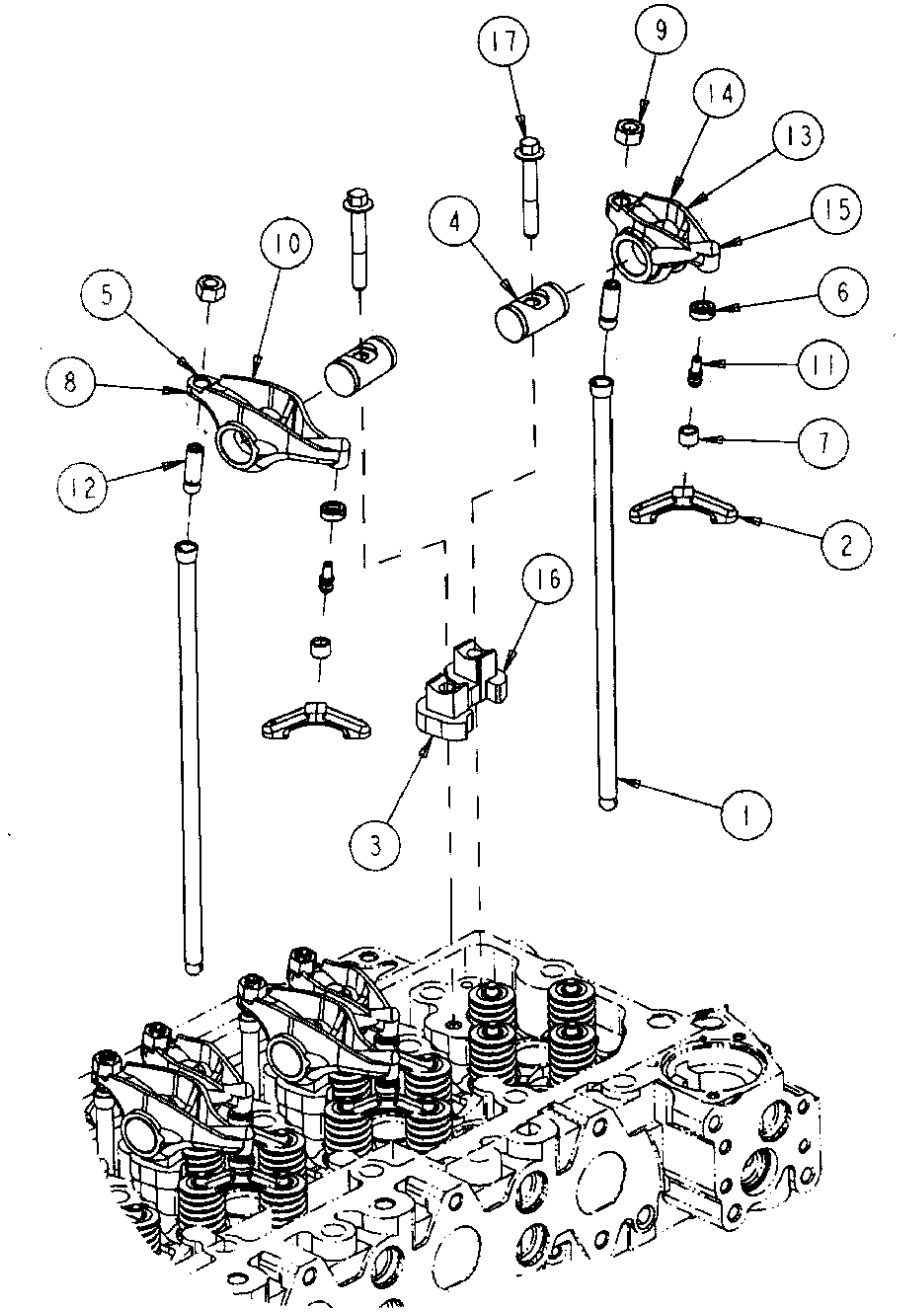

Follow the numbered sequence and turn all capscrews an additional 90⁰ of rotation.




As an overcheck to make sure all capscrews have been rotated 90⁰, check the torque on all capscrews to 136 N•m. If any capscrews turn at 136 N•m loosen only that capscrews and retighten using the above mentioned sequence.



## Rocker Lever Assembly Exploded View




| SL.NO | PART NAME | QTY |
|---|---|---|
| 1 | ROD PUSH | 12 |
| 2 | CROSS HEAD VALVE | 12 |
| 3 | ASSEMBLY ROCKER LEVER | 6 |
| 4 | SHAFT ROCKER LEVER | 12 |
| 5 | LEVER ROCKER | 6 |
| 6 | RETAINER SOCKET | 12 |
| 7 | SOCKET ROCKER LEVER | 12 |
| 8 | LEVER ROCKER LEVER | 6 |
| 9 | NUT HEAVY HEXAGON | 12 |

| SL.NO | PART NAME | QTY |
|---|---|---|
| 10 | LEVER ROCKER | 6 |
| 11 | BALL ROCKER LEVER | 12 |
| 12 | SCREW RKR LEVER ADJUSTING | 12 |
| 13 | LEVER ROCKER | 6 |
| 14 | LEVER ROCKER | 6 |
| 15 | LEVER ROCKER | 6 |
| 16 | SUPPORT ROCKER LEVER | 6 |
| 17 | SCREW HEX FLANGE HEAD CAP | 12 |

## Rocker Levers - Removal



**14 mm, Allen key 6 mm**

Loosen the nuts on the rocker lever adjusting screws and loosen screws until they stop.



**10 mm**

Remove lever, shaft, support, cross head, socketer, ball and retainer by unscrewing hex flange head cap.











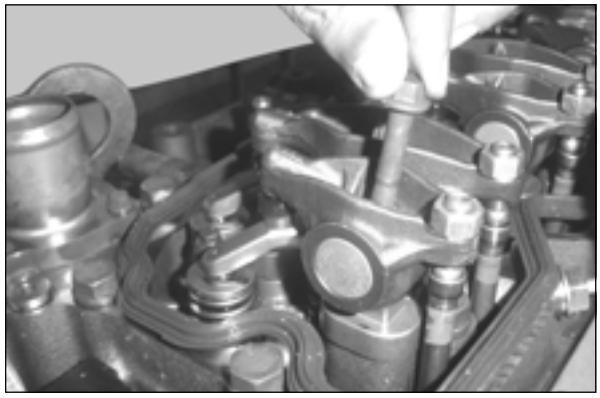
## Rocker Levers - Disassembly



**10mm Spanner**

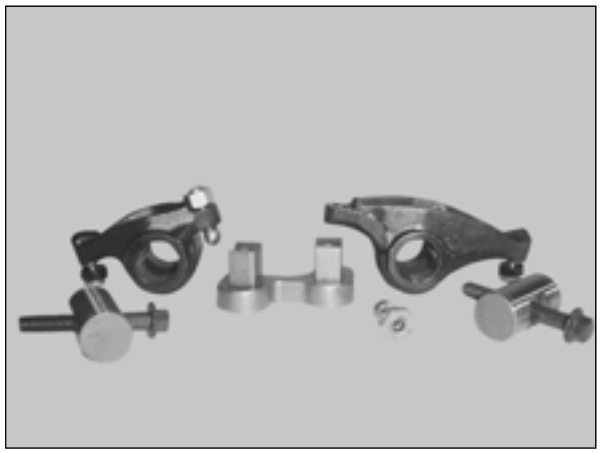


Unscrew Hex flange head cap.





Remove rocker levers with shaft.



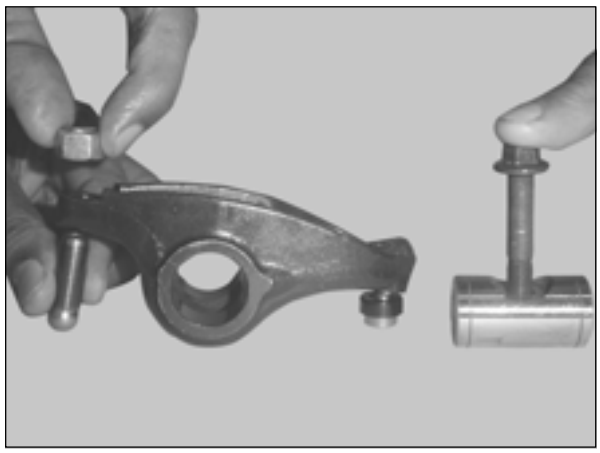


Remove support rocker lever and cross head.





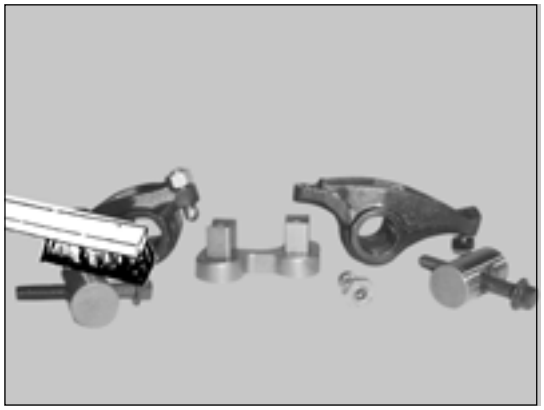
Remove the locknut and adjusting screw.

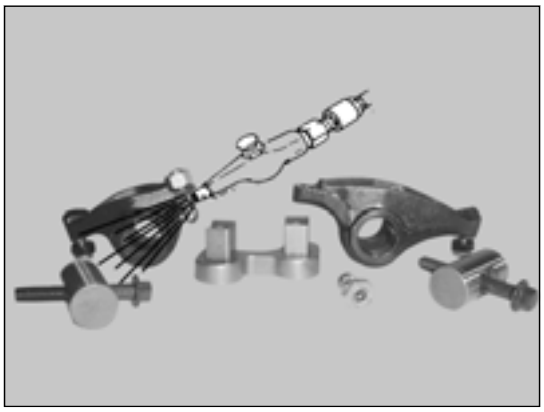


## Rocker Levers and Pedestals - Cleaning

Clean all parts in a strong solution of laundry detergent in hot water.

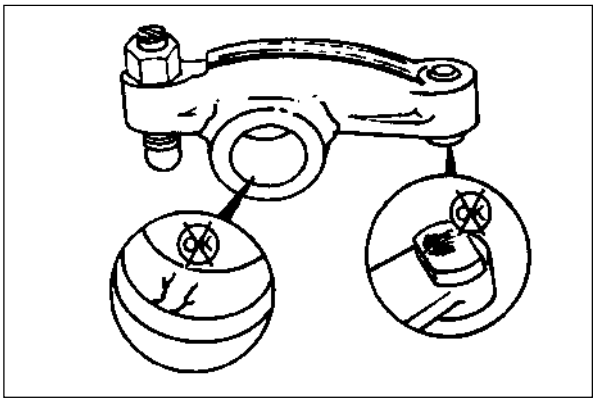
Use compressed air to dry the parts after rinsing in clean, hot water.





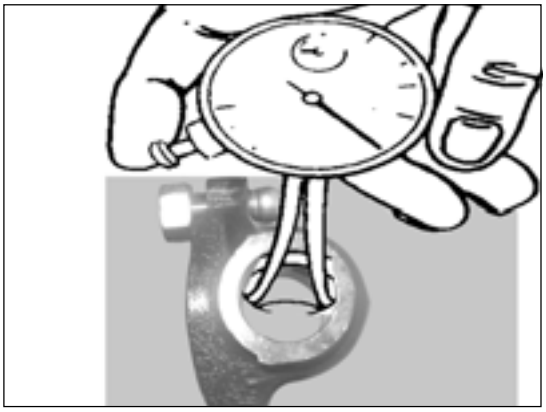
## Rocker Lever - Inspection

Inspect for cracks and excessive wear in the bore and the contact surface for the valve stem.



Measure the rocker lever bore.

| Diameter | |
|---|---|
| mm | |
| 22.000 | MIN |
| 22.051 | MAX |



## Rocker Lever Pedestals - Inspection

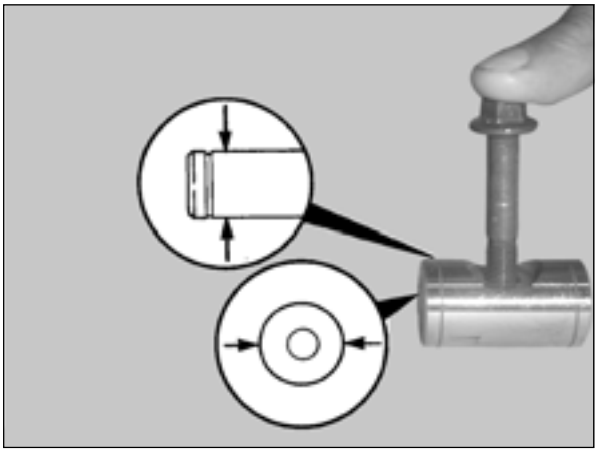




Inspect the pedestal and shaft for obvious damage.

Measure the shaft diameter.

| Diameter | |
|---|---|
| **mm** | |
| 21.940 | MIN |
| 22.031 | MAX |



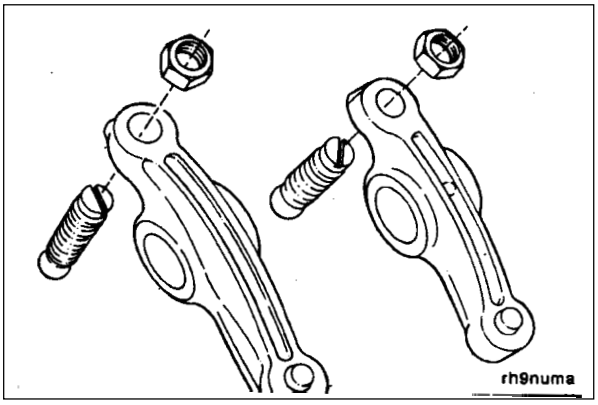
## Rocker Levers - Assembly



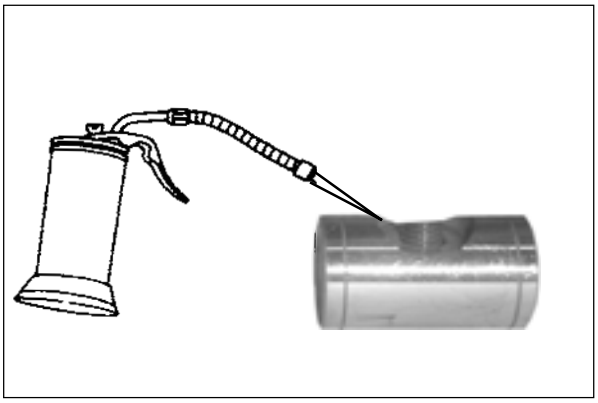
Install the adjusting screw and locknut.

Lubricate the shaft with clean engine oil.

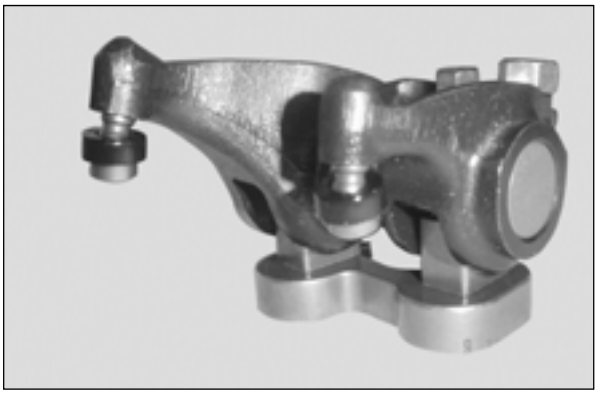
Position the levers on the rocker shaft.





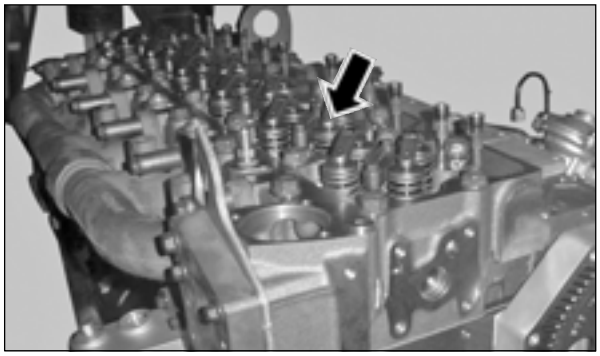







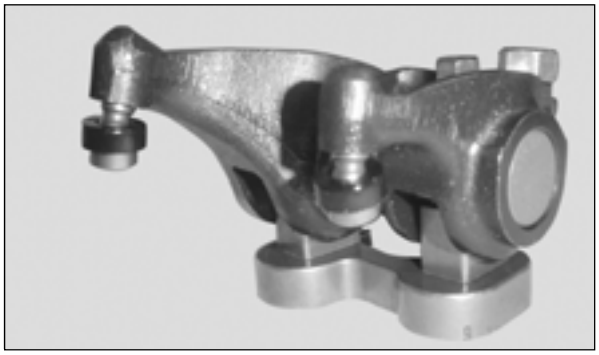
## Rocker Levers - Installation

Lubricate the valve stems with engine oil.

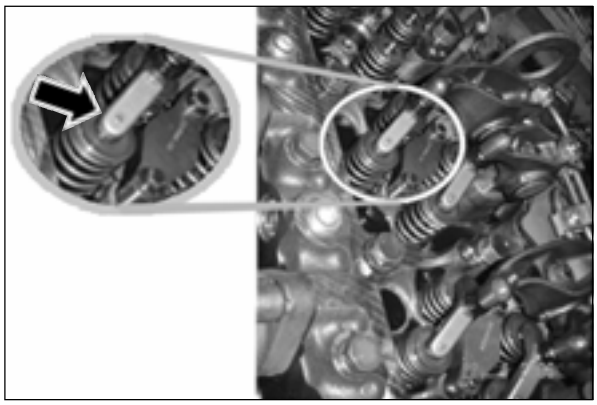


**14 mm, 6 mm**

Completely loosen the rocker lever adjusting screws.



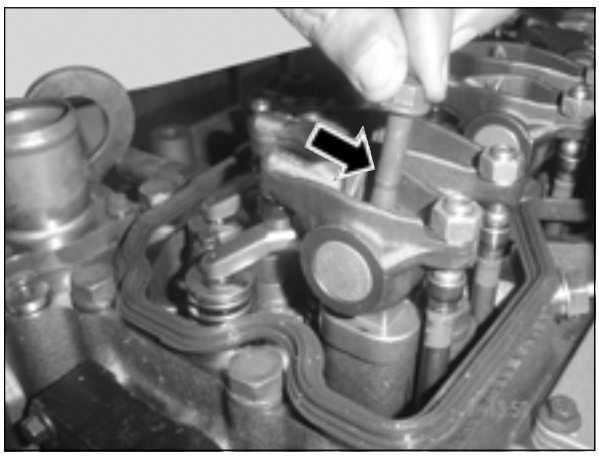
- 'Point' Mark on the Cross Head - Valve has to be assembled towards Exhaust Manifold side
- 'Point' Mark on the Cross head - valve has a Elongated slot on the bottom side



**NOTE :** The rocker lever pedestals are aligned with dowels. Install the pedestals.

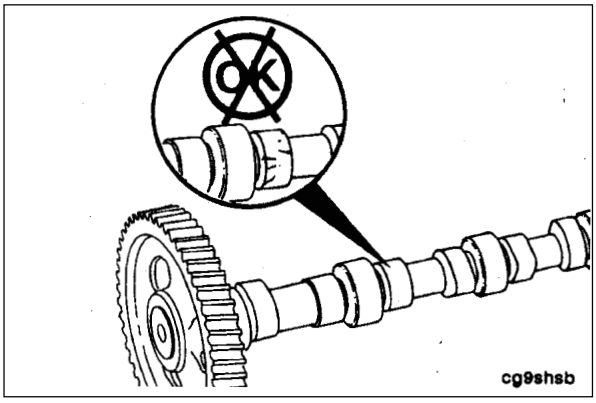
Lubricate the 8mm pedestal capscrew threads and under the capscrew heads with engine oil.

Place retainer socket rocker lever assembly cross head valve and socketer, ball, retainer in position.

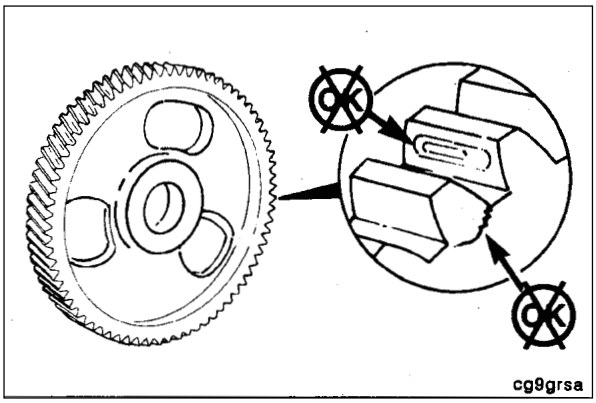


## Camshaft and Gear - Inspection

Inspect the lift pump lobe; valve lobes and bearing journals for cracking, pitting or scoring.

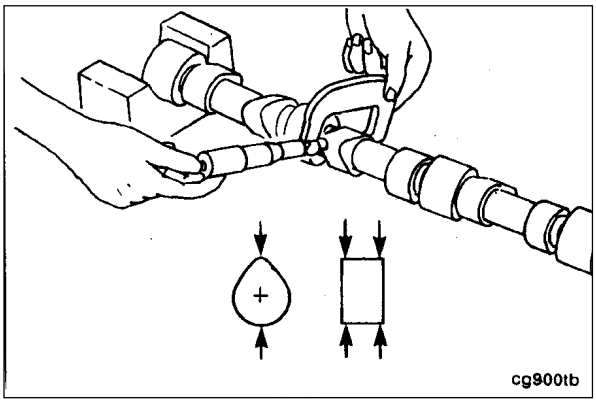



Inspect the gear teeth for pitting; look for cracks at the root of the teeth.



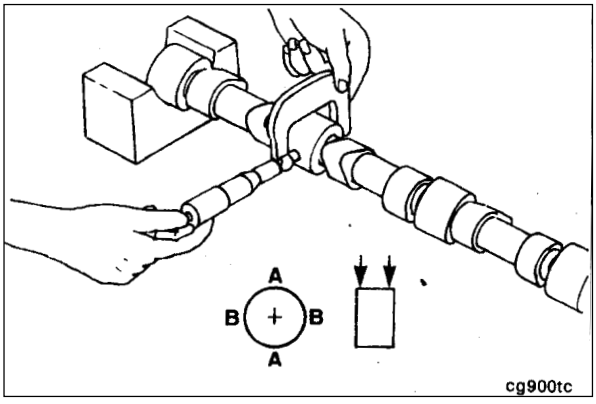

Measure the fuel transfer pump lobe and valve lobes.

| | Diameter at Peak of Lobe mm | |
|---|---|---|
| Intake | 47.173 | MIN |
| | 47.853 | MAX |
| Exhaust | 45.654 | MIN |
| | 46.334 | MAX |
| Lift Pump | 35.500 | MIN |
| | 36.260 | MAX |



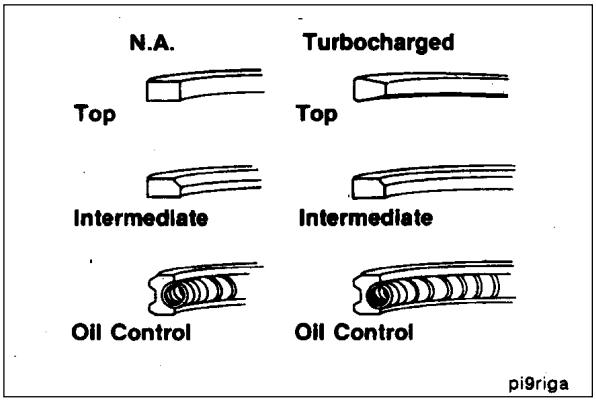

Measure the bearing journals.

| Journal Diameter mm | |
|---|---|
| 53.962 | MIN |
| 54.013 | MAX |



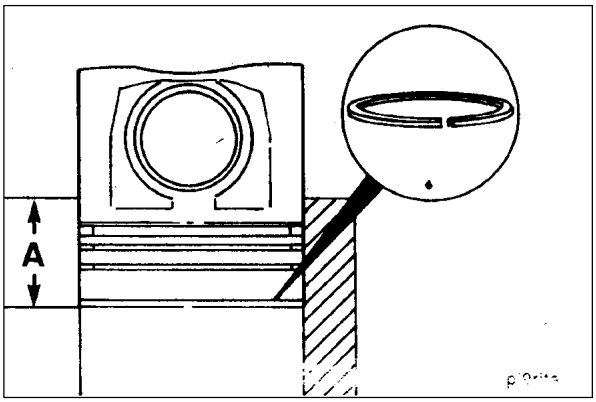
## Piston Ring Gap - Checking

**The top ring for a turbocharged engine is not the same as the top ring for a naturally aspirated engine.**



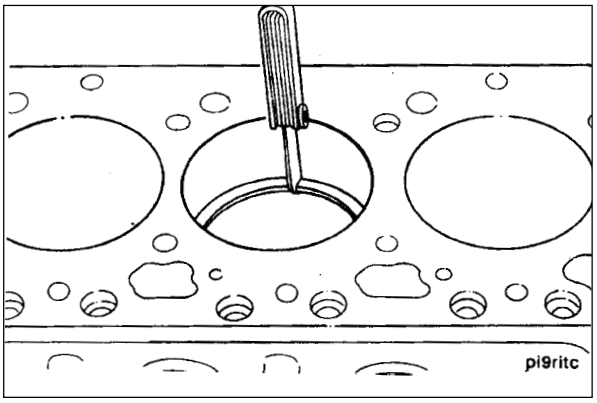

Position each ring in the cylinder and use a piston to square it with the bore.

A - 89 mm




Use a feeler gauge to measure the gap.

| | mm | Ring Gap |
|---|---|---|
| **Top** | 0.26 | MIN |
| | 0.36 | MAX |
| **Intermediate** | 0.85 | MIN |
| | 1.15 | MAX |
| **Oil Control** | 0.25 | MIN |
| | 0.55 | MAX |



## NOTES

## NOTES

## NOTES

# Shop Manual

# Tata Cummins
# B Series Engine BS-III (Mechanical)

(Supplement to Shop Manual Tata Cummins B Series Engine - Edition XLI/B2006)

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# About the Manual

This manual contains information exclusively for TATA CUMMINS B Series engines (BS III Mechanical) as supplement to Shop Manual TATA Cummins B Series Engines.

The booklet covers dismantling / assembly inspection and repairs/ for components/ assemblies which are exclusive to Tata Cummins B Series Engines (BS-III Mechanical). For other components / assemblies which are common to Tata CUMMINS B Series engine please refer Shop Manual TATA CUMMINS B Series Engines, Edition : XLI / B-2006.

# General Engine Specifications

## General Engine Data

Basic Engine model ..... B 5.9 - 13031

Horse Power ..... 130 HP @ 2500 rpm

Bore ..... 102 mm

Stroke ..... 120 mm

Aspiration ..... Turbocharged and after cooled

Displacement
- 6B ..... 5.88 liters

Engine idle rpm ..... 800

Rated rpm ..... 2500

Maximum no load governed speed ..... 2850

Compression ratio

B5.9 Automotive, charge air cooled ..... 18:1

Firing order 6 cylinder ..... 1-5-3-6-2-4

Valve Settings
- Intake Valve Adjustment ..... 0.25 mm
- Exhaust Valve Adjustment ..... 0.51 mm

Engine rotation (viewed from front of engine) ..... Clockwise

Engine weight (with standard accessories)
- 6 cylinder engines ..... 413 to 437 kg

## Lubrication System

Oil pressure
- At Idle (minimum allowable) ..... 69kPa [10 Psi]
- At rated speed (minimum allowable) ..... 207 kPa [30 Psi]

Regulating valve opening pressure ..... 517 kPa [65 Psi]

Differential pressure to open oil filter by pass valve ..... 172 kPa [20 Psi]

Oil capacity of standard engine
- 6 cylinder engines (oil sump capacity) ..... 15.3 liters

Total system capacity
- 6 cylinder engines ..... 17.4 liters

## Cooling System

Thermostat

Begins to open ..... 81$^0$C [180$^0$F]

Fully open ..... 95$^0$C [203$^0$-F]

Pressure cap for 99$^0$ C [210$^0$ F] system ..... 50 kPa [7 Psi]

Pressure cap for 104$^0$ C [220$^0$ F] system ..... 103 kPa [15 Psi]

## Intake Air and Exhaust System

Maximum allowable intake restriction at rated speed and load (wit dirty air filter element)

Turbocharged ..... 63.5 cm $H_2O$ [25 in $H_2O$]

Maximum turbocharger outlet restriction at rated speed and load ..... 76.2 mm Hg [3 in Hg]

Automotive ..... 114.3 mm Hg [4.5 in Hg]

## Fuel System

Fuel transfer pump maximum inlet restriction ..... 100 mm Hg [4 in Hg]

Fuel transfer pump output pressure at rated speed

Distributor fuel injection pumps (maximum) ..... 70 kPa [10 PSi]

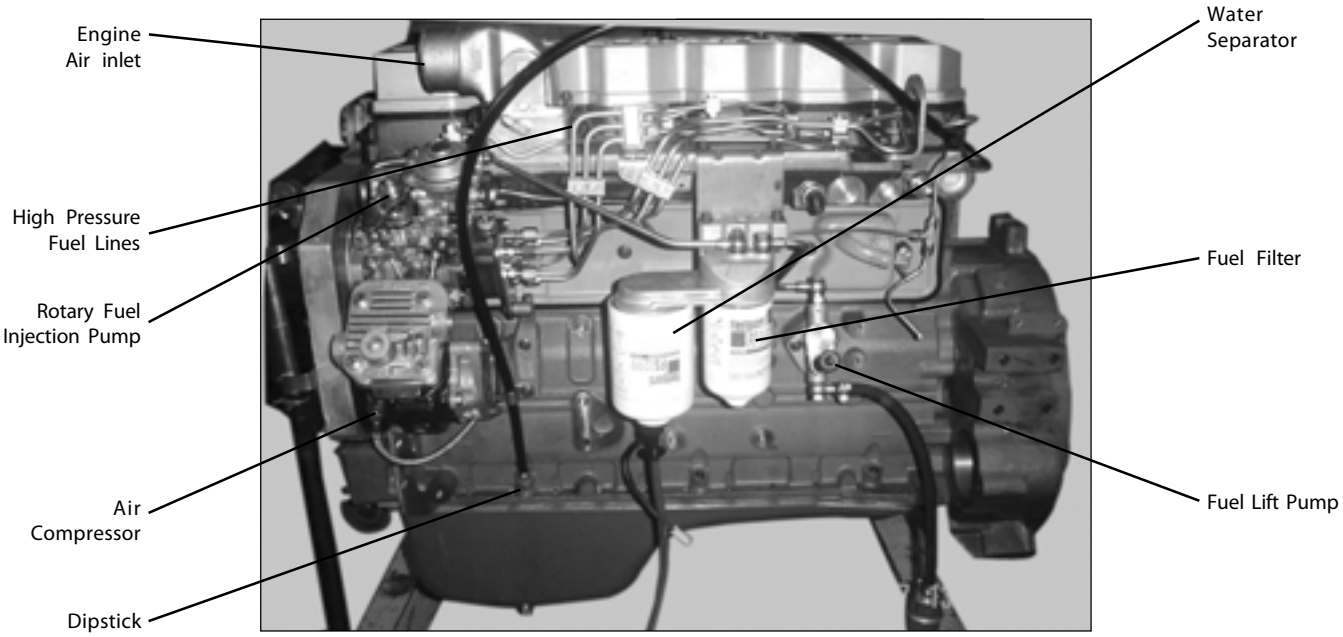
Mico Rotary VP 14 mechanical injection pump (minimum) ..... 172 kPa [25 Psi]

Fuel filter restriction (maximum pressure drop across filters) ..... 35 kPa [5 Psi]

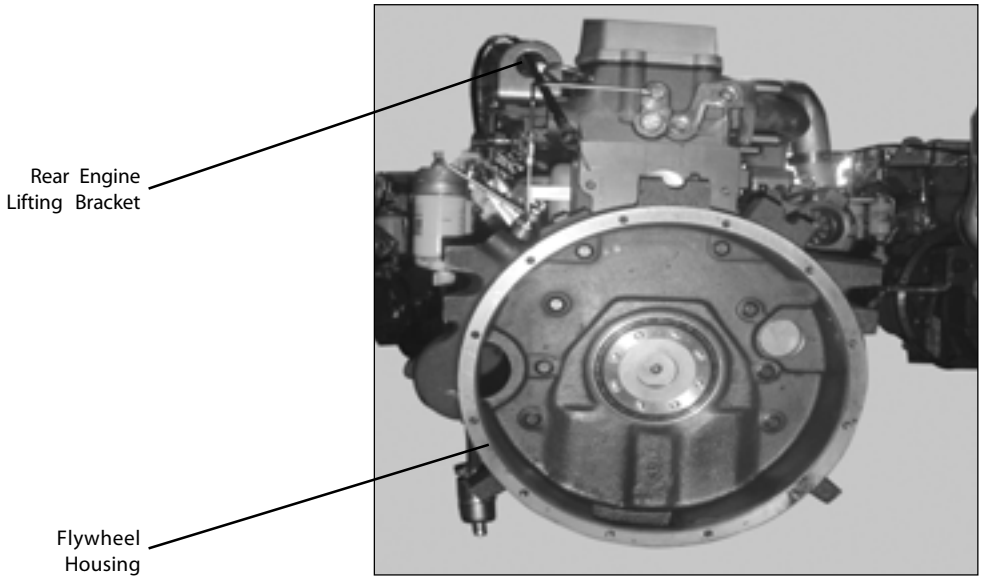
Fuel return restriction (maximum) ..... 518 mm Hg [20.4 in Hg]

# BS-III Engine Introduction

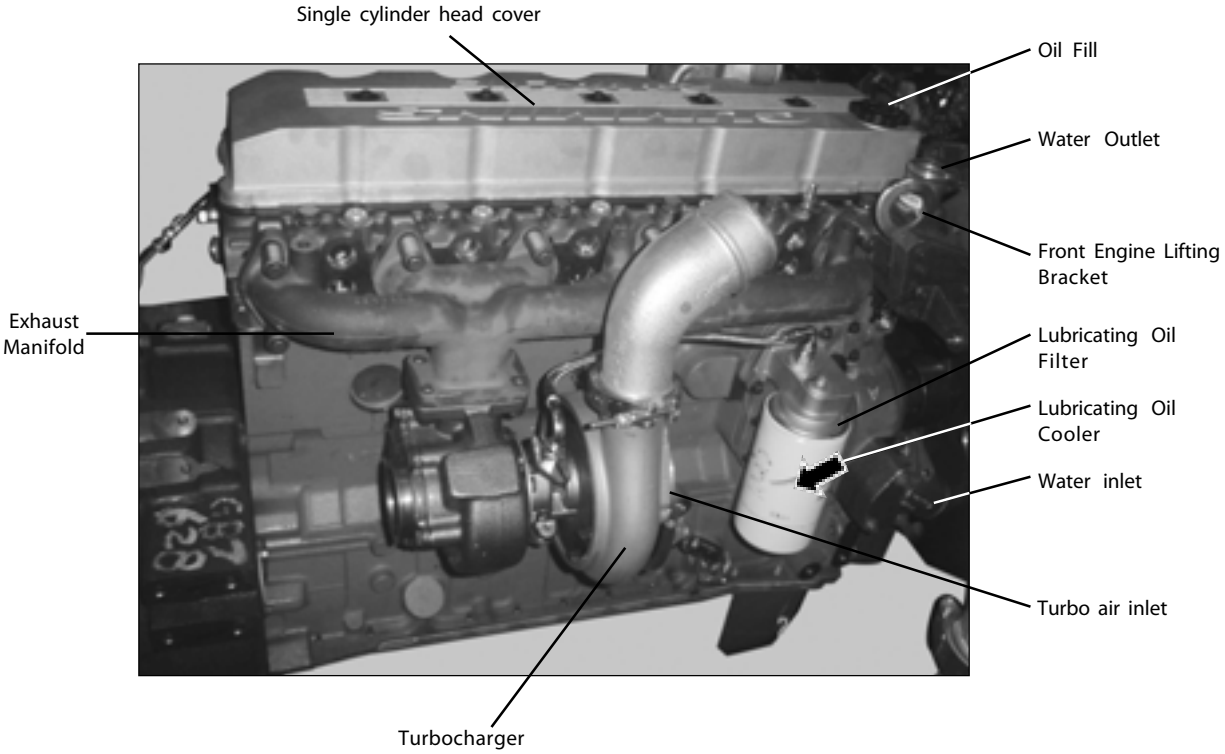
The illustrations which follow show the locations of the major external engine components, the filters, and other service and maintenance points.



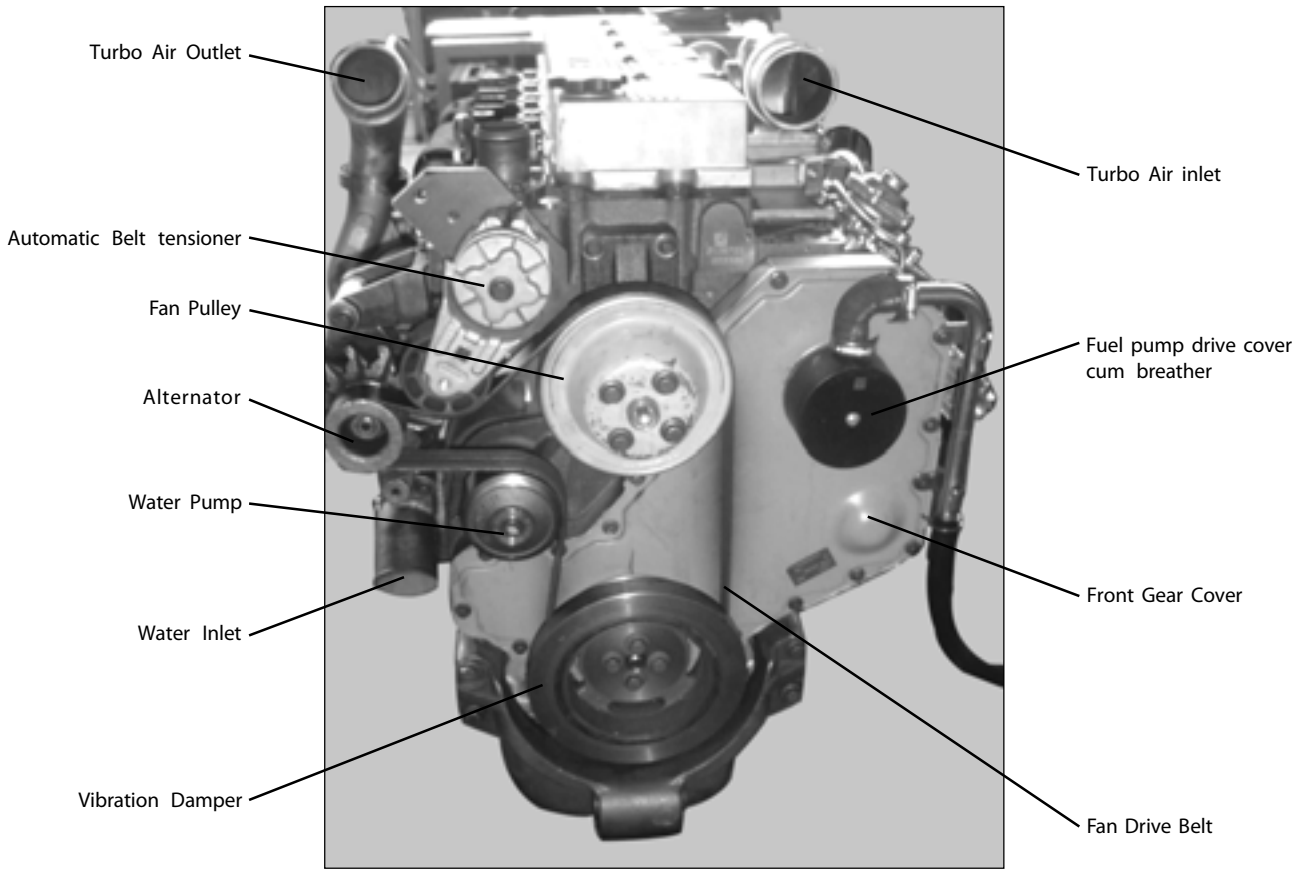

**FIP Side view**




**Rear View**




**Turbocharger Side View**




**Front View**

## MAJOR DIFFERENCES IN 6BT BS –III (MECHANICAL) Compared to 6BT BS-II ENGINE

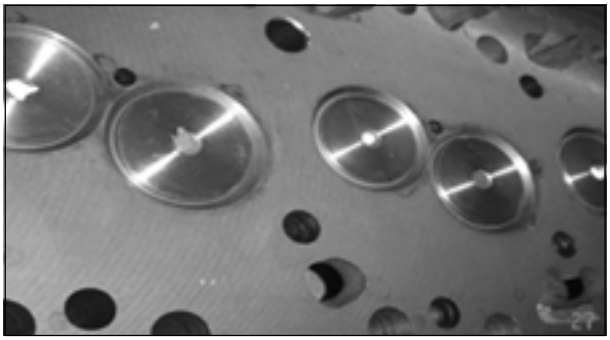
| | | | | | |
|---|---|---|---|---|---|
| 1 | Cylinder Head | 7 | Exhaust Manifold | 13 | Cylinder head Gasket |
| 2 | Valve (Inlet / Exhaust) | 8 | Camshaft | 14 | Valve Cover |
| 3 | Piston | 9 | Thermostat | 15 | Fuel Adapter |
| 4 | Rocker assembly | 10 | Valve (Inlet / Exhaust) | 16 | Fuel Return |
| 5 | Push Rod | 11 | Piston Ring | | |
| 6 | Injector | 12 | Valve Tappet | | |

### CYLINDER HEAD ASSEMBLY

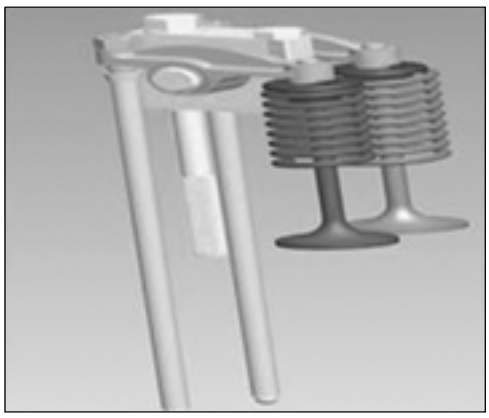
**BSII**



- 2 Valves Per Cylinders
- Cylinder head bolts - 3 Different lengths



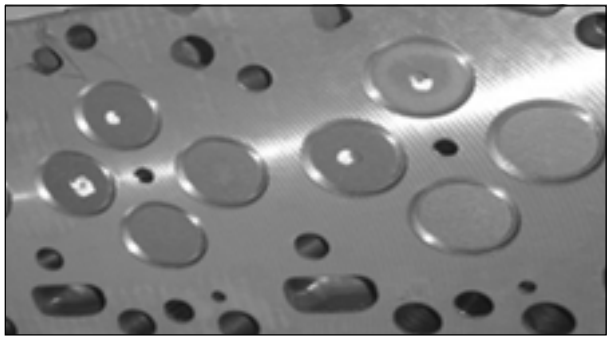
- Two valve per cylinder valve train



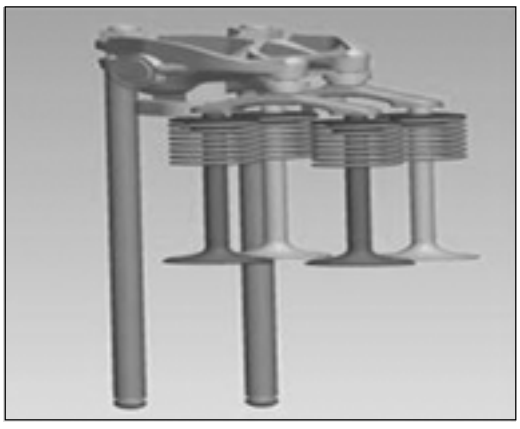
**BSIII**



- 4 Valves Per Cylinders
- All Cylinder head bolts are of same length.



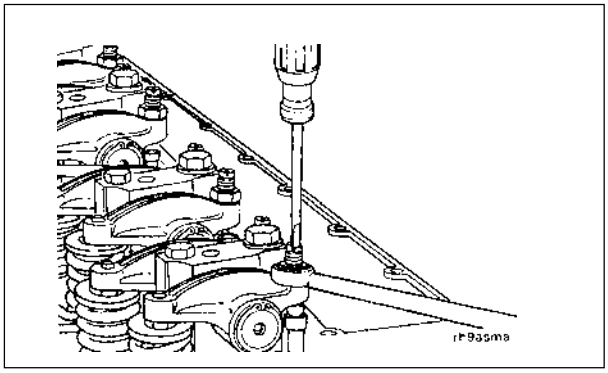
- Four valve per cylinder Valve train



## BSII

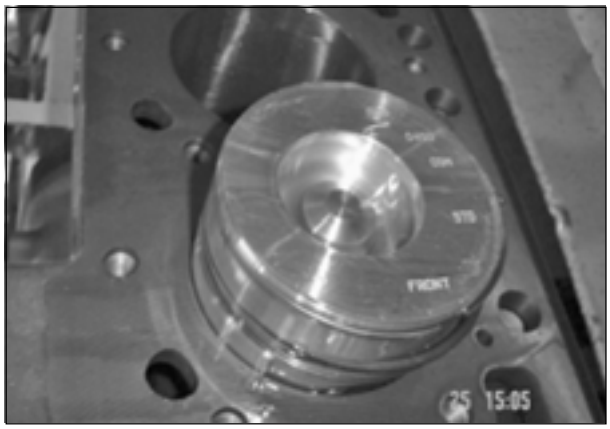
## BSIII

### ROCKER ASSEMBLY

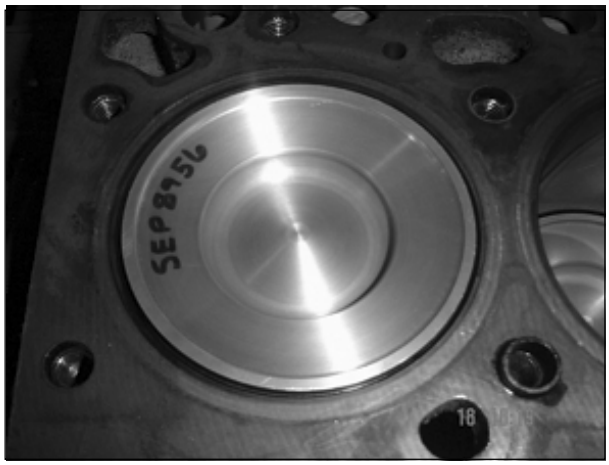




### PISTON



- Offset Piston Bowl




- Central Bowl Piston

### HIGH PRESSURE LINES AND INJECTORS



- High Pressure lines and injectors on Exhaust side of Cylinder head



- High Pressure Lines on Intake side of cylinder head

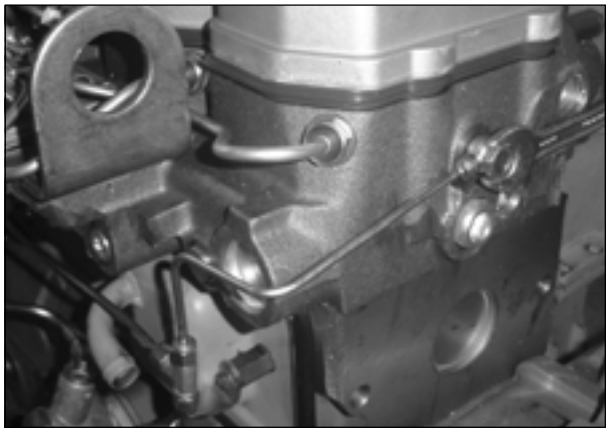
## BSII

## BSIII

### FUEL RETURN LINE

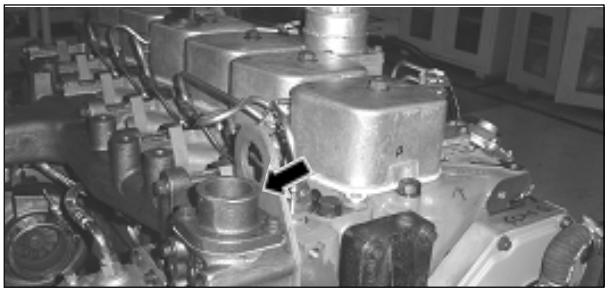



- External Injector Fuel Return line

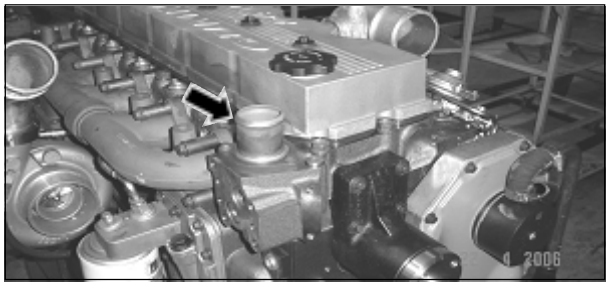


- No External Fuel return line
- Integral Fuel Return Line

### THERMOSTAT HOUSING

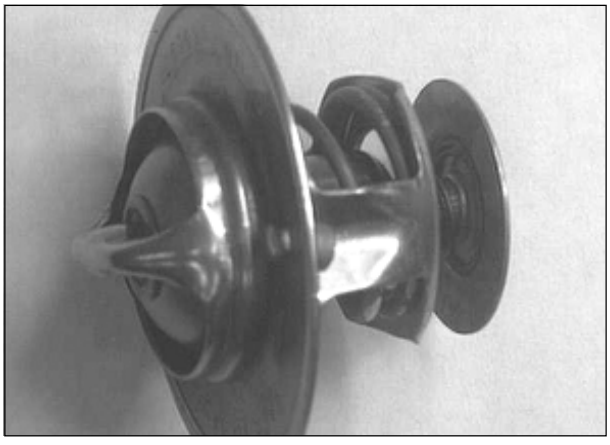


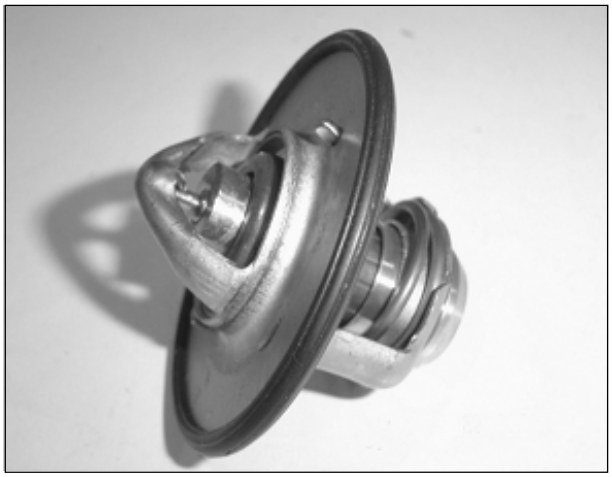
- Separate thermostat Housing




- Vertical and integral Thermostat housing in cylinder head itself.

### THERMOSTAT



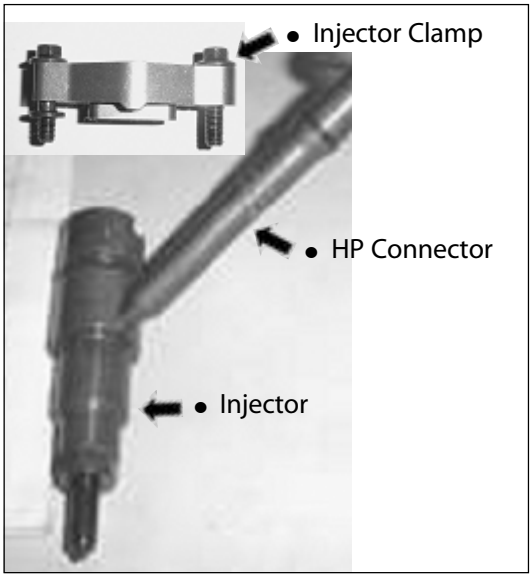


## BSII

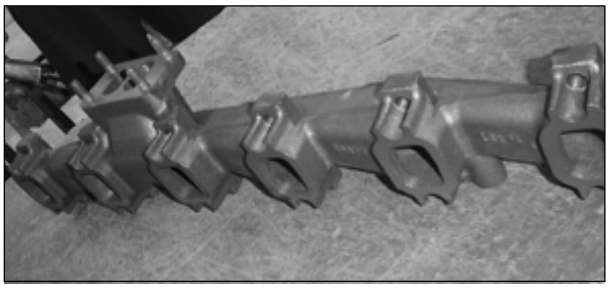
## BSIII

### INJECTOR

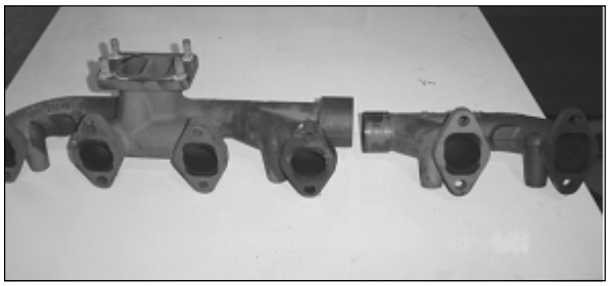





### EXHAUST MANIFOLD



- Single Piece Pulse type exhaust manifold

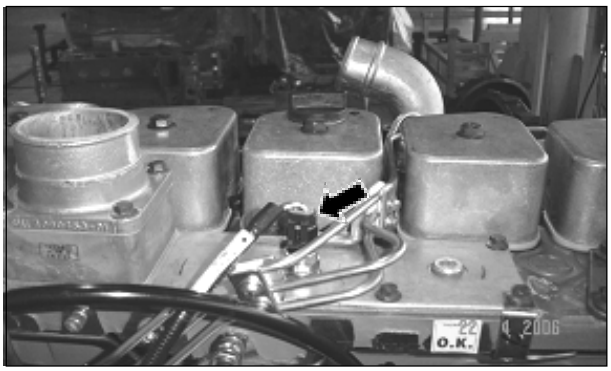


- Two Piece Pulse type exhaust manifold

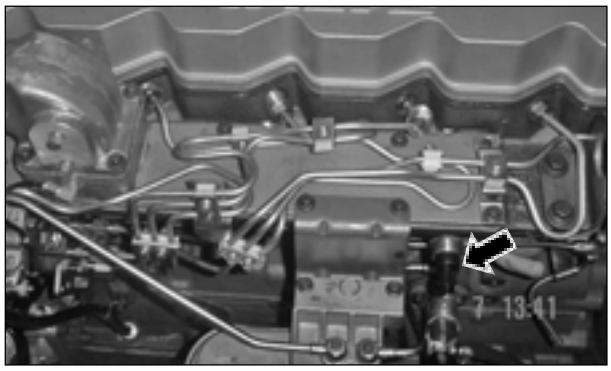
## BSII

## BSIII

### THERMO SWITCH LOCATION

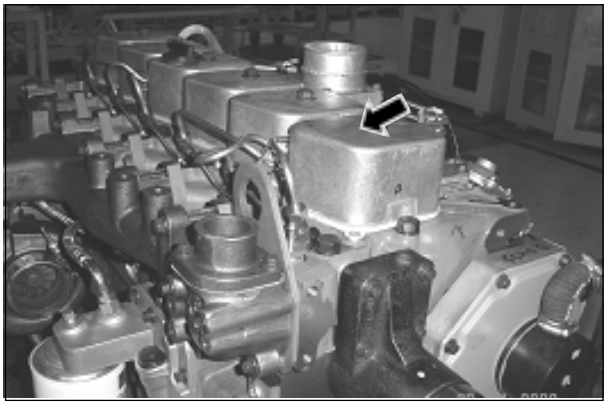


- Intake cover mounted Thermo switch connecting KSB

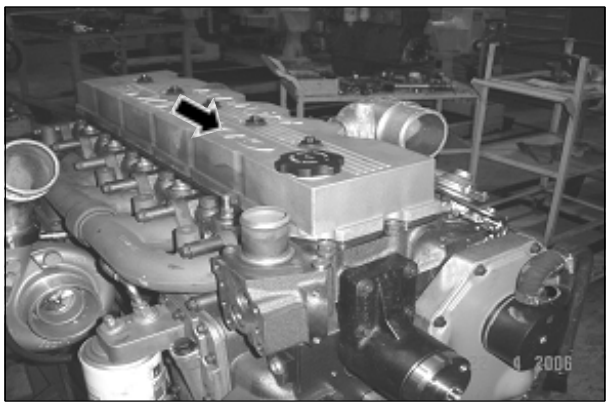


- Cylinder head mounted Thermo switch connecting KSB

### VALVE COVER



- Individual Valve cover and valve cover gasket for each cylinder (6 pieces)



- Single and integral Valve cover assembly and gasket (one piece)

## Thermostat- Removal

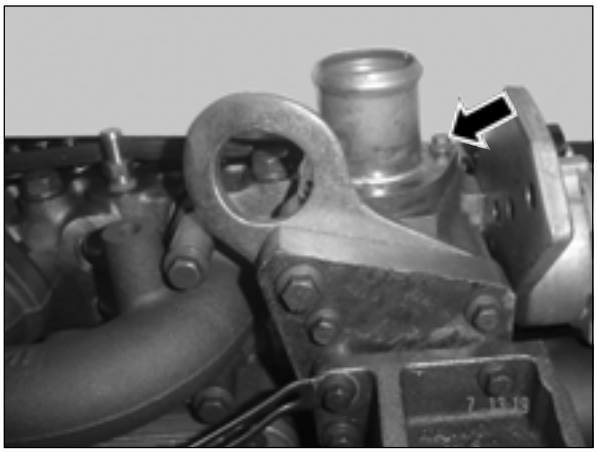




**10 mm Scew driver**

Drain coolant and disconnect water lines.

Remove the capscrews from the thermostat housing.



## Thermostat - Inspection

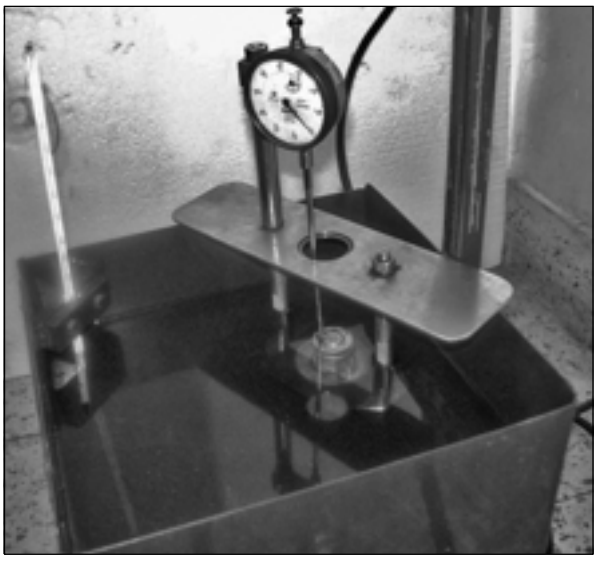


Visually inspect the thermostat for obvious damage such as obstructions caused by debris, broken springs, or stuck or missing vent pins.





The thermostat can be checked for correct operation.



**Requirements**

**Start to open** at $83^0$ C [$181^0$ F].

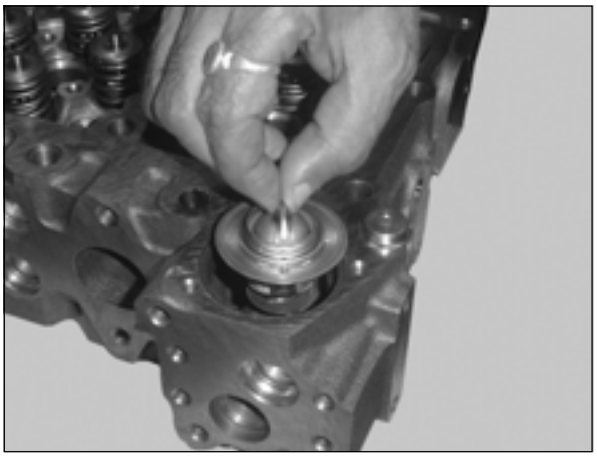
**Fully open at** $95^0$ C [$203^0$ F].

Max. Valve lift 6.6 mm

## Thermostat - Installation



Position the thermostat as shown.





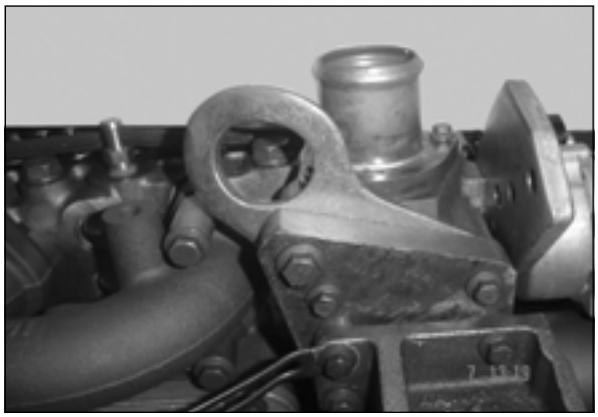
**10 mm**

Install Thermostat cover and tighten.

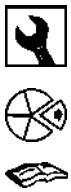


**Torque Value :** 24 N•m



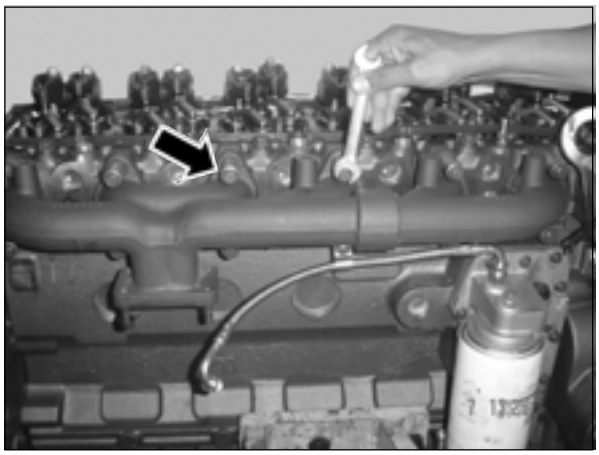


## Exhaust Manifold - Removal



**13 mm**

Remove the capscrews, exhaust manifold and gaskets.

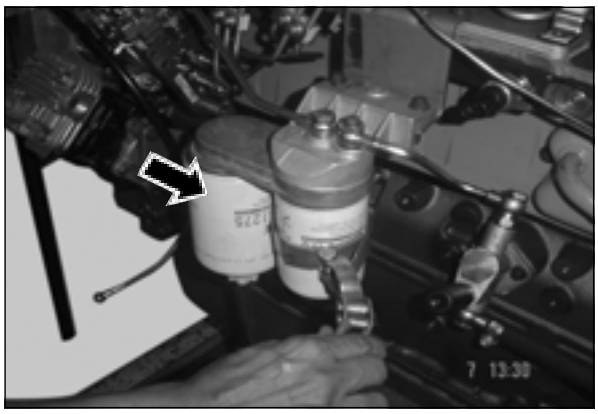


## Fuel Filter - Removal



**75-80 mm, 90-95 mm Strap Wrenches**

Remove the fuel filter(s).

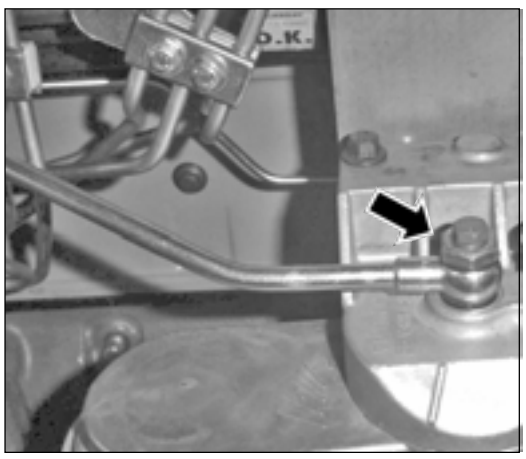


## Fuel Filter Head - Removal



**24 mm**

If equipped with a dual filter head, remove the nut, dual filter head and O-ring.



**Screwdriver**

Remove fuel filter adapter and O-ring.



## KSB Connections (Remote mounted) - Removal

Remove the KSB wiring harness connections.



*FIP KSB Unit*

# Fuel Lines - Removal

## High Pressure Fuel Line - Removal



**17 mm Crowsfoot Wrench**



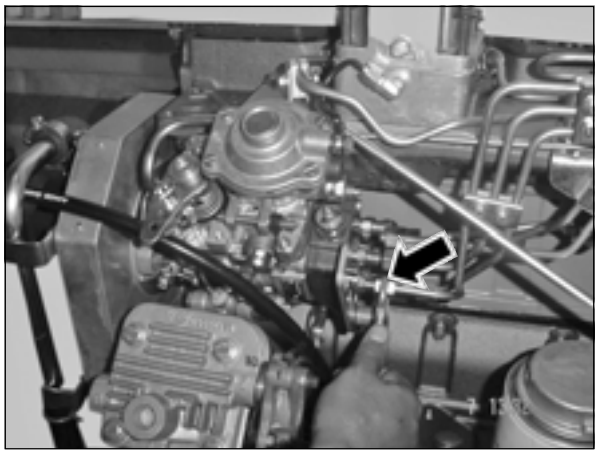
**19 mm Crowsfoot Wrench**



**Caution: Hold the fuel pump delivery valves securely when loosening the high pressure lines on the rotary pumps.**

Remove the high pressure line fittings from the injection pump.

**19 mm**

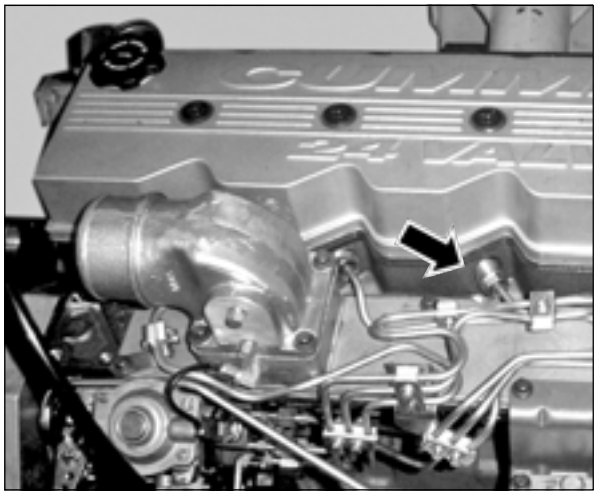


Remove the high pressure lines form the injectors.









**10 mm**



Remove the manifold cover capscrews that secure the high pressure line support brackets.



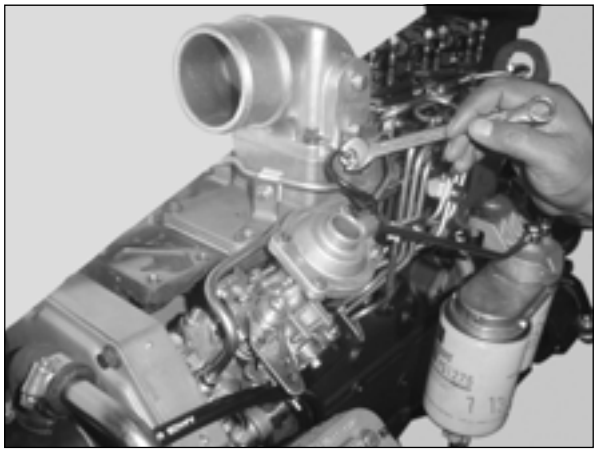
Remove the high pressure lines as an assembly. Cap or cover the injector openings.





**12 mm and 13 mm**

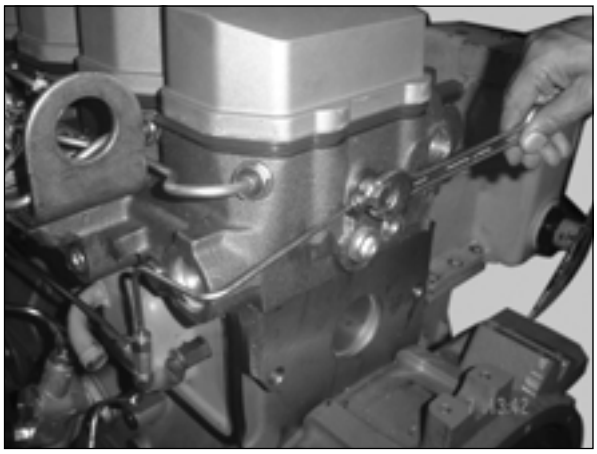
If so equipped, remove the air/fuel control tube and turbocharger wastegate line.



## Fuel Drain Manifold - Removal

**16 mm**

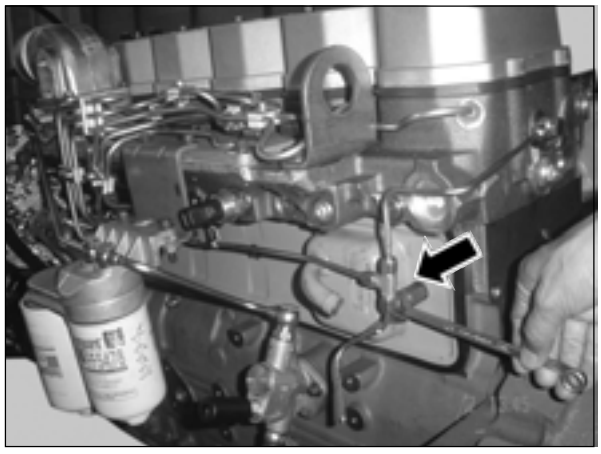
Remove the fuel drain manifold banjo fittings and sealing washers.



**17 mm and 10 mm**

**Rotary Fuel Pump**

Remove the fuel drain manifold support brackets and banjo fitting.

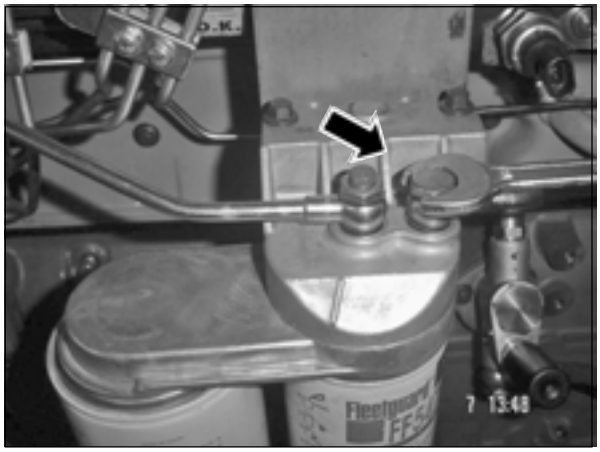


## Low Pressure Fuel Lines - Removal



**17 mm**

Disconnect the two banjo fittings at the filter head.

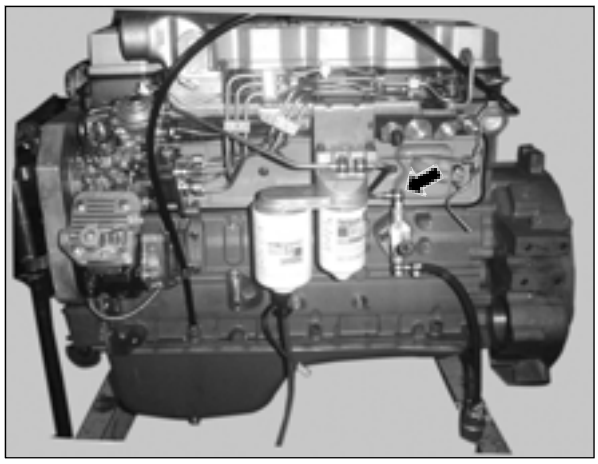


**14 mm and 17 mm**



**Caution: Be sure the fuel transfer pump connection is held securely when loosening the fuel line.**

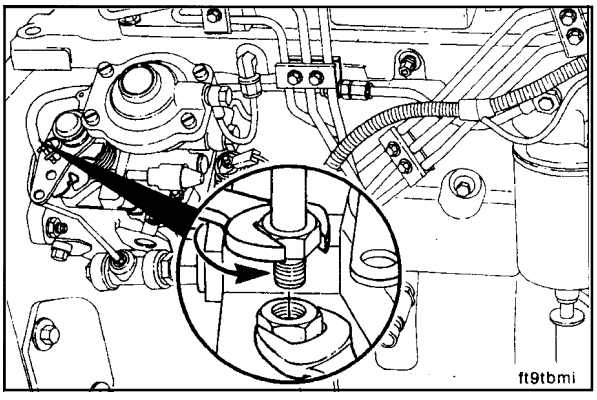
Loosen the nut and remove the fuel line from the lift pump.



**14 mm and 17 mm**



**Caution: Be sure the fuel pump connection is held securely when loosening the supply line.**



## Fuel Lines - Installation

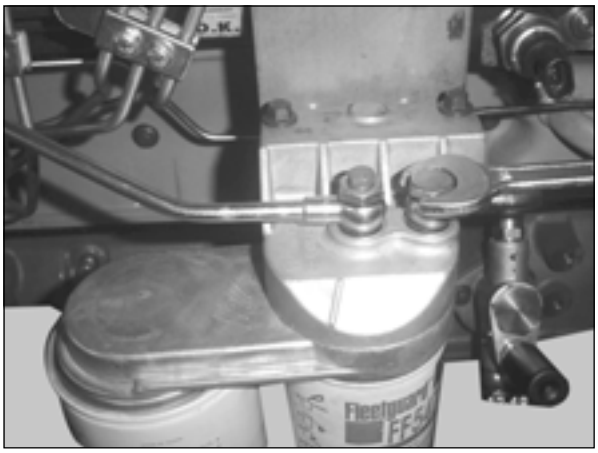


**17 mm**

Install the fuel filter supply line.

The banjo fittings at the filter head require sealing washers on each side of the line. The banjo fitting with the vent screw is used to install the pump supply line.





## Injection Pump Supply Line - Installation

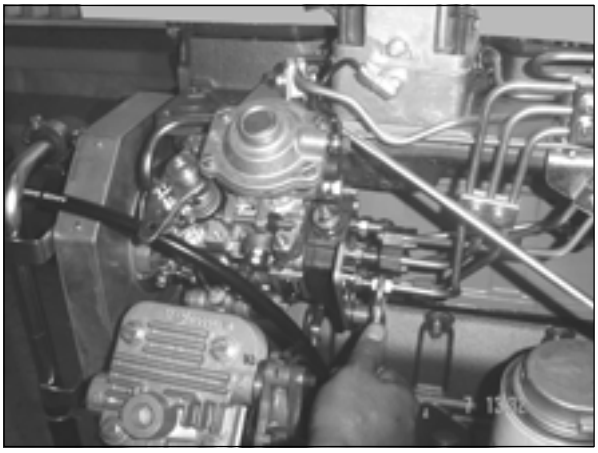




**17 and 14 mm**

Install the MICO Bosch injection pump fuel supply line.

**Torque Value :** 32 N•m



## Fuel Drain Manifold - Installation





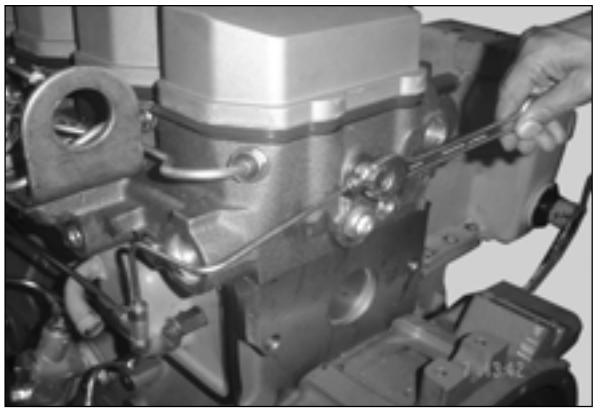


**10 mm**

Use new sealing washer for the new fuel drain manifold.

Intall the fuel drain manifold.

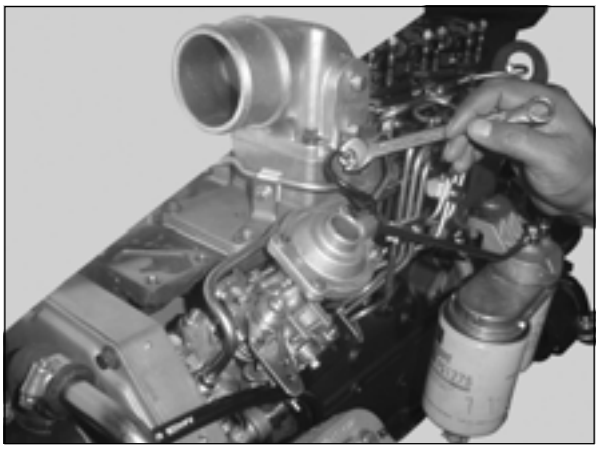
**Torque Value :** 9 N•m



## Injection Pump Vent Line - Installation

**10 and 19 mm**

Connect the Bosch injection pump vent.



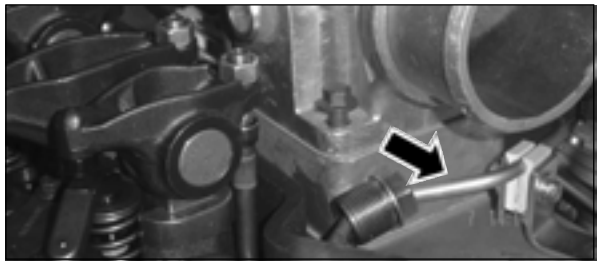
## High Pressure Fuel Lines - Installation





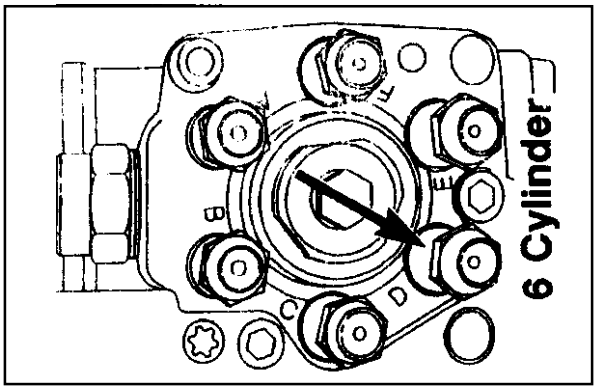
Assemble the high pressure fuel lines.

The number one cylinder delivery valve is marked on the pump as illustrated.



6 cylinder= D

Firing Order
6 Cylinder
D= 1 A= 6
E= 5 B= 2
F= 3 C= 4




**13 mm**

Tighten all of the manifold cover capscrews.

**Torque Value:** 24 N•m [18 ft.-lb]

**14 mm, 17 mm**





Make sure that the high pressure lines will not rub against other engine components.

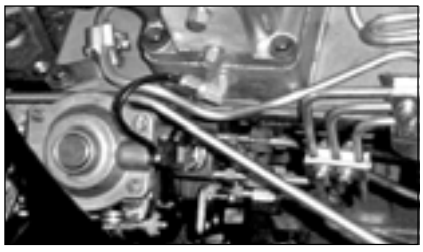
Tighten the high pressure lines at the injection pump and injectors securely.



**Torque Value :** 24 N•m



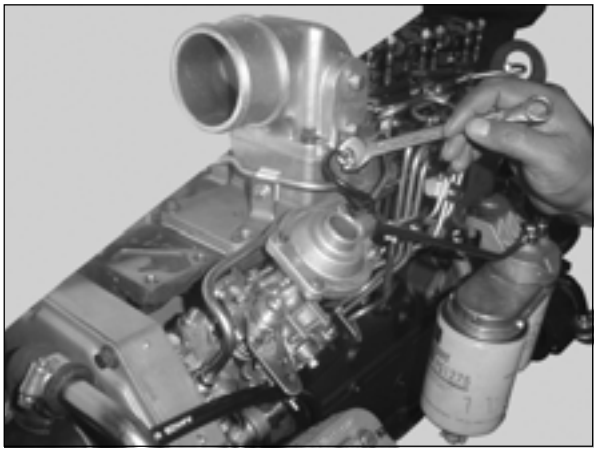




**12 mm and 13 mm**

Install the air fuel control tube.

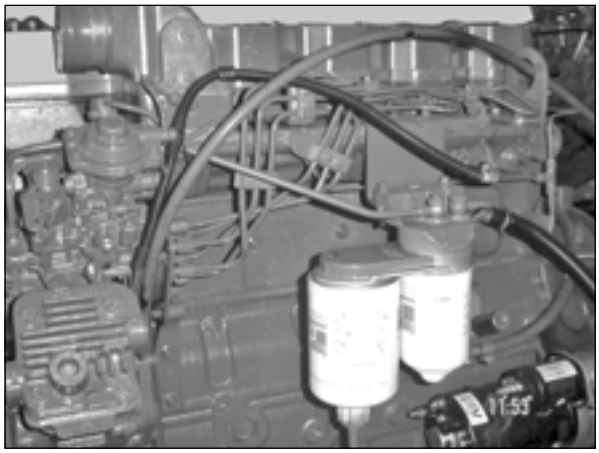
Use new sealing washers when installing the tube.



**KSB Installation**
**13 mm and 10 mm**

Install the remote mounted KSB valve.

**Torque Value:** 24 N•m



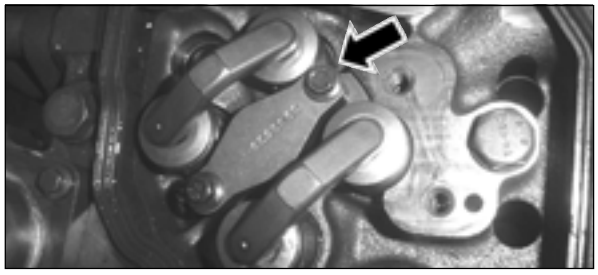
## Injector - Removal



After removing manifold cover gasket and diconnecting high pressure fuel lines remove HP connector to injector nozzle.



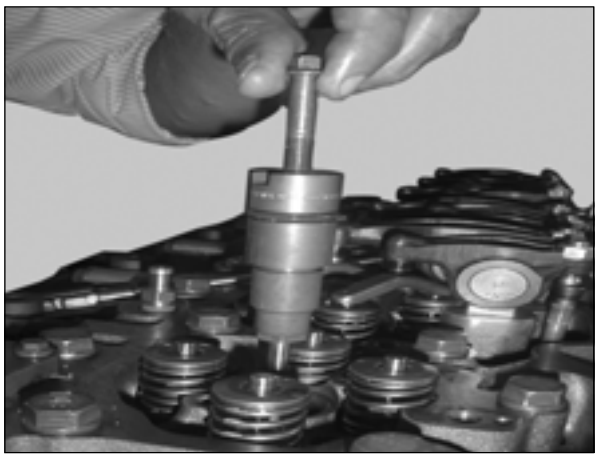
Remove screw hex flange head cap and injector clamp.



**Injector Puller**

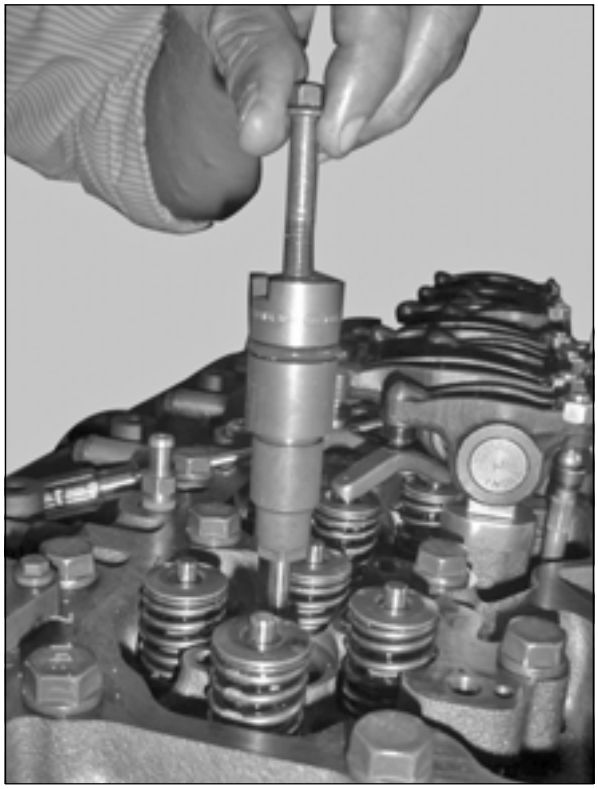


Remove the injectors



## Injector - Installation



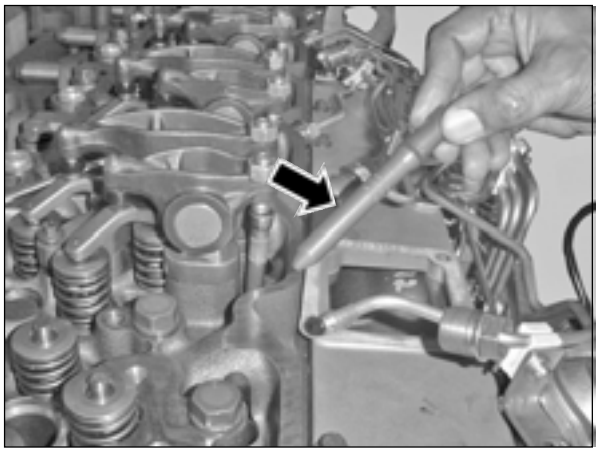


Apply a coat of anti-seize compound to the injector.

**NOTE :** Avoid getting anti-seize compound in the fuel drain hole.

Press injector nozzle into the nozzle hole in such a way that it aligns fitment of male connector.

Assemble HP male connector properly to match with injector nozzle hole.



**Note** : Orientation of inlet features of injector should be towards the HP connector.

Always replace HP connector when installing a new injector.

**Caution: Some sockets can damage the sealing surface of the fuel drain outlet.**









**10 mm deep well socket**

Place injector clamp so that clamp is centred on the injector.

Fit clamp injector and tighten M6 screw hex flange head.

**Torque Value :** 60 N•m

**Note** : Place injector completely using holding clamp to index injector.

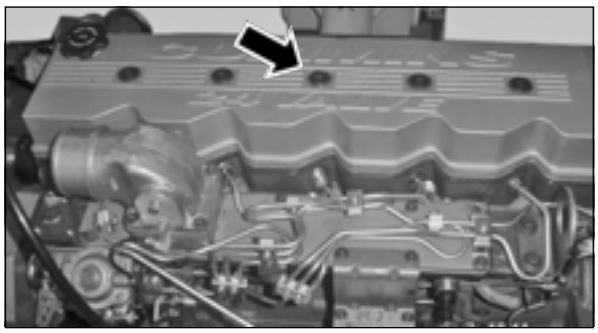
## Valve Cover - Removal





**10 mm**

Remove the special capscrews, isolator & valve covers.



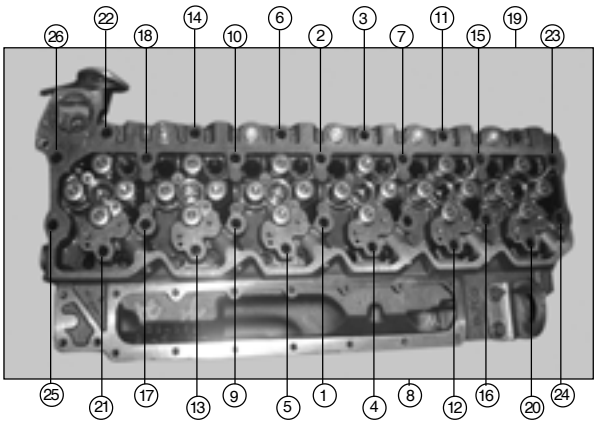
## Cylinder Head - Removal





**18 mm**

Remove the remaining cylinder head capscrews in the sequence shown.




Remove the cylinder head and gasket from the block.





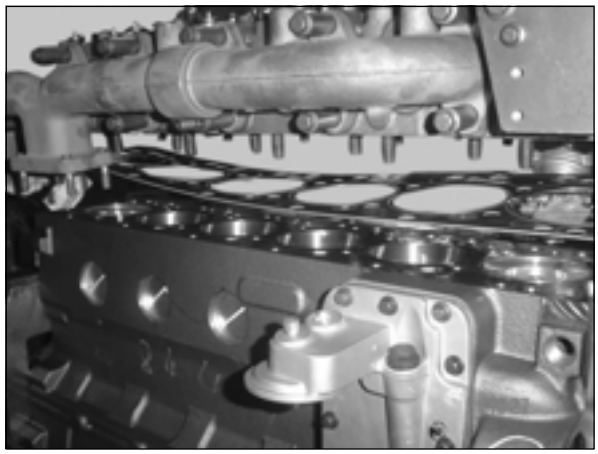


### Cylinder Head Torque

6 Cylinder- 9 Kg + 90 Deg.

**10 mm**

Remove the front cover and gasket.



**Note:** Tata Cummins BSII and BSIII Engine cylinder head gasket is different.

## Push Rods - Removal



Remove the push rods.



## Push Rods - Installation

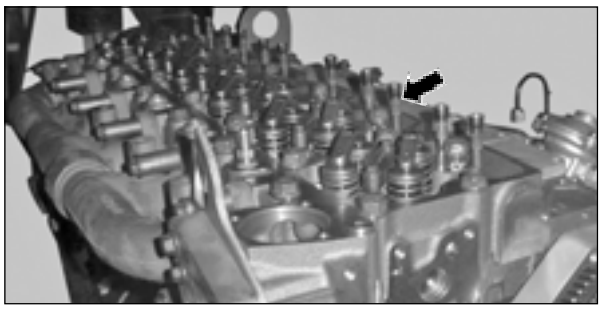


Position the push rods into the valve tappets.



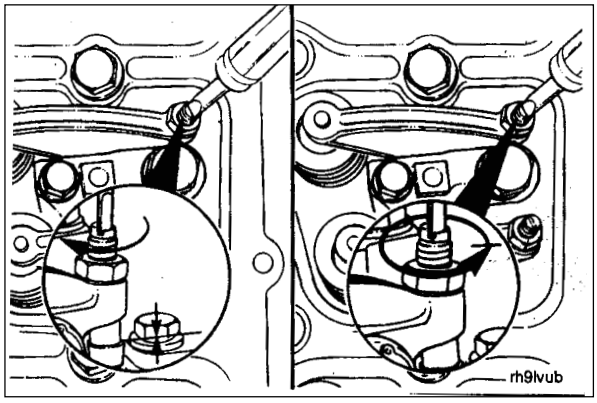
Lubricate the push rod sockets with engine oil.

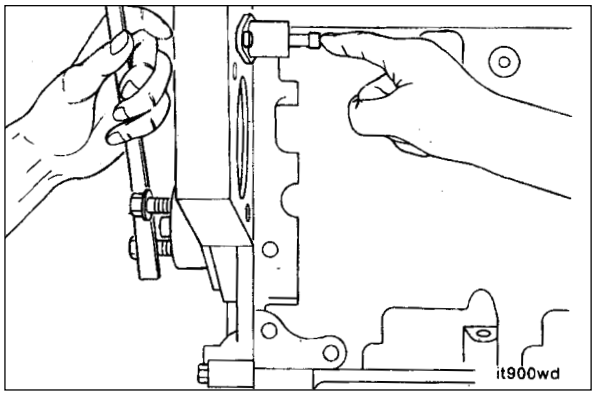




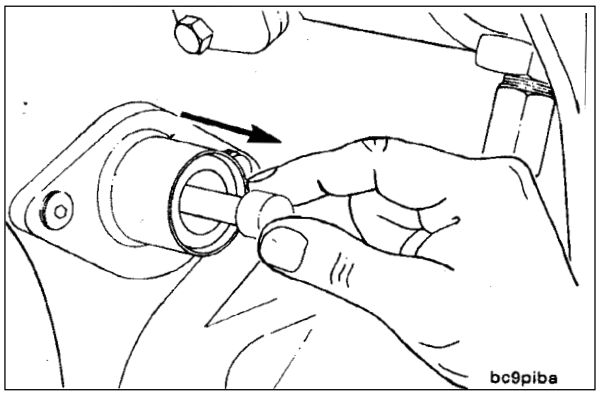
## Valve Clearance - Adjustment

Turn the valve adjustment screws in until they touch the push rod sockets. Loosen them one full turn.
Locate TDC for Cylinder Number 1.




Disengage the timing pin.



## Feeler Gauge

**Valve Stem to Rocker Lever Clearance**

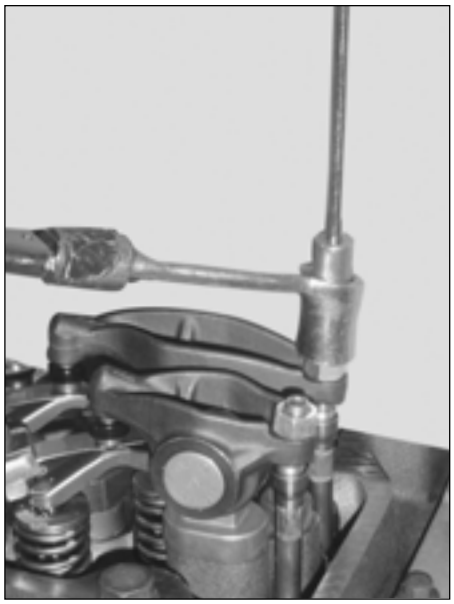
| Intake Valve | Exhaust Valve |
|---|---|
| 0.254 mm | 0.508 |

The clearance is correct when some resistance can be "felt" when the feeler gauge is pulled through the space between the valve stem and rocker lever.

Adjust the valves as indicated in the following illustrations. Tighten the locknuts and check the clearance again.

**Torque Value :** 24 N•m

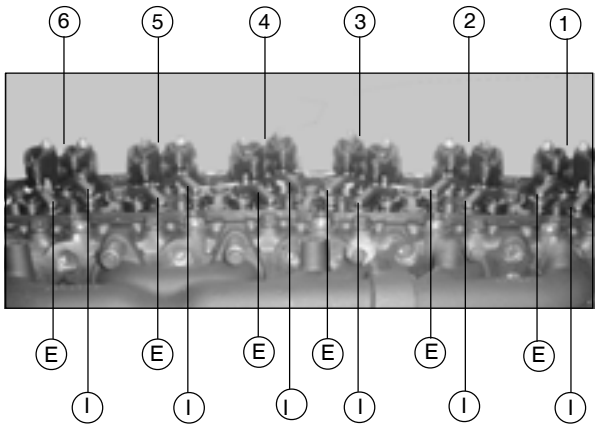
**Caution : Perform step A of the valve set procedure with Cylinder No. 1 at TDC compression stroke (timing pin will engage).**

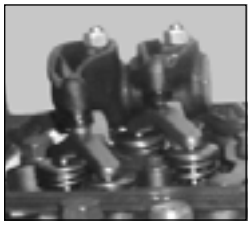


**Step A - Six Cylinder**

| | Valve | |
|---|---|---|
| Cylinder | I = Intake | E = Exhaust |
| 1 | * | * |
| 2 | * | # |
| 3 | # | * |
| 4 | * | # |
| 5 | # | * |
| 6 | # | # |

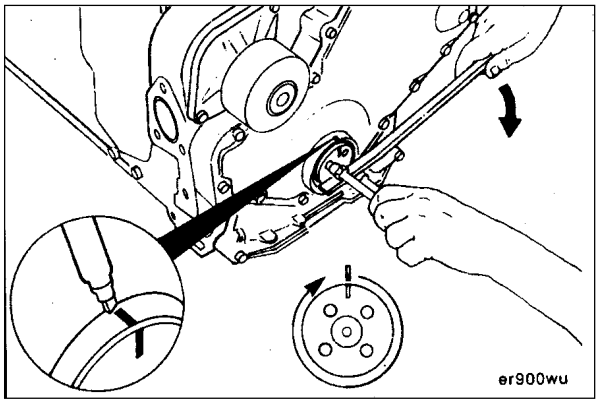
* = Set
# = Do not Set



**Perform Step B of the valve set procedure with Cylinder Number 1 at TDC plus 360 degrees (timing pin will not engage).**

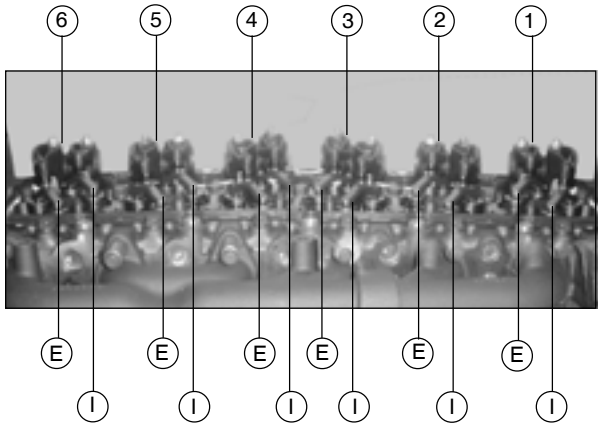
Mark the crankshaft and front cover. Rotate the Crankshaft one full turn.



**Step B - Six Cylinder**

| Cylinder | Valve I = Intake | E = Exhaust |
|---|---|---|
| 1 | # | # |
| 2 | # | * |
| 3 | * | # |
| 4 | # | * |
| 5 | * | # |
| 6 | * | * |

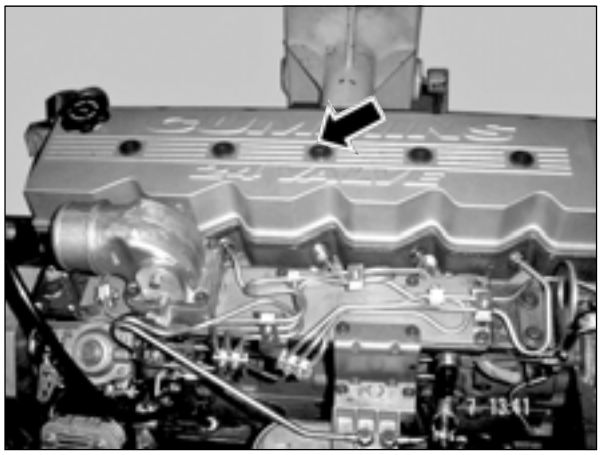
* = Set
# = Do not Set




## Valve Covers - Installation

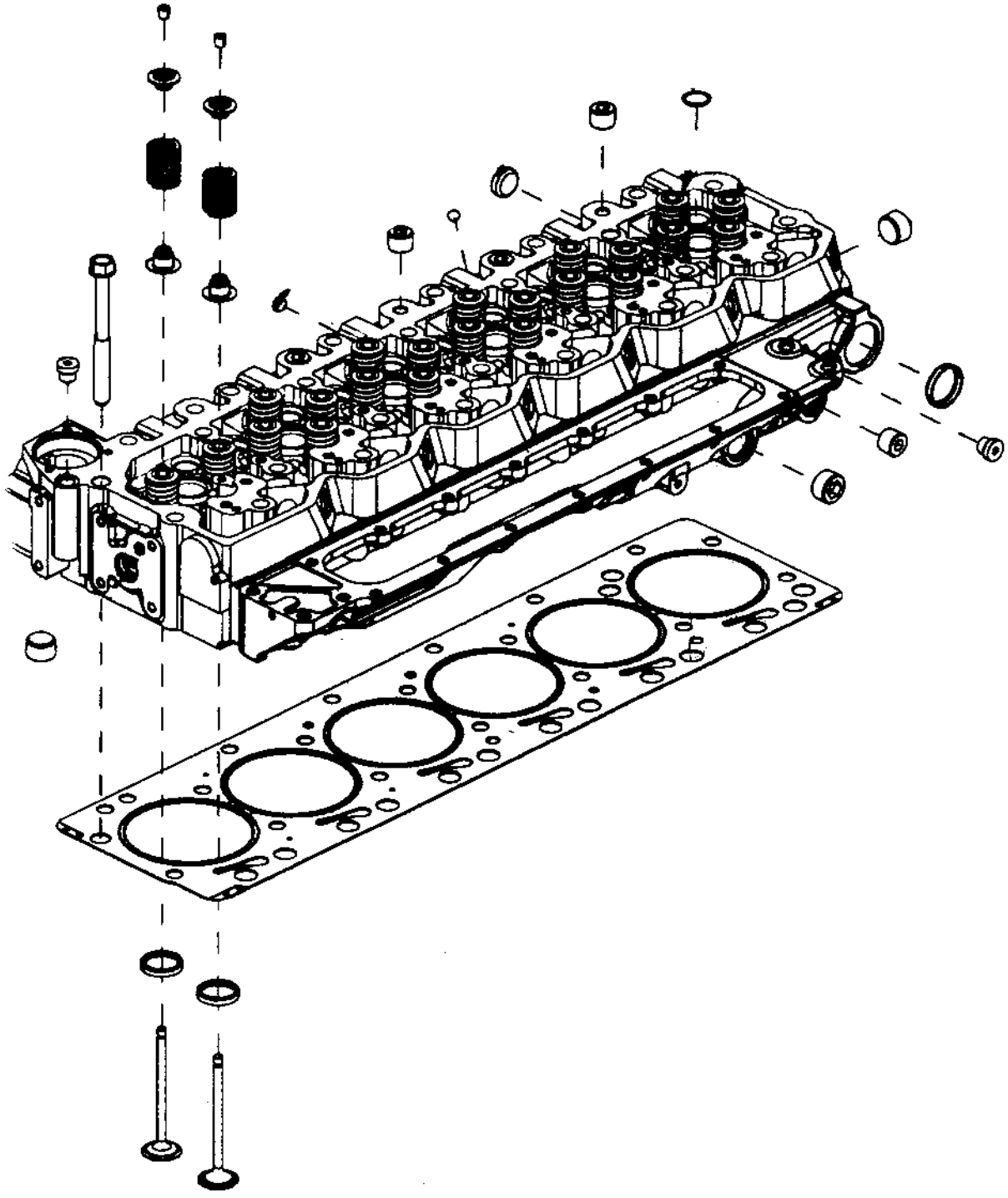
**16 mm**

Assemble the gaskets, valve covers, Isolator vibration, Plain washer and special, capscrews.



# Cylinder Head

## Exploded View

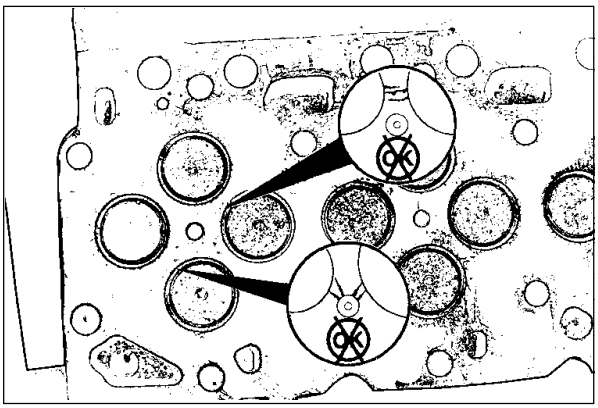


## Cylinder Head - Pre-check Before Disassembly

Clean the cylinder head with solvent.

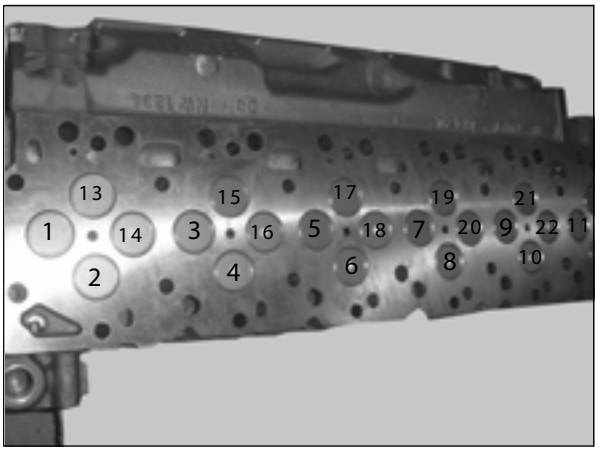


Visually inspect the cylinder head for obvious damage that would prohibit reuse. Check for cracks and damage to the combustion face that would result in loss of sealing.

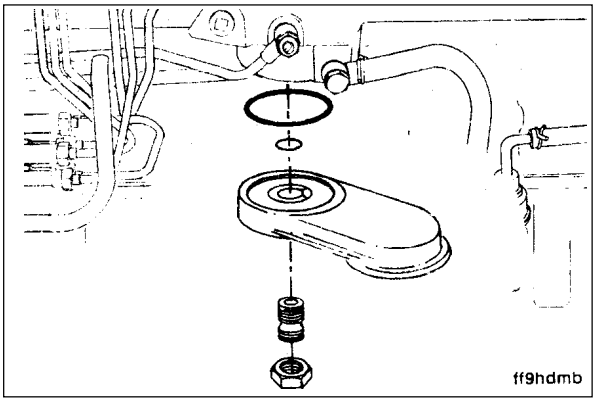


## Cylinder Head - Disassembly

Mark the valves to identify their position.




Compress the valve spring and remove the valve stem collets.

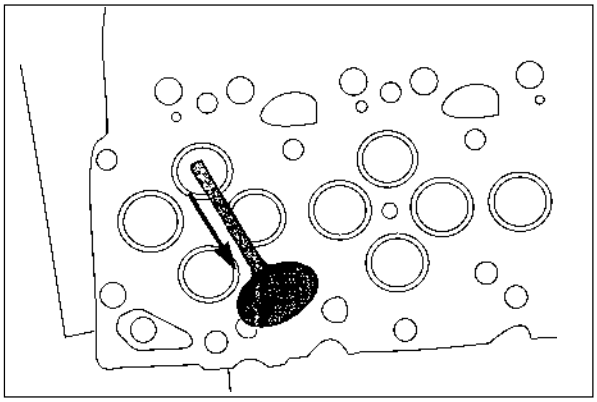


Release valve spring and remove the retainer and spring.

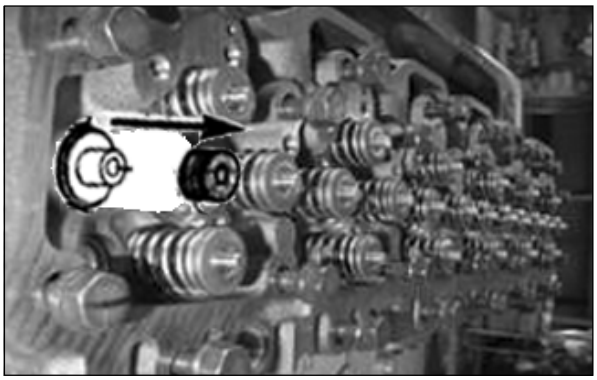


Remove the remaining collets, retainers, springs and valves.

**Keep the valves in a labeled rack for a correct match, with companion seats while making measurements.**

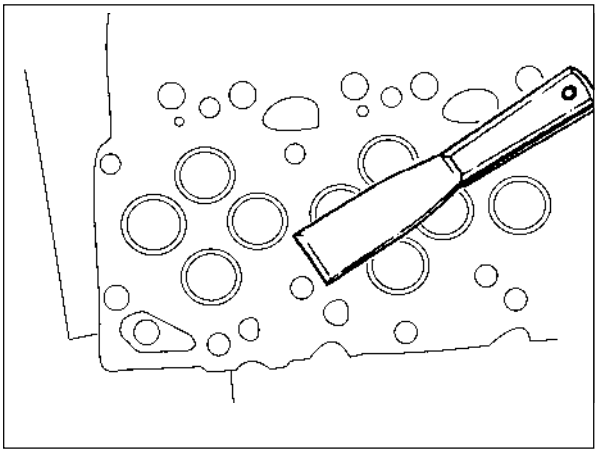


Remove the valve stem seals.



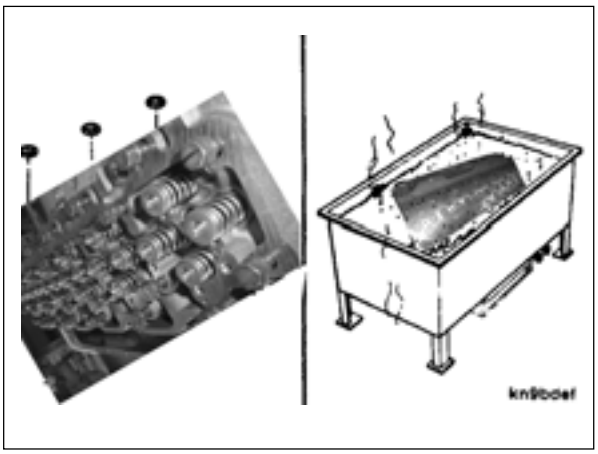
## Cylinder Head Cleaning

Clean the carbon from the injector nozzle seat.

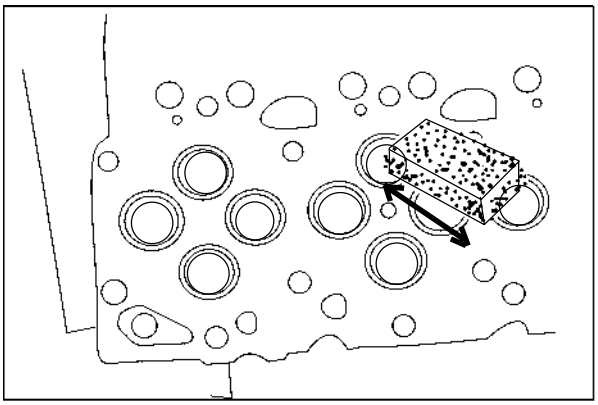


Scrape the gasket material from all gasket surfaces.

Clean the build-up of deposits from the coolant



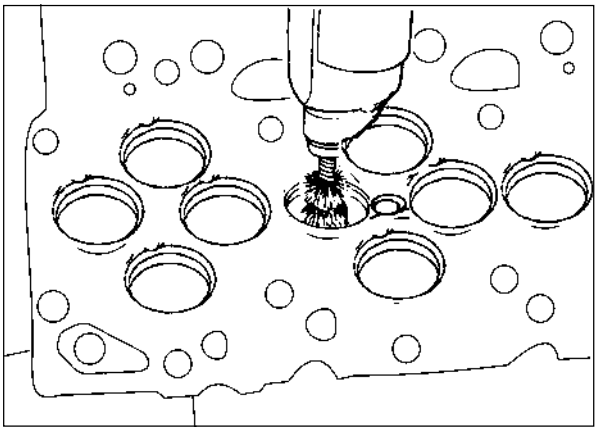
passages. Excessive deposits may be cleaned in an acid tank but the cup plugs must first be removed. Refer to Cup Plug Replacement procedure (2-10).



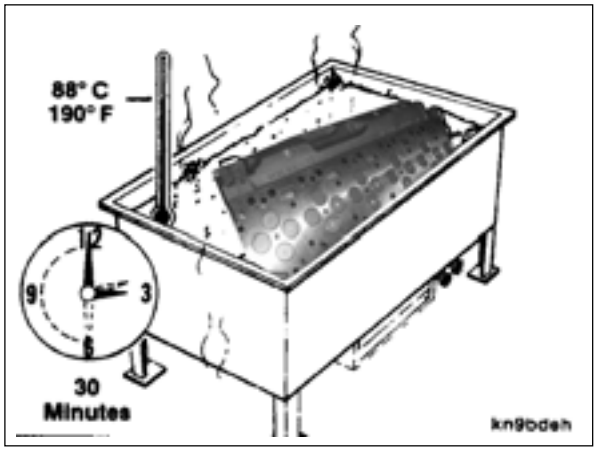
Clean the combustion face with a Scotch-Brite® pad or an equivalent cleaning pad and diesel fuel or solvent.

**Warning: Wear protective eye covering.**

Clean carbon deposits from the valve pockets with a high quality steel wire wheel installed in a drill or a die grinder.

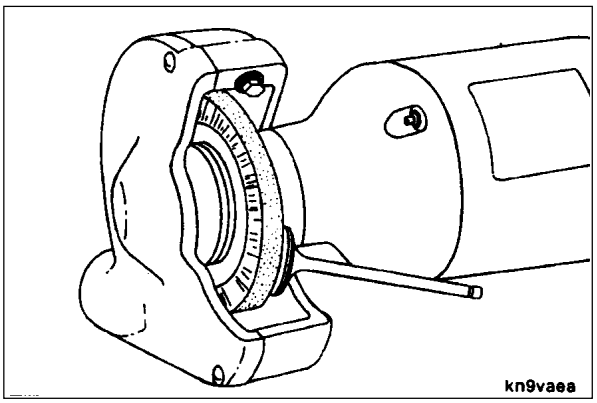


**NOTE :** An inferior quality wire wheel will loose steel bristles during operation, thus causing additional contamination.



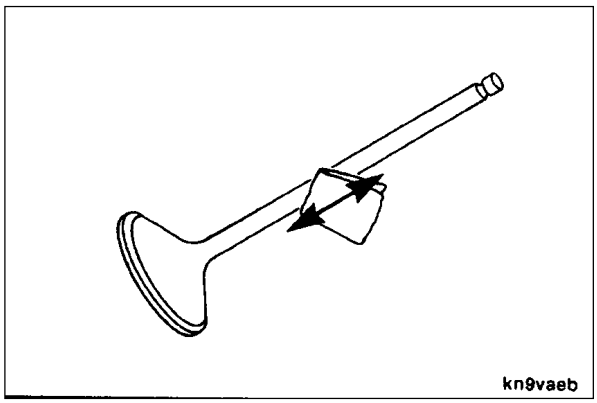

Wash the cylinder head in hot soapy water solution.

After rinsing, use compressed air to dry the cylinder head.




**Warning: Wear protective eye covering.**

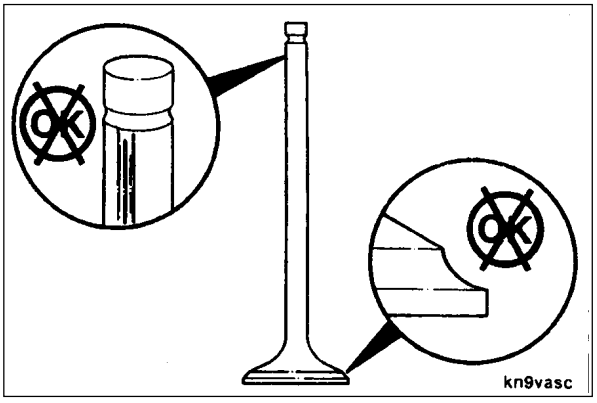
Clean the valve heads with a soft wire wheel.




## Valve - Inspection

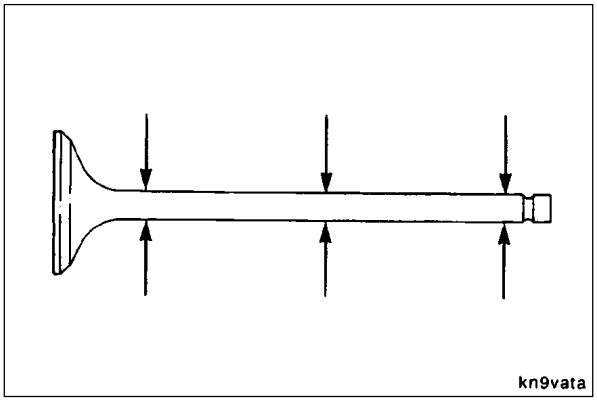
Inspect for abnormal wear on the heads and stems.

**Keep the valves in a labeled rack to prevent mixing prior to making measurements.**



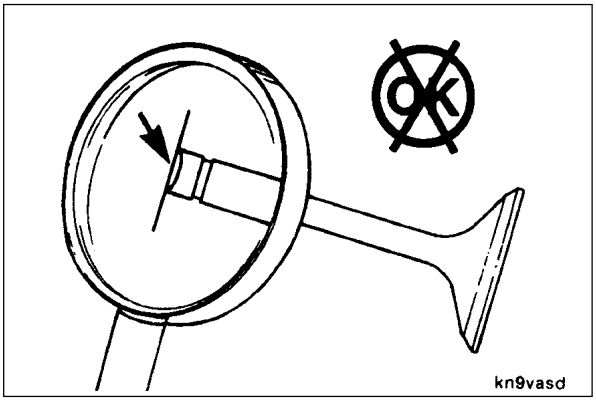
**Measure the valve stem diameter.**

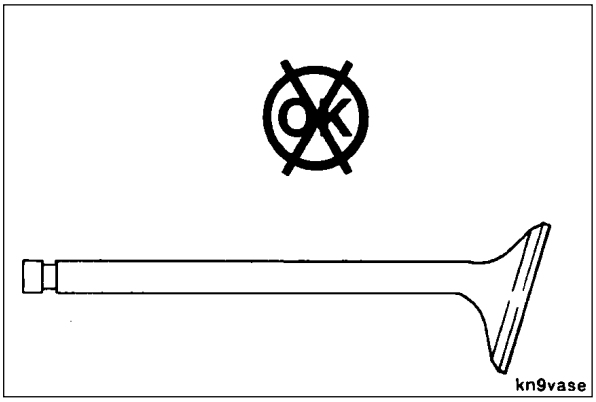
| Valve Stem Diameter | |
|---|---|
| **mm** | |
| 6.97 | MIN |
| 7.01 | MAX |




Check the valve stem tip for flatness.
Visually inspect for bent valves.

Polish the valve stem with a Scotch-Brites pad or equivalent cleaning pad and diesel fuel or solvent.



## Valve Guide Inspection

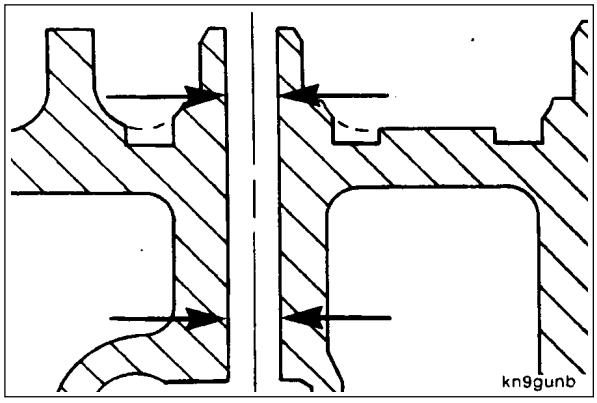
Inspect the valve guides for scuffing or scoring.

Measure the valve guide bore.

**Valve Guide Bore Diameter**

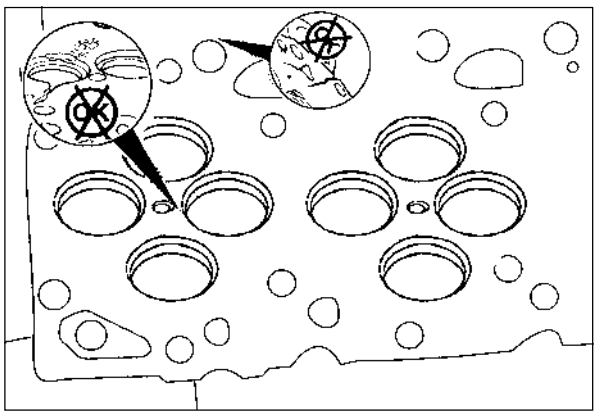
| **mm** | |
|---|---|
| 7.042 | MIN |
| 7.062 | MAX |

If the inspection reveals damaged valve guides, refer to the Alternative Repair Manual Bulletin No. 1150110003.




## Cylinder Head Combustion Face Inspection

Visually inspect the cylinder head combustion surfaces for any irregularities (dents, guttering, fire ring embedment, etc.). If any of these conditions exist, the surface must be machined in accordance with the appropriate procedure from the Alternative Repair Manual, Bulletin No. 115011 0003.

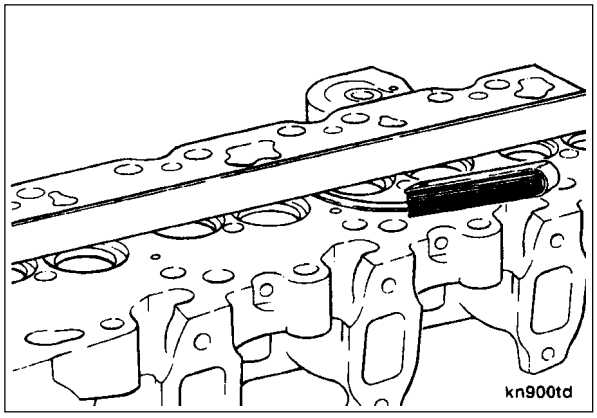


Measure the cylinder head overall flatness:

End-to-End 0.20 mm (6B)

Side-to-Side 0.076 mm

Visually inspect for any localized dips or imperfections. If present, the cylinder head deck must be reground.




## Repair Tools

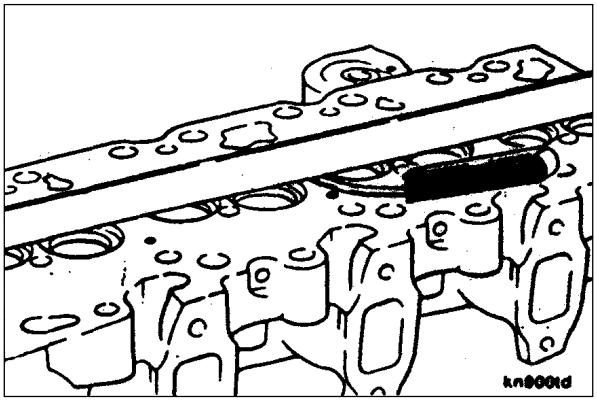
Valve Refacer

Valve Seat Grinder

Valve Guide Installation Tool

**NOTE :** The repairs can be performed with standard gasoline automotive tooling at engine repair shops

## Combustion Deck Inspection and Refacing



Inspect the head surface for nicks erosion etc.

Check for head distortion as illustrated

**Limit**

**Variation :** .010 mm in any given 50.8 mm diameter area. The overall end to end or side to side variation limit is :

0.30 mm - 6 cylinder

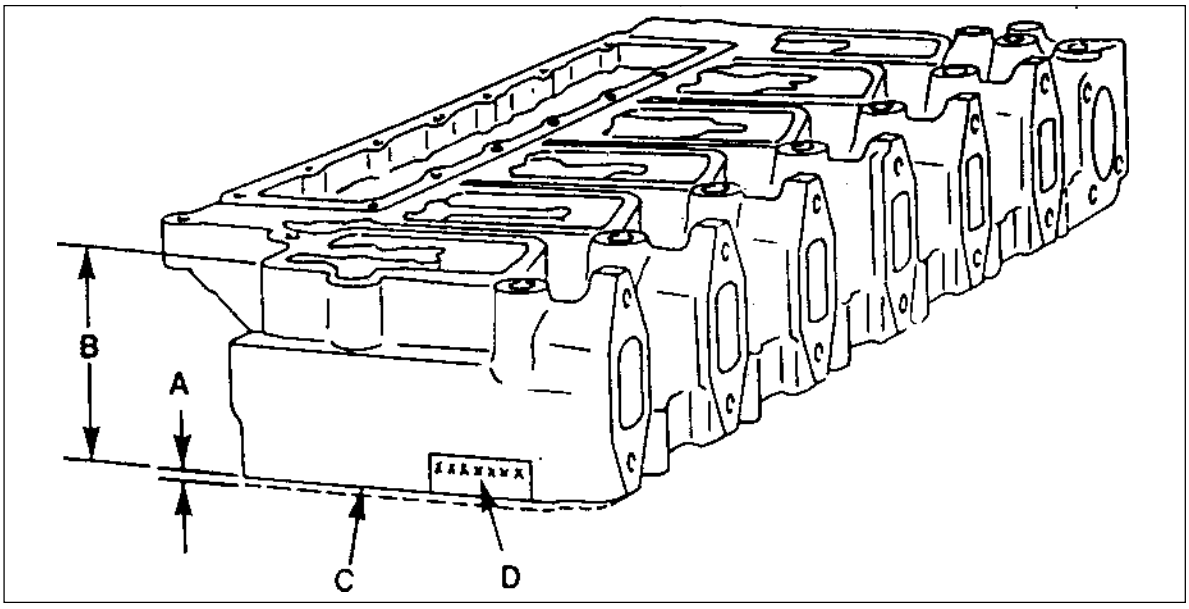
The combustion deck may be refaced in whatever increments necessary to clean up surface and maintain surface finish and flatness tolerancing as long as combined total of stock removal on all clean ups do not exceed 1.00 mm. Each amount of stock removed must be steel stamped just above edge of combustion deck on lower right and corner of rear face.

A = 1.00 mm total

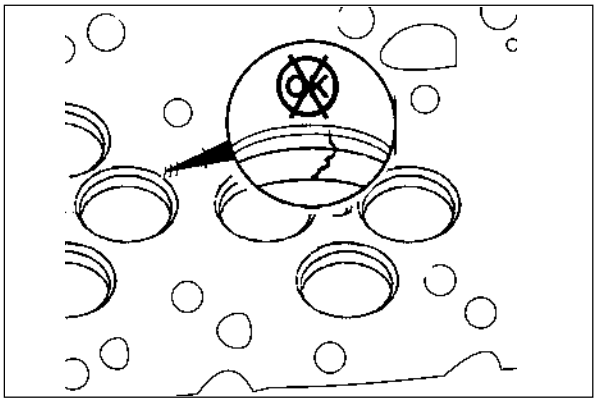
B = 94.00 ± 0.25 mm Minimum (reference only)

C = Surface finish 1.5 to 3.2 micrometers

D = Identification area for stamping amounts of stock removed




## Valve Seat Inspection

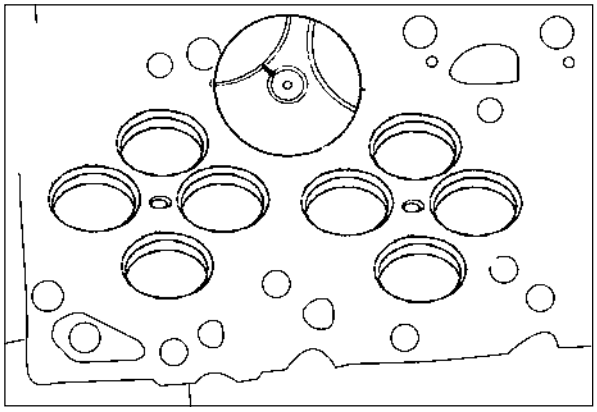


Inspect the valve seats for cracks or burned spots.

Refer to the following reuse guidelines for any cracks discovered. Service valve seats are available for seats with burned spots that will require more than 0.254 mm grinding to clean up.

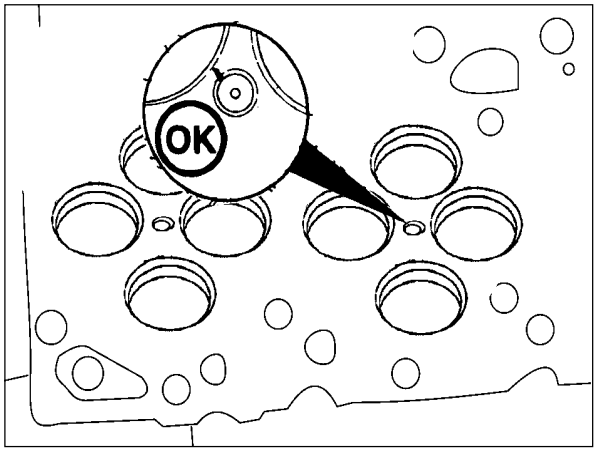
## Cylinder Head Cracks - Reuse Guidelines

These guidelines apply **only** to cracks extending through the valve seats.

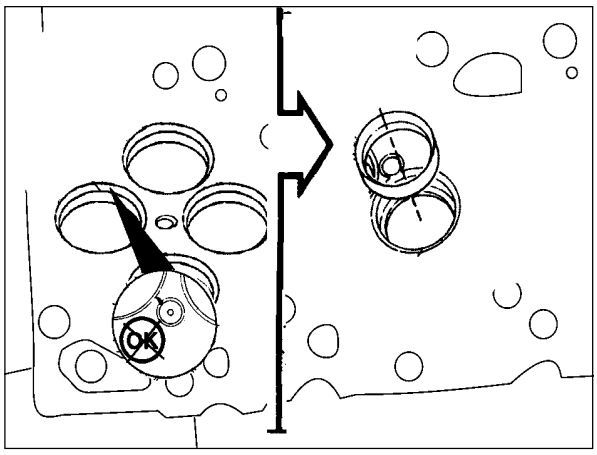


The reuse guidelines for a cylinder head with a crack extending from the injector bore to the valve seat is as follows:

If the cracks does not extend into the valve seat, the head is reusable.




If the crack extends into or through the valve seat, the head must be repaired by installing a valve seat insert as per the Alternative Repair Manual, Bulletin No. 1 5011 0003.




## Valve Spring Inspection

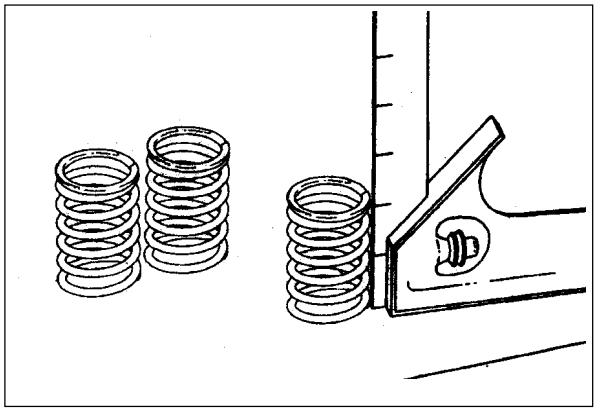
Inspect the Valve Springs.

Measure the valve spring.

**Limits**

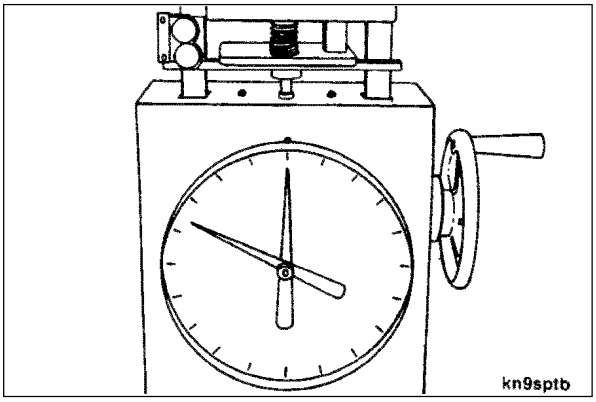
Approx. Free Length (L): 55.63 mm

Maximum Inclination : 1.0 mm



**Spring Specifications**

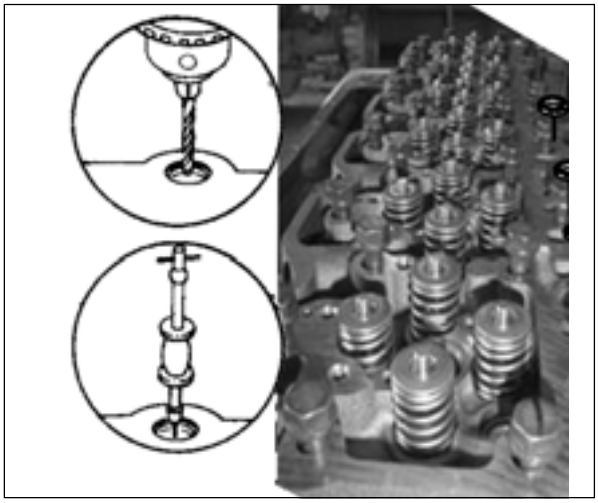
| Spring Color | Approximate Free Length | Load at 49.25 mm Height |
|---|---|---|
| Blue 55.63mm | | 289.13 to 321.16 N |
| White | 70.64mm | 643.2 to 691.2 N |




## Cup Plug Replacement

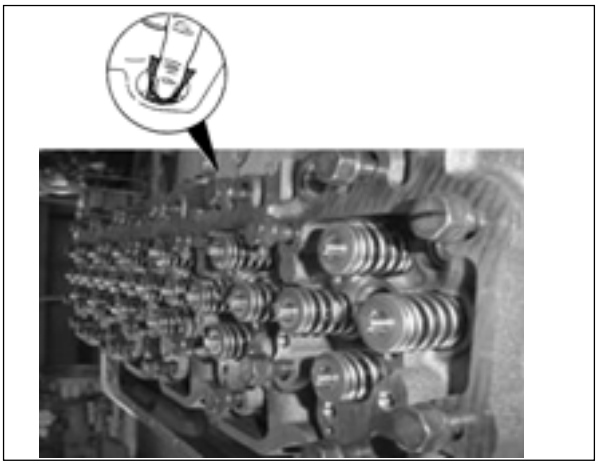
**Drill Motor, 3 mm [1/8 inch drill bit, slide hammer, #10 metal screw**

Remove the cup plugs from the cylinder head.



**400 grit sandpaper, Diesel Fuel**

Thoroughly clean the cup plug holes.

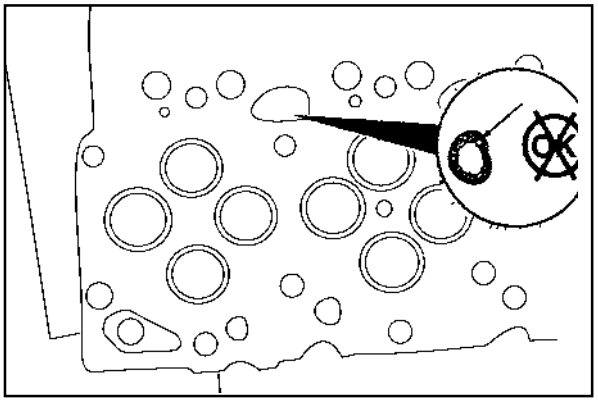


**Caution: Use protective clothing to prevent personal injury.**

Inspect for build-up of deposits in the coolant passages which can cause engine overheating.

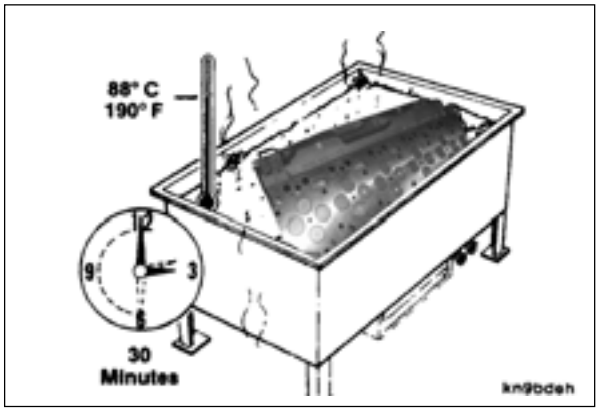
Be sure the coolant passages are clean.

Excessive deposits may be cleaned in an acid tank, but the cylinder head must be disassembled first.



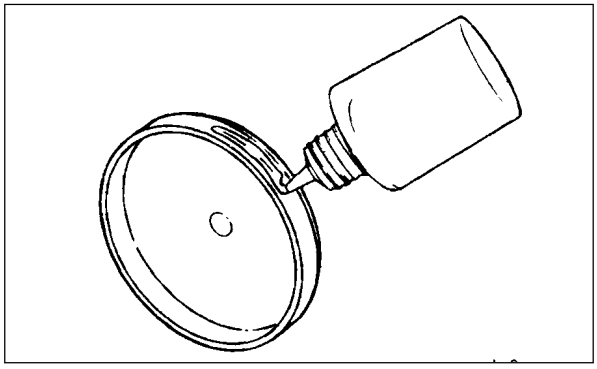
**Caution: Use protective clothing to prevent personal injury.**

The cylinder head may be cleaned in a hot tank using a soap and water solution.



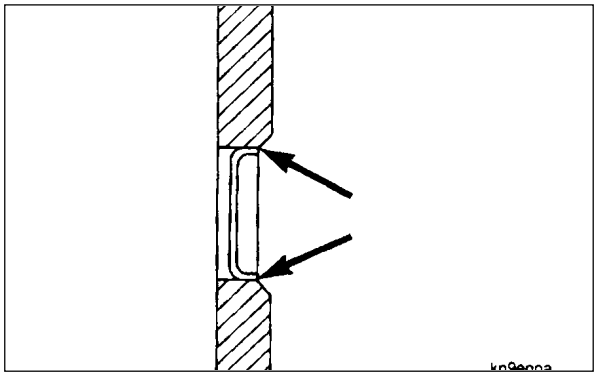

**NOTE:** The cup plugs and cup plug holes must be clean and free of oil before installing the cup plugs.

Apply a bead of Locate™ 277 around the outside diameter of all cup plugs before installing.



**Cup Plug Driver**

Drive all cup plugs in until the outer edge is flush with the counter sink.



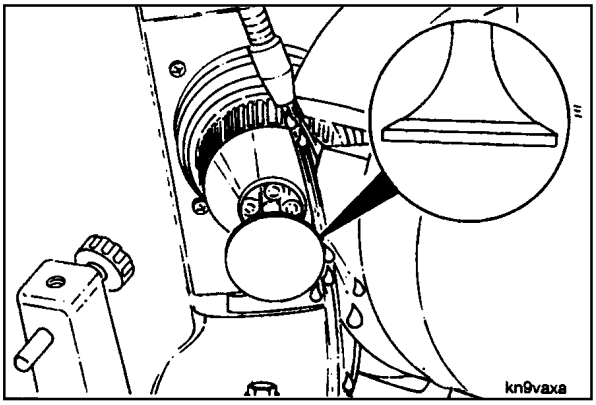


**Cup Plug Locations**

1. 13/16 inch

## Valves - Grinding

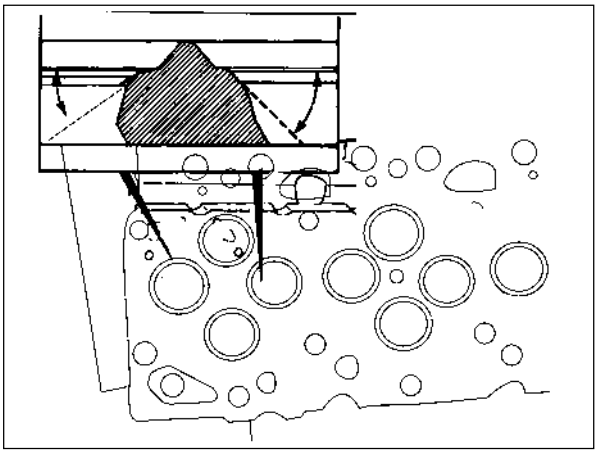
Re-face all reused valves. Check/replace bent valves.




**Seat Angle**

**Intake :** 30 Degrees

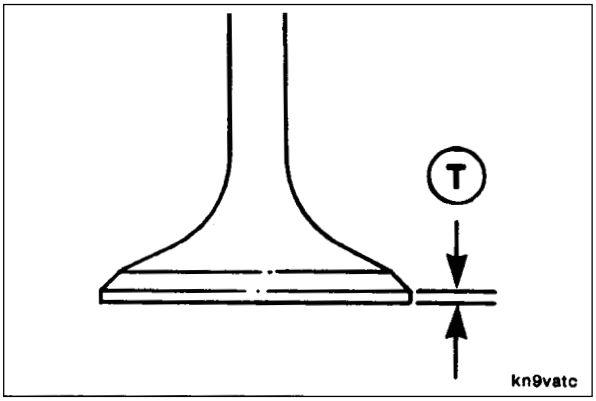
**Exhaust :** 45 Degrees



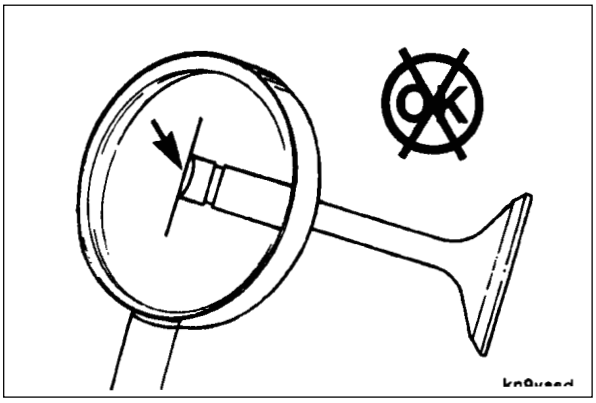
Measure rim thickness.

**Valve Rim Thickness**

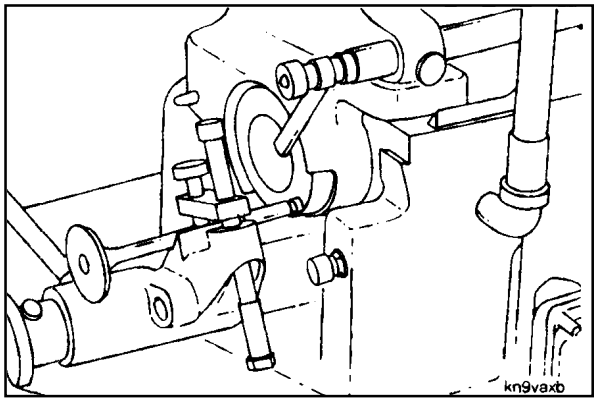
**Minimum (T) :** 0.79 mm




Check the valve stem tip for flatness.



If required, re-surface the tip.

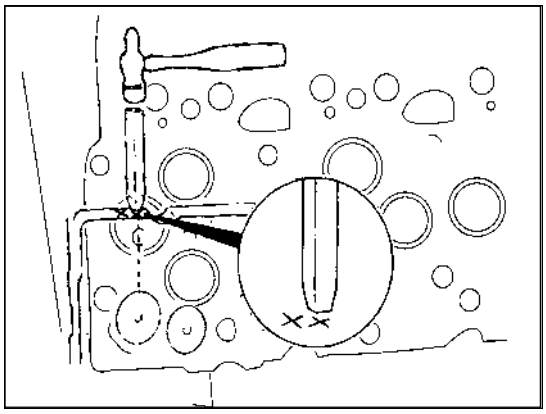



## Valve Seats - Grinding

The illustrated marks indicate valve seats have been ground previously. Additional grinding will result in grinding past the induction hardened area.

Replace previously re-ground seats will with service seats.

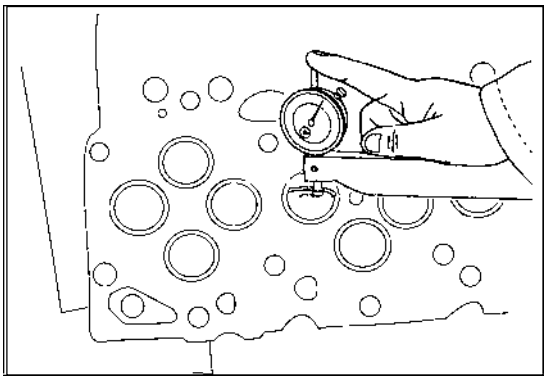
Refer to the Alternative Repair Manual, Bulletin No. 115011 0003.



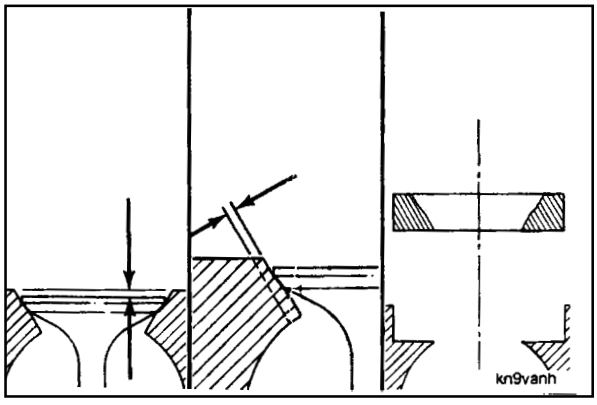
### Calculating the Grinding Depth

#### Measuring the Valve Depth

install the valves in their designated location and measure the valve depth.



There are two valve seat parameters that are critical to the valve grinding process. The first is to comply with the valve depth limits and the second is to not grind through the hardened layer of the valve seat by observing the grind depth limit. If either of these parameters are out of specification, refer to the 'alternative Repair Manual," Bulletin No. 1150110003.

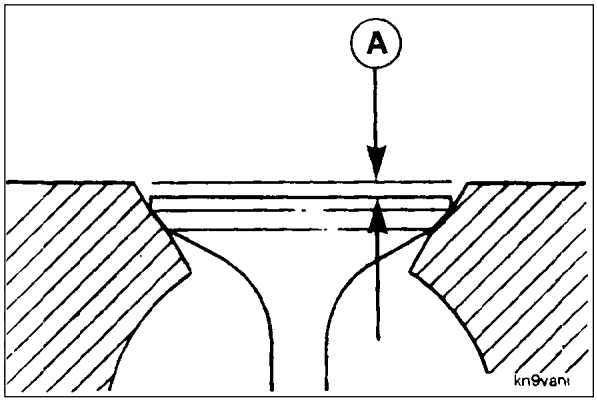


The valve depth is the distance from the valve face to the head deck.

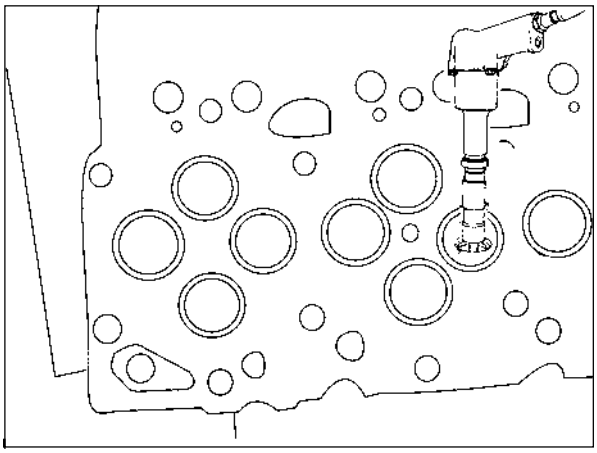
Record the depth of each valve as (A).

| Valve Depth | |
|---|---|
| 0.99 mm | MIN |
| 1.52 mm | MAX |

If valve depth does not meet specification the valve seat must be replaced.



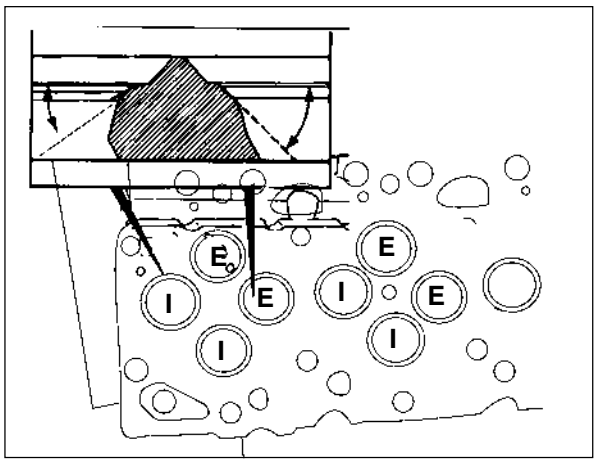

After valves meet initial valve depth criteria, grind the valve seats to remove all scores, scratches and burns.



**Seat Angle**

**Intake :** 30 Degrees

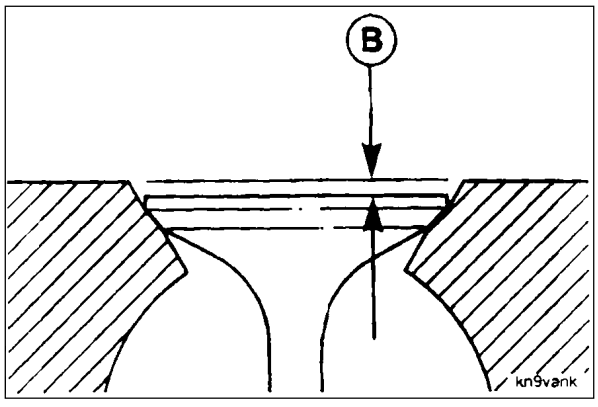
**Exhaust :** 45 Degrees




Since the seats have been ground, it is necessary to re-measure the valve depth and to calculate the grinding depth.

Install the valves in their respective bores and measure the depth. Record the depth of each valve as (B).

**Make sure the seats are clean before you measure the depth.**



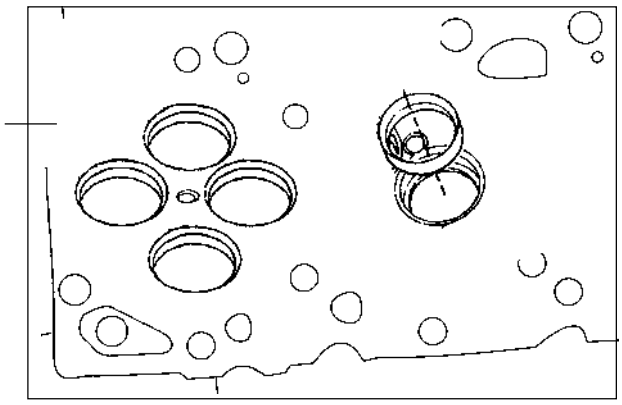
Calculate grinding depth (GD) as follows:

G D = (B) -(A)

**Seat Grinding Depth Limit**

GD: 0.254 mm

Service valve seats are available for over the limit seats.

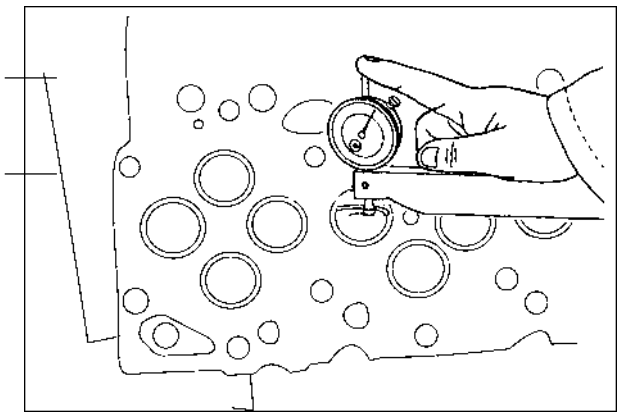


Confirm that the valve depth after grind (B) is still within the original specification.

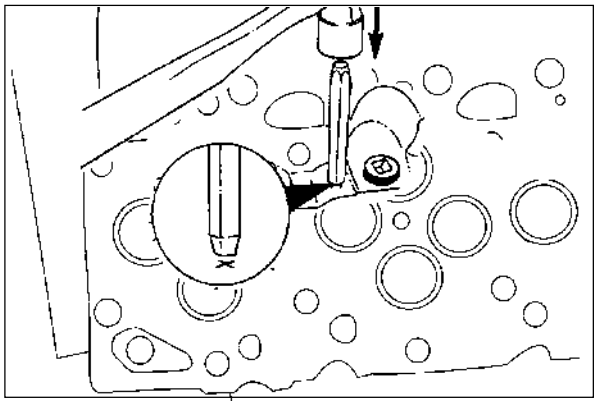
**Valve Depth**

Compress the valve spring after assembling the spring and retainer.

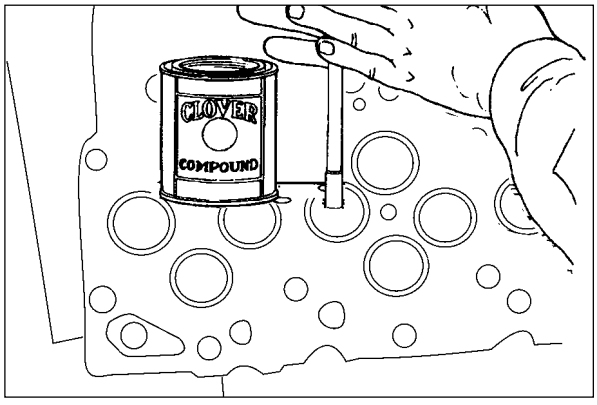
Install new valve collates and release the spring tension.



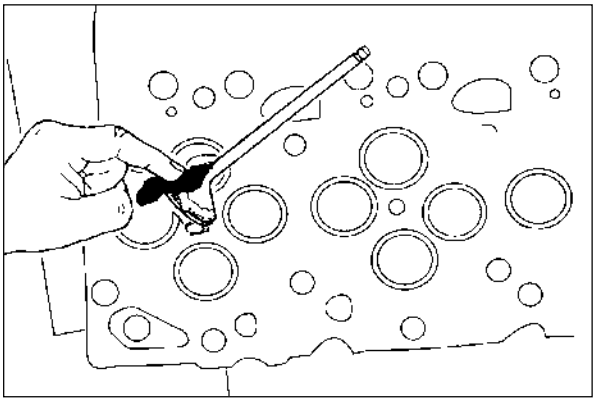
Mark the cylinder head with an (X) to identify each reground valve seat.




Apply a light coat of valve lapping compound to each valve and lap each valve to its companion seat.

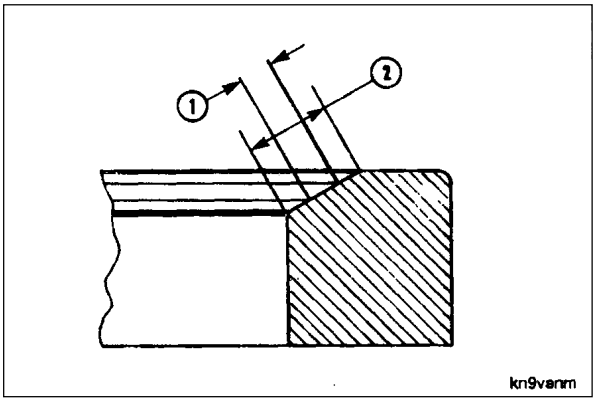


Remove the valves and clean the lapping compound from the valves and seats.



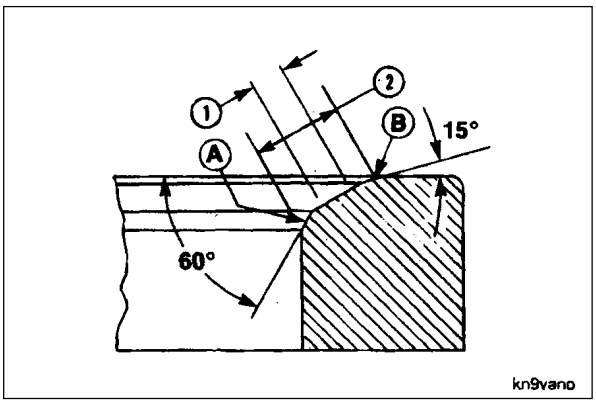
The valve should seat in the center of the valve face. Measure the valve seat width indicated by the lapped surface.

| Valve Seat Width Limit | |
|---|---|
| 1.5 mm | MIN (1 ) |
| 2.0 mm | MAX (2) |



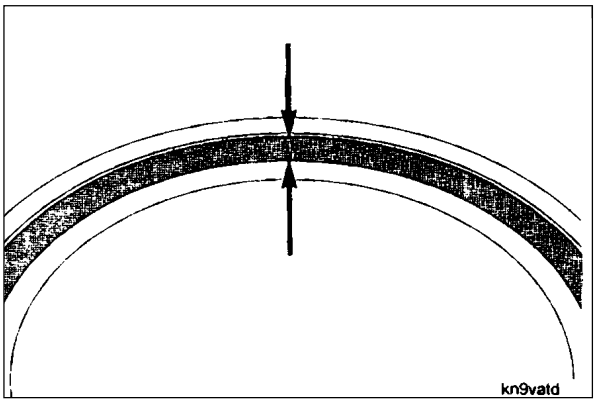

Grind area (A) with a 60 degree stone and (B) with a 15 degree stone to center the seat on the valve face and obtain the valve seat width limits.

| Valve Seat Width Limit | |
|---|---|
| 1.5 mm | MIN |
| 2.0 mm | MAX |

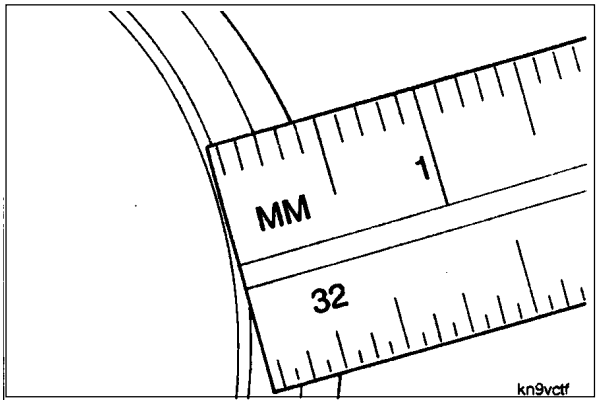



The lapped surface on the valve face is the key to determining how much of each angle to grind.

If the lapped surface is at the bottom of the valve face, the seat will require more grinding with the 60 degree stone than with the 15 degree stone.



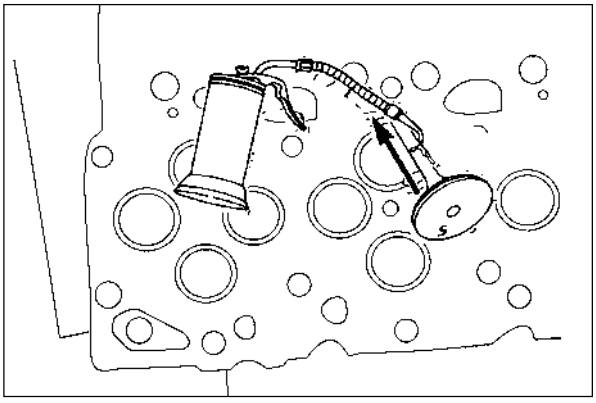
If the lapped surface is at the top of the valve face, the seat will require more grinding with the 15 degree stone than with the 60 degree stone.



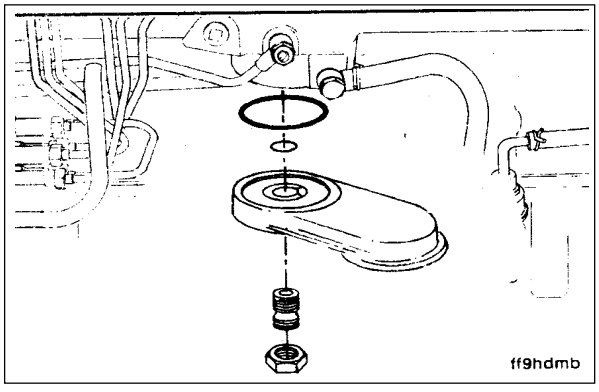

After centering the seat on the valve face, coat the valve face with Dykem™ Steel Blue™ and allow to dry.



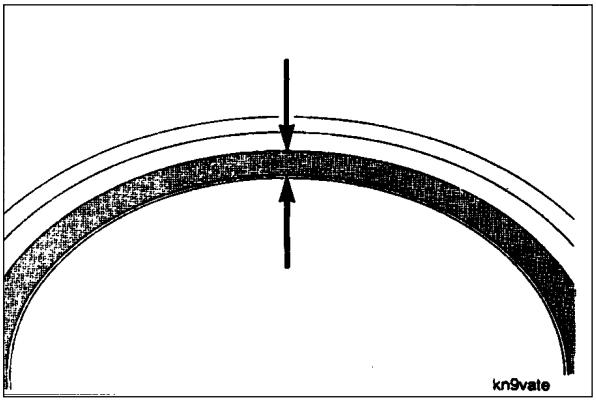
Apply a coat of valve lapping compound to the valve and lap the valve to its companion seat.



Remove the valve and clean the lapping compound from the valve face and seat.



Inspect the valve face for seat width and centering.




| Valve Seat Width | | |
|---|---|---|
| Intake | 1.79 ± 0.30 mm | MIN |
| Exhaust | 2.1 ± 0.30 mm | MAX |

## Installing Service Valve Seat (s)

If it is necessary to install guides, install the valve guides before installing the service seats.

**Intake valve insert pocket machining. (Valve Insert Part No. 3906854)**

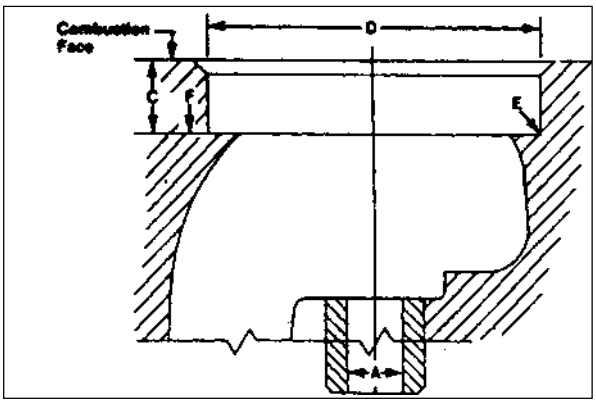
A = 7.052 ± 0.010 mm

C = 8.2 ± 0.0.90 mm

D = 34.85 ± 0.013 mm diameter

E = 0.79 ± 0.1 mm radius maximum

F = 3.2 micrometers surface finish




## Exhaust Valve Insert Pocket Machining (Valve Insert Part No. 3904105)

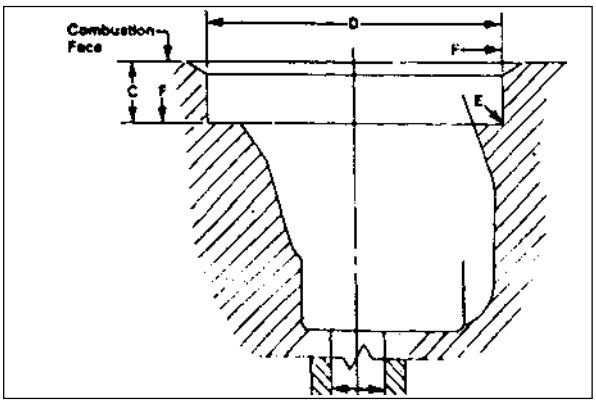
A = 7.052 ± 0.010 mm diameter

C = 8.2 ± 0.09 mm

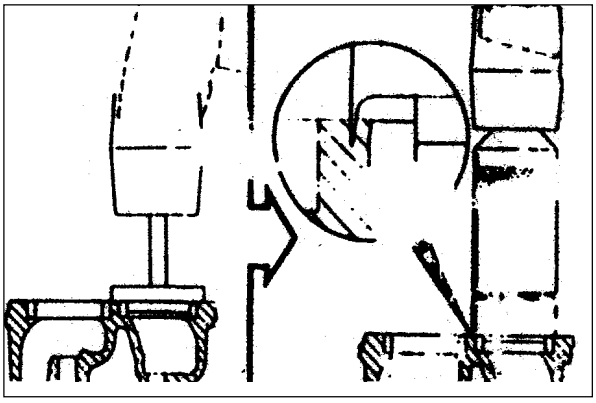
D = 34.85 ± 0.013 mm diameter

E = 0.79 ± 0.10 mm radius maximum

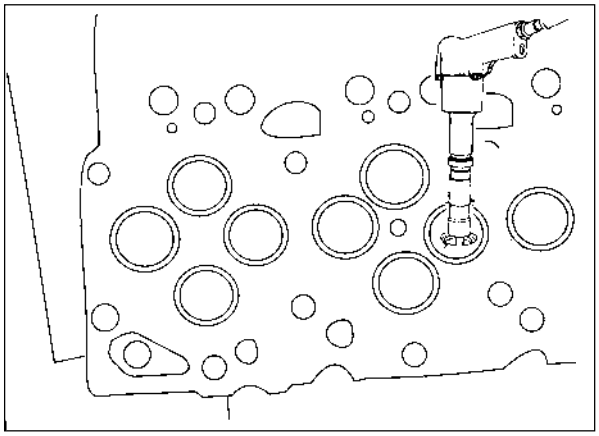
F = 3.2 micrometers surface finish



Press Service seals into machined pockets
Take the valve seats into the pockets.



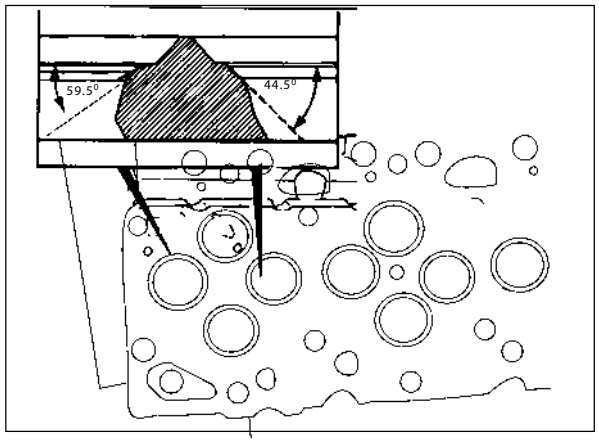
Grind the valve seats lightly to ensure proper seat angle.



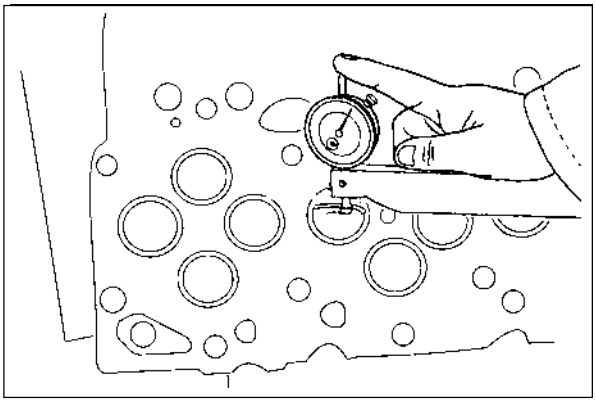
**Seat Angle**

**Intake :** 59.5$^0$ Degrees

**Exhaust :** 44.5$^0$ Degrees

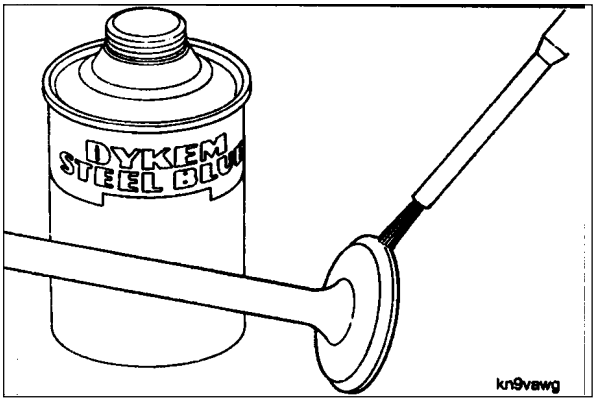



Install the valves in their designated location and ensure the depth



## Cylinder Head - Assembly





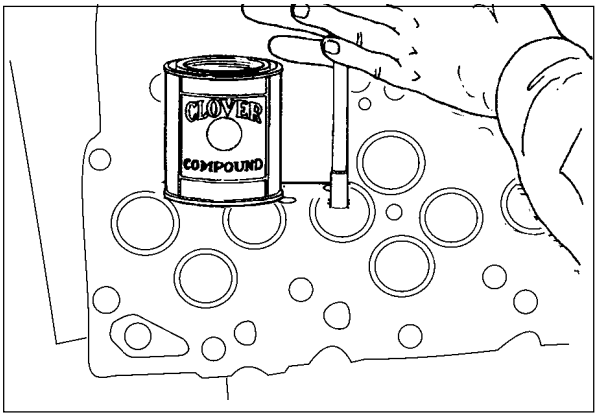

**NOTE :** Clean all cylinder head components before assembling.

Install the valve stem seals.

The intake and exhaust seals are the same.



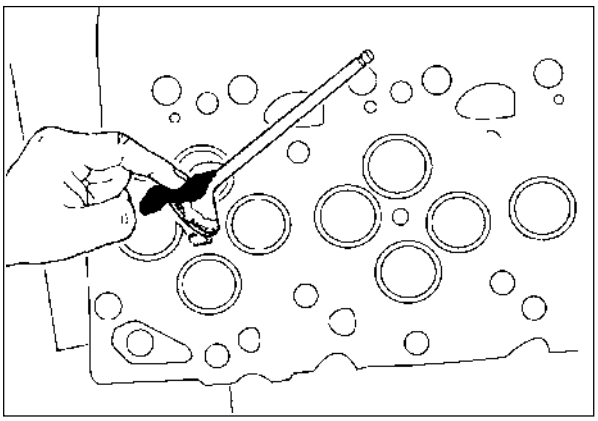





Lubricate the stems with SAE $90^0$ engine oil before Installing the valves.

**Valve Spring Compressor**

Compress the valve spring after assembling the spring and retainer.



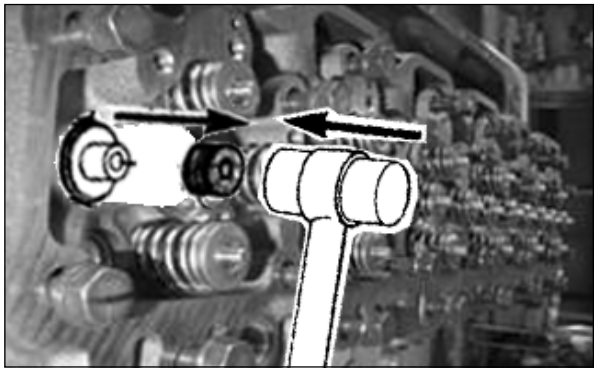
Install new valve collates and release the spring tension.



**Plastic Hammer**

**Warning: Wear eye protection. If the collets are not correctly installed, they can fly out when the stems are hit with a hammer**

After assembly, hit the valve stems with a plastic hammer to make sure that the collets are seated.



## Cylinder Head - Installation

**Caution : Make sure the cylinder head and block surface are clean and not nicked or gouged.**

**Mallet**

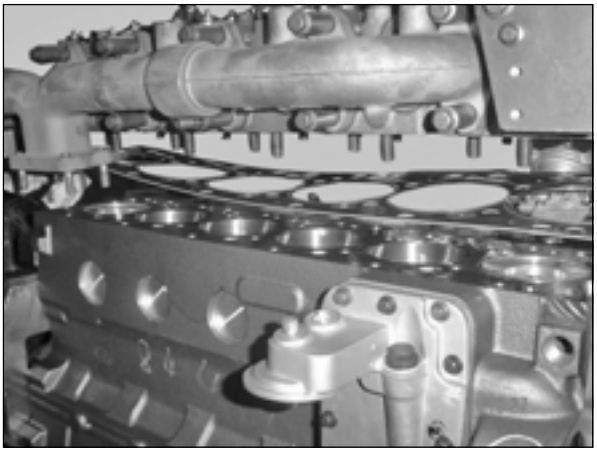
If removed, install the two cylinder head dowels. Drive the dowels to the bottom of the dowel bore.

**Caution: Make sure the gasket is correctly aligned with holes in the block.**

Position the head gasket over the dowels.



Carefully put the cylinder head on the block and seat it onto the dowels.

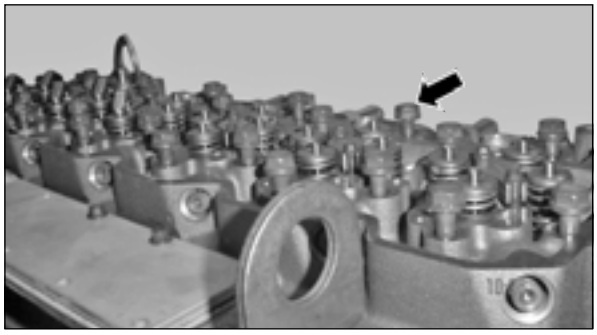


## Cylinder Head - Tightening

Lubricate the 12 mm pedestal/head capscrew bolt threads and under the capscrew heads with engine oil.

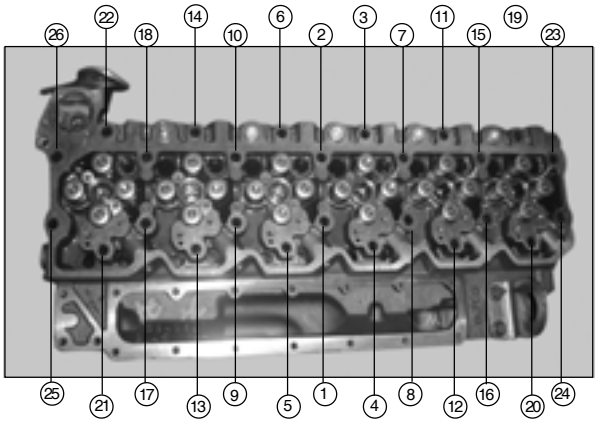
Install the capscrews finger tight.
Lubricate the threads and under the heads on the remaining head capscrews with engine oil.

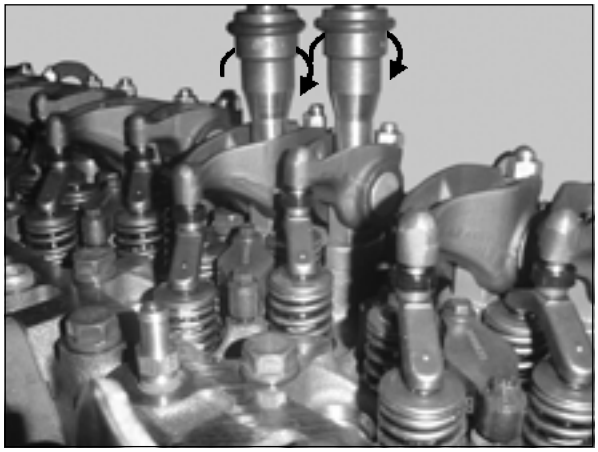
Install the capscrews finger tight.



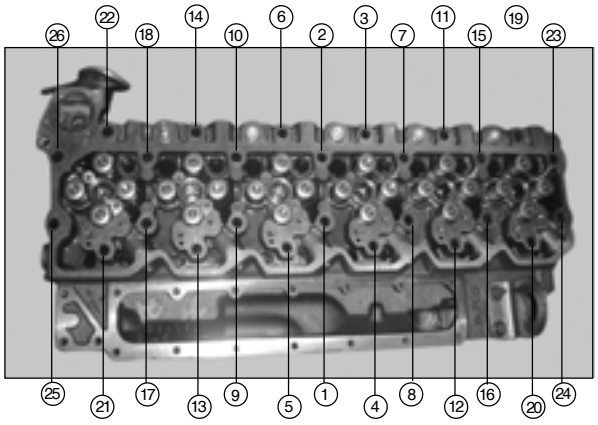
Use the illustrated sequence to tighten the cylinder head capscrews.

Follow the numbered sequence as shown above and tighten all capscrews to 90 Nm.

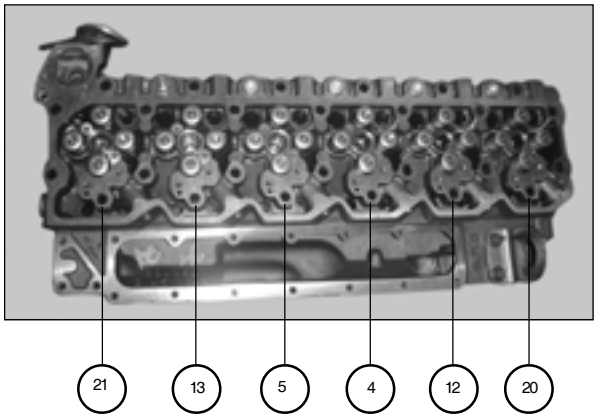


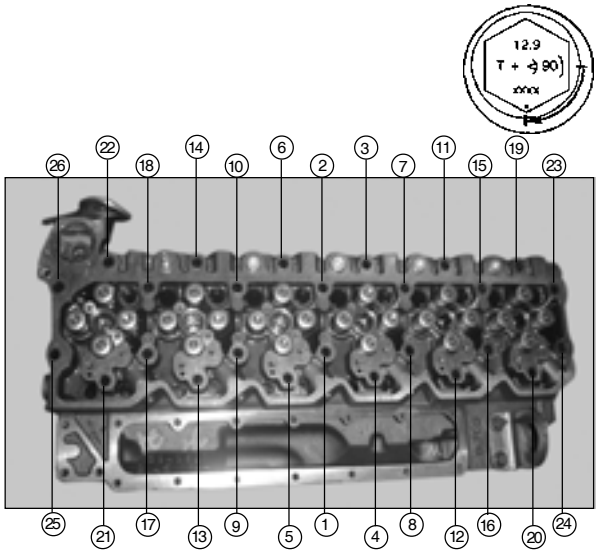
Follow the numbered sequence and recheck the torque on all capscrews to 90 Nm.



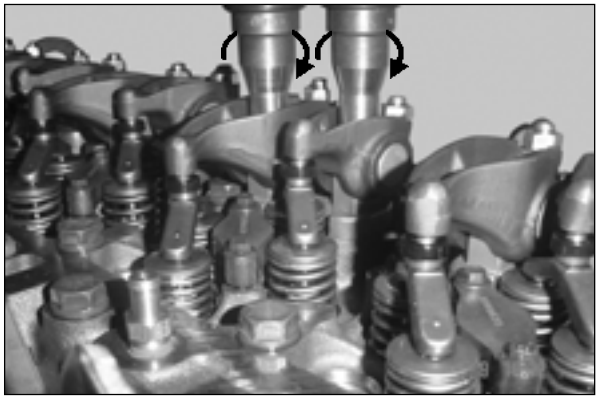
Follow the numbered sequence and tighten ONLY THE SIX CAPSCREWS (No. 4, 5, 12, 13, 20, 21) to 120 Nm.



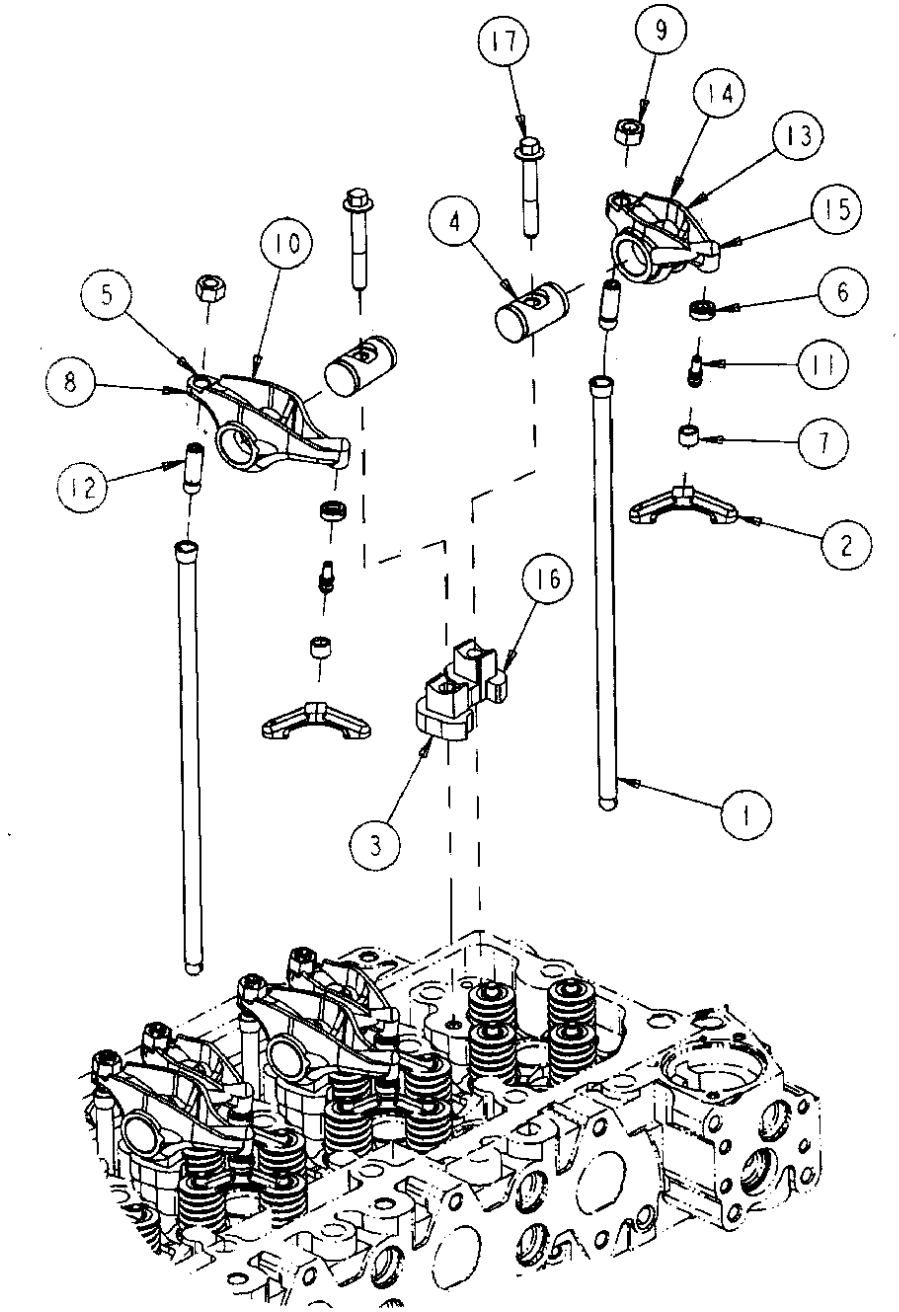

Follow the numbered sequence and turn all capscrews an additional 90⁰ of rotation.




As an overcheck to make sure all capscrews have been rotated 90⁰, check the torque on all capscrews to 136 N•m. If any capscrews turn at 136 N•m loosen only that capscrews and retighten using the above mentioned sequence.



## Rocker Lever Assembly Exploded View




| SL.NO | PART NAME | QTY |
|---|---|---|
| 1 | ROD PUSH | 12 |
| 2 | CROSS HEAD VALVE | 12 |
| 3 | ASSEMBLY ROCKER LEVER | 6 |
| 4 | SHAFT ROCKER LEVER | 12 |
| 5 | LEVER ROCKER | 6 |
| 6 | RETAINER SOCKET | 12 |
| 7 | SOCKET ROCKER LEVER | 12 |
| 8 | LEVER ROCKER LEVER | 6 |
| 9 | NUT HEAVY HEXAGON | 12 |

| SL.NO | PART NAME | QTY |
|---|---|---|
| 10 | LEVER ROCKER | 6 |
| 11 | BALL ROCKER LEVER | 12 |
| 12 | SCREW RKR LEVER ADJUSTING | 12 |
| 13 | LEVER ROCKER | 6 |
| 14 | LEVER ROCKER | 6 |
| 15 | LEVER ROCKER | 6 |
| 16 | SUPPORT ROCKER LEVER | 6 |
| 17 | SCREW HEX FLANGE HEAD CAP | 12 |

## Rocker Levers - Removal



**14 mm, Allen key 6 mm**

Loosen the nuts on the rocker lever adjusting screws and loosen screws until they stop.



**10 mm**

Remove lever, shaft, support, cross head, socketer, ball and retainer by unscrewing hex flange head cap.











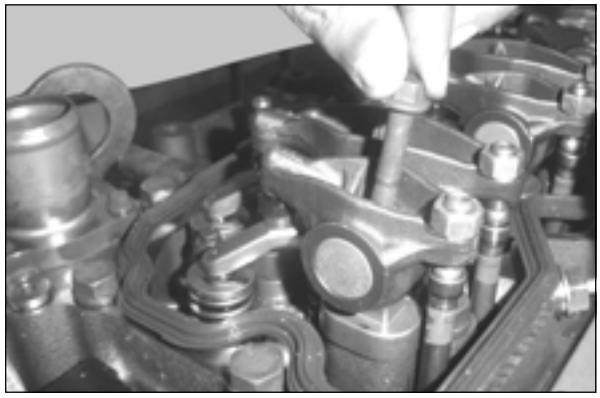
## Rocker Levers - Disassembly



**10mm Spanner**

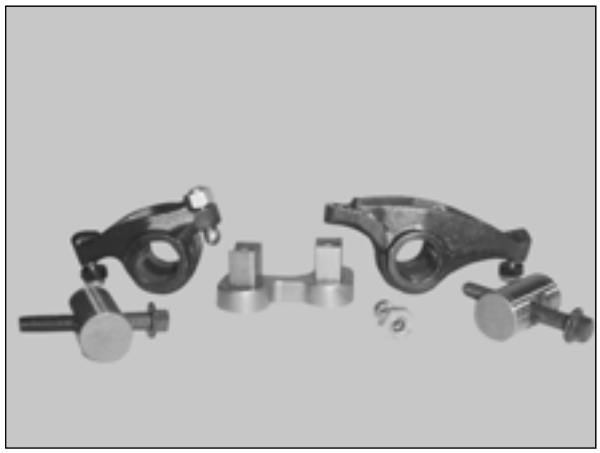


Unscrew Hex flange head cap.





Remove rocker levers with shaft.



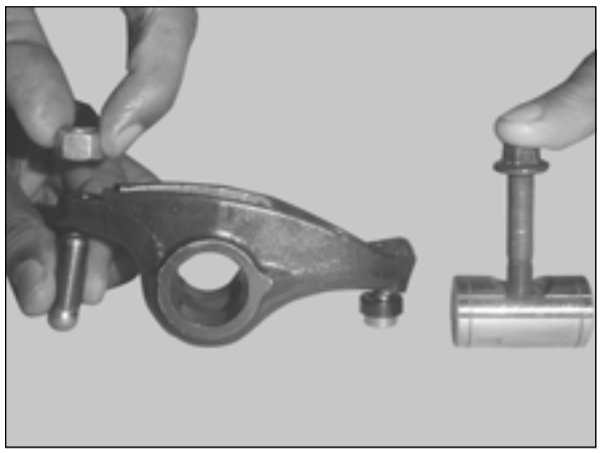


Remove support rocker lever and cross head.





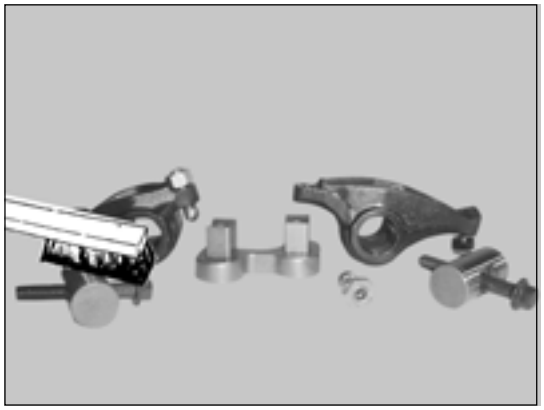
Remove the locknut and adjusting screw.

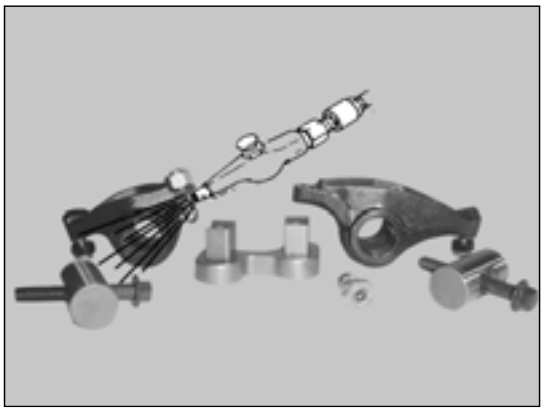


## Rocker Levers and Pedestals - Cleaning

Clean all parts in a strong solution of laundry detergent in hot water.

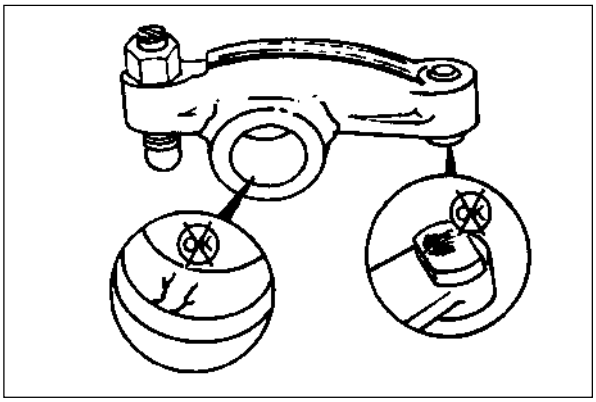
Use compressed air to dry the parts after rinsing in clean, hot water.





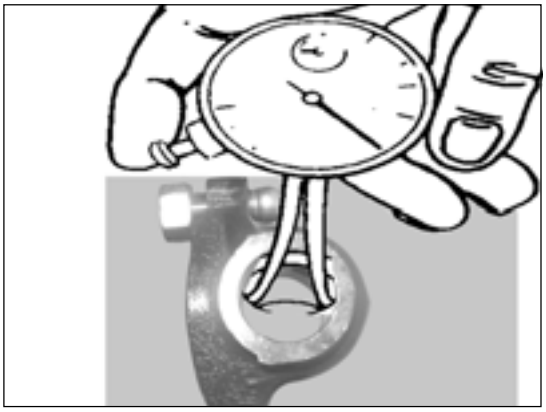
## Rocker Lever - Inspection

Inspect for cracks and excessive wear in the bore and the contact surface for the valve stem.



Measure the rocker lever bore.

| Diameter | |
|---|---|
| mm | |
| 22.000 | MIN |
| 22.051 | MAX |



## Rocker Lever Pedestals - Inspection

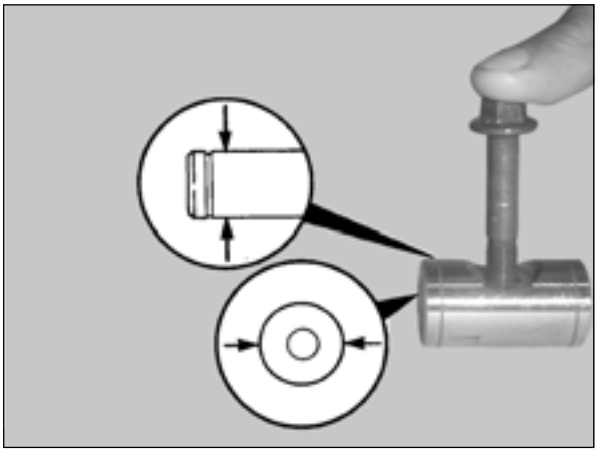




Inspect the pedestal and shaft for obvious damage.

Measure the shaft diameter.

| Diameter | |
|---|---|
| **mm** | |
| 21.940 | MIN |
| 22.031 | MAX |



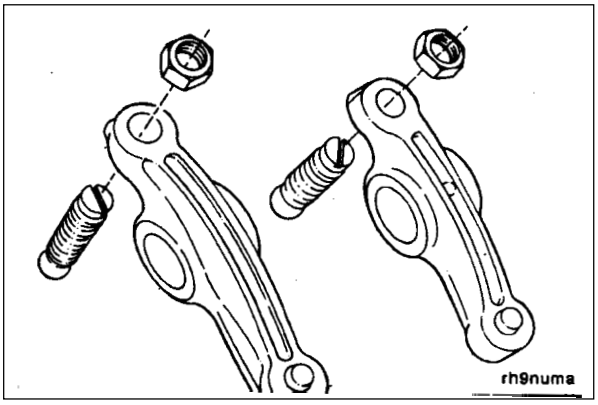
## Rocker Levers - Assembly



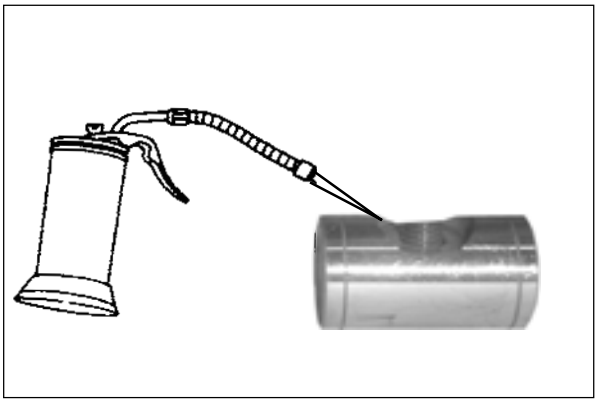
Install the adjusting screw and locknut.

Lubricate the shaft with clean engine oil.

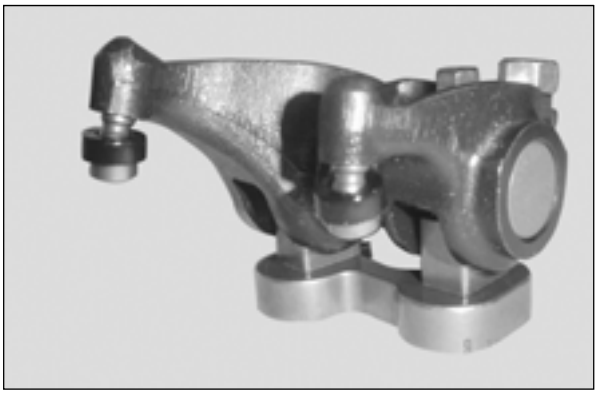
Position the levers on the rocker shaft.





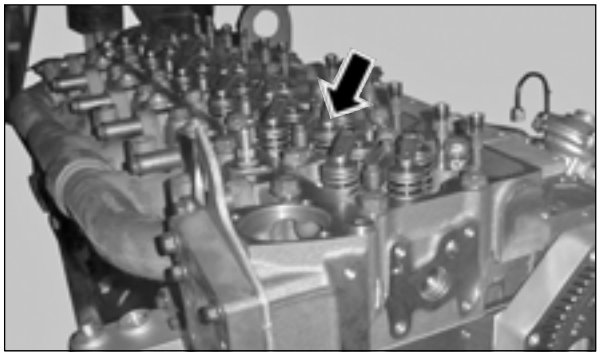







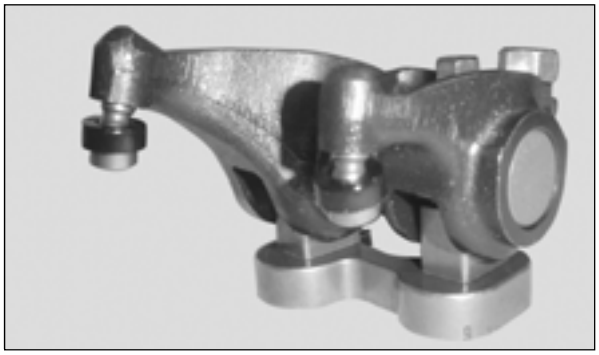
## Rocker Levers - Installation

Lubricate the valve stems with engine oil.

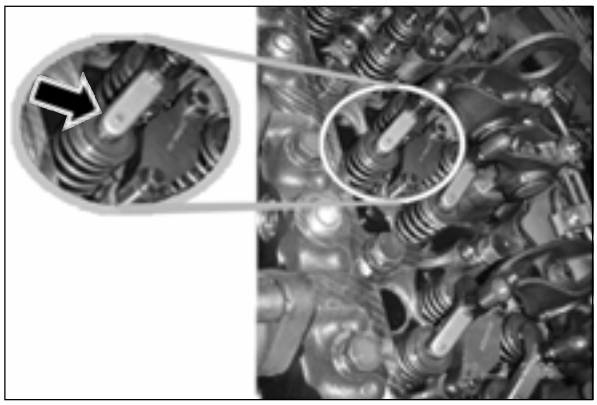


**14 mm, 6 mm**

Completely loosen the rocker lever adjusting screws.



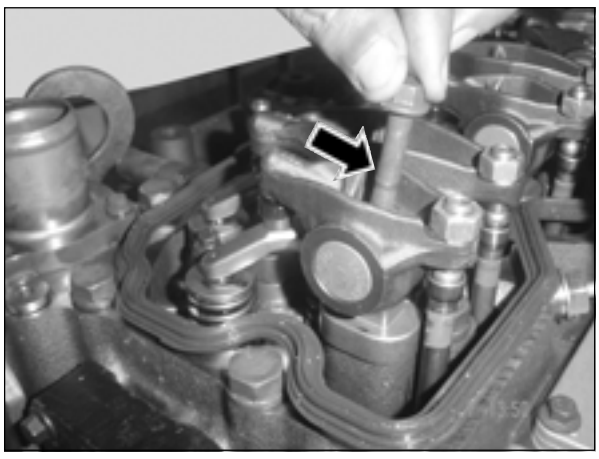
- 'Point' Mark on the Cross Head - Valve has to be assembled towards Exhaust Manifold side
- 'Point' Mark on the Cross head - valve has a Elongated slot on the bottom side



**NOTE :** The rocker lever pedestals are aligned with dowels. Install the pedestals.

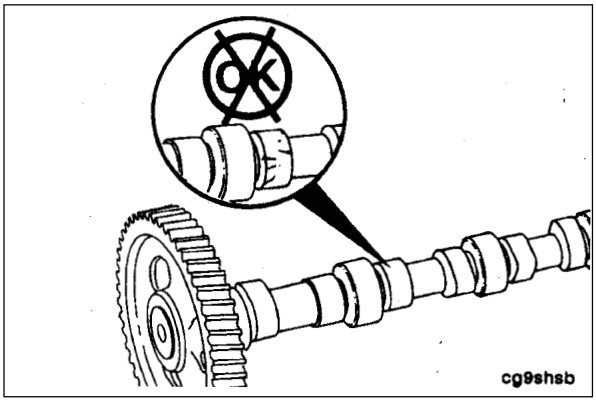
Lubricate the 8mm pedestal capscrew threads and under the capscrew heads with engine oil.

Place retainer socket rocker lever assembly cross head valve and socketer, ball, retainer in position.

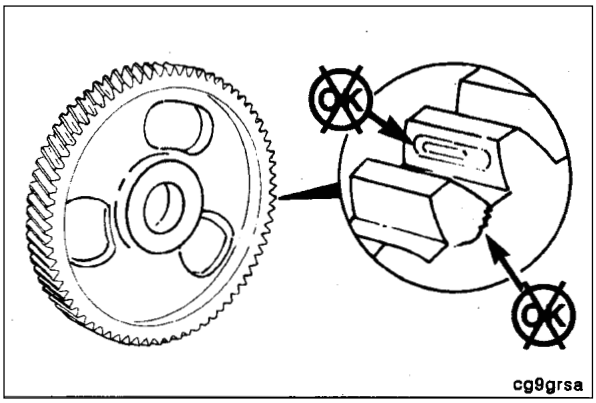


## Camshaft and Gear - Inspection

Inspect the lift pump lobe; valve lobes and bearing journals for cracking, pitting or scoring.

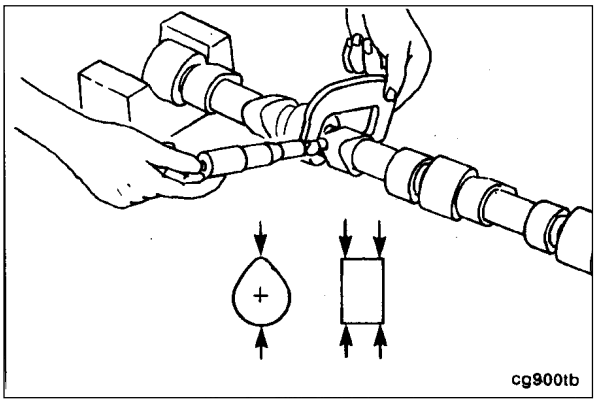



Inspect the gear teeth for pitting; look for cracks at the root of the teeth.



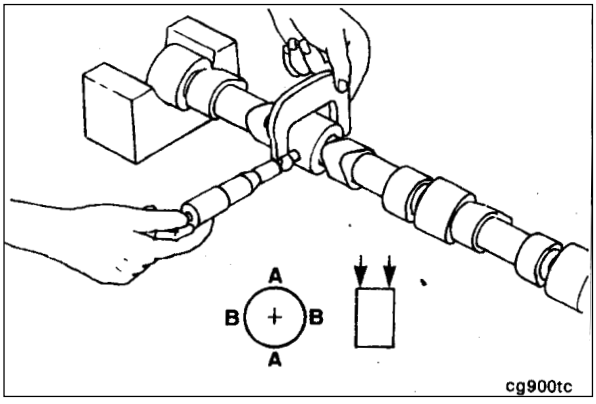

Measure the fuel transfer pump lobe and valve lobes.

| | Diameter at Peak of Lobe mm | |
|---|---|---|
| Intake | 47.173 | MIN |
| | 47.853 | MAX |
| Exhaust | 45.654 | MIN |
| | 46.334 | MAX |
| Lift Pump | 35.500 | MIN |
| | 36.260 | MAX |



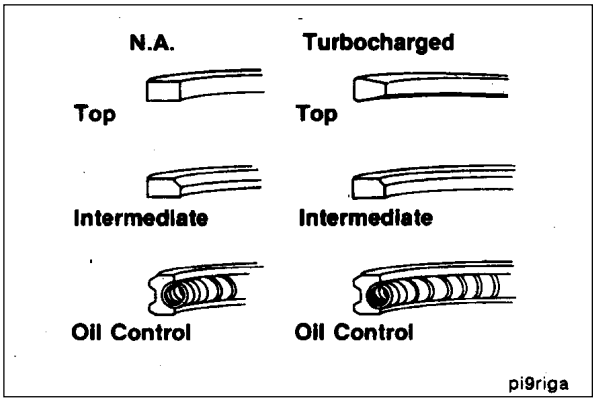

Measure the bearing journals.

| Journal Diameter mm | |
|---|---|
| 53.962 | MIN |
| 54.013 | MAX |



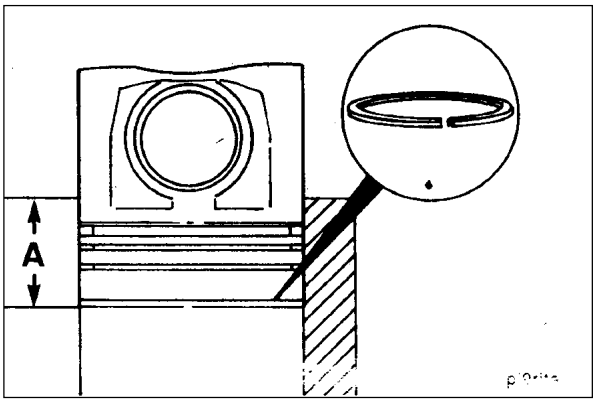
## Piston Ring Gap - Checking

**The top ring for a turbocharged engine is not the same as the top ring for a naturally aspirated engine.**



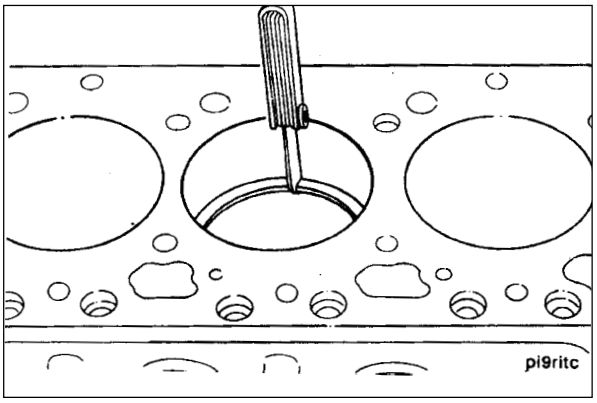

Position each ring in the cylinder and use a piston to square it with the bore.

A - 89 mm




Use a feeler gauge to measure the gap.

| | mm | Ring Gap |
|---|---|---|
| **Top** | 0.26 | MIN |
| | 0.36 | MAX |
| **Intermediate** | 0.85 | MIN |
| | 1.15 | MAX |
| **Oil Control** | 0.25 | MIN |
| | 0.55 | MAX |



## NOTES

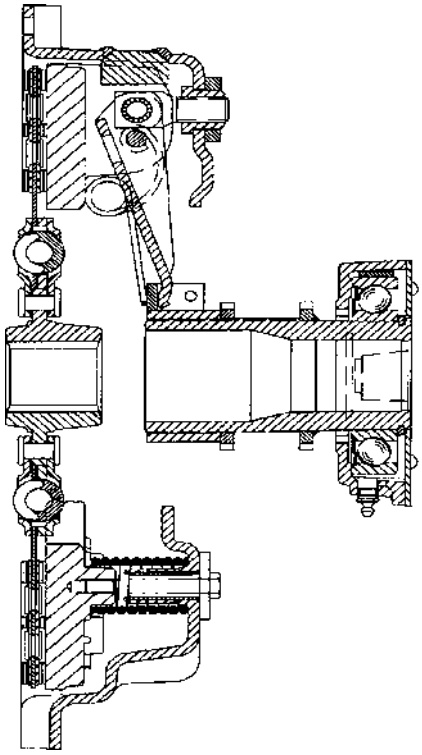
## NOTES

## NOTES

# Clutch 25

# 352 DIA LIPE CLUTCH

# WORKSHOP MANUAL
# CLUTCH - 352 Ø PULL TYPE (LIPE)



**TATA MOTORS LIMITED**
**Customer Service**
Commercial Vehicle Business Unit
Mumbai Pune Jamshedpur Lucknow Dharwad

# 352 DIA LIPE CLUTCH

The contents given in this book are not binding, are subject to change without notice and are for illustration purpose only.

All Specifications given in this manual are in Metric System.

**Published by :**
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(Commercial Vehicles),
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**Edition :** XLI/D-2006/001-1000

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# 1. INTRODUCTION

The 352 Ø Lipe/Setco clutch is a Single Disc Pull type coil spring clutch with Ceramic lining. Pull type clutch offers the advantage of low pedal effort for ease of operation for the driver. And low Release load exerts lesser axial load on the engine bearings. The cera-metallic lining with its high friction coefficient provides high slip torque with low clamp load resulting in reduced clutch slippage even under severe and adverse Indian operating conditions-and lower fuel consumption. The Material and the properties of the Ceramic buttons ensure smooth engagement assuring easier gear shifting and long life.

One of the most important features of the Lipe design is the ease and with which the clutch can be repaired in the field.

High tensile pressed sheet metal cover makes the assembly lighter compared to cast cover and easier for handling during service and clutch installation. The needle bushes at 9 locations ensure smooth and easy movements of the internal linkages. The 12 peripheral openings on the cover, the mass of the thicker pressure plate with good heat soaking capability, the fins on the pressure plate under the 21 Pressure springs – all these unique features contribute to keeping the clutch cool with good air circulation, faster heat removal, enhancing the clutch life.

Clutch Disc transmits power from the engine to the drive line. Lipe Clutch Disc is a six paddle design with 6 pairs of buttons, with a total friction area of 464 sq. cms. This offers 21% more friction area compared to 3 paddle version ensuring longer life, reduced slippage and smoother take off. 8 damper springs at the hub center absorb torsional oscillations of the engine and reduce the “Neutral Gear Rattle”.

# 2. CLUTCH CONSTRUCTION AND OPERATION

The LIPE clutch assemblies are of pull type, dry disc design and incorporate an adjustable clutch release bearing assembly. Adjustment of the release bearing assembly compensates for the disc friction wear throughout the clutch life.

**The Clutch consists of :**

a. Cover assembly,

b. Disc Assembly,

c. Release bearing assembly.

**2. CLUTCH OPERATION (SEE FIG. 1)**

With the Pull type clutch, depressing the Clutch Pedal pulls the Release Bearing Assembly back towards the Transmission in the direction **A**, as shown. This results in the retraction of the Pressure Plate in the direction B which relieves the pressure on the Driven Disc. Full disengagement occurs when the release bearing assembly is actuated 13 mm. Releasing the Clutch Pedal allows the Release Bearing Assembly to travel back towards the Flywheel slowly re-engaging the clutch assembly.

When the Disc wears in service, the Pressure plate moves towards the Flywheel in direction C, and through the action of linkage mechanism the Release bearing Assembly moves forward in the direction **C**.

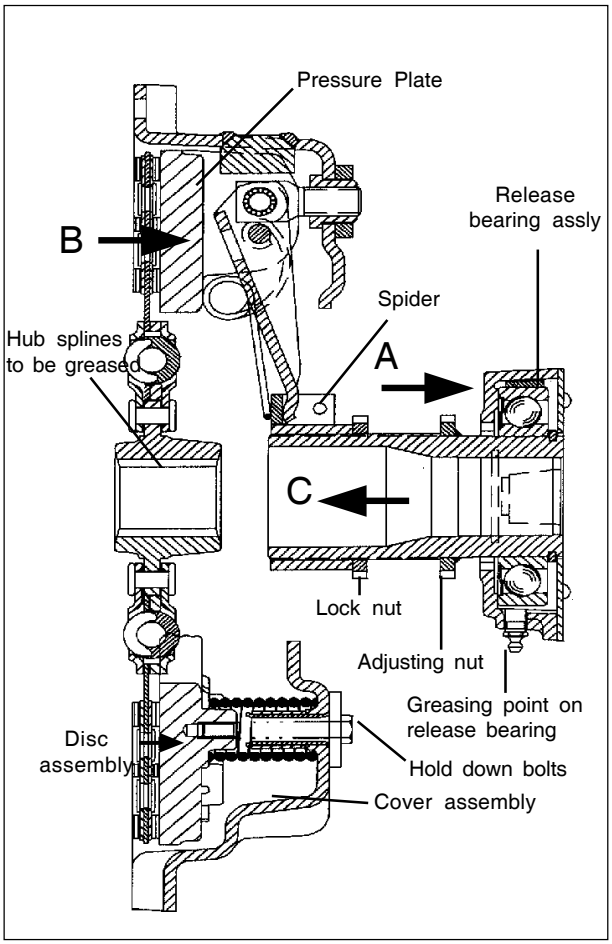



Fig 1

# 3. DESIGN FEATURES OF 352 Ø LIPE CLUTCHES

**1. Easy to adjust clutches.**

Downtime is without question one of the most serious problems facing today's road transport operations, both large and small. Well aware of the importance of helping keep vehicle off-the - Road time to a minimum, Lipe have gone to great length in designing a clutch range that not only exhibits reliable performance in service, but which has been proven in a multitude of fleets and operating conditions. And the story doesn't end there. Unique in-built design features of single and twin plate designs, enables clutch adjustment to be made quickly, easily and with no fuss, Clutch adjustment takes only a couple of minutes, requires one man, and can be made in whatever position the flywheel happens to stop.



Fig 1

**2. Wear indication**

By observing the gap between the locking and adjusting nut, visible when the inspection cover is removed, the operator is provided with a reliable wear indication.

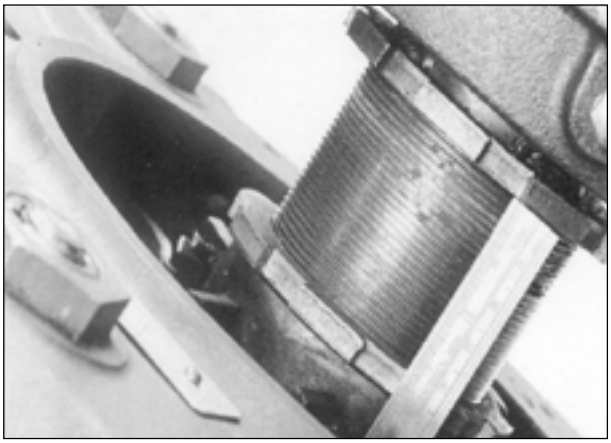


Fig 2

**3. Ceramic Buttons with long life**

The 352 dia Lipe clutch has ceramic lining with 12 buttons with total area of 464 sqcm.

**4. Total friction wear.**

Friction wear on Lipe disks is 4.1 mm. Optimum Slip torque ratio with respect to Engine torque. Lipe has offered two different disc assemblies with right ratio of damping torque to engine torque. This absorbs the engine torsionals better in both cases.

**5. Maximum out of balance:**

This is an important parameter which decides the level of clutch induced vibrations on the vehicle. Max value of 36 cm-gm on Lipe.

**6. Release load And Pedal effort.**

The release load is an important factor which determines the pedal effort to the driver. On the Lipe 352 Ø clutch the release load is set for max value of 245 kg but varies between 216 kg to 245 from the starting point to fully pedal depressed

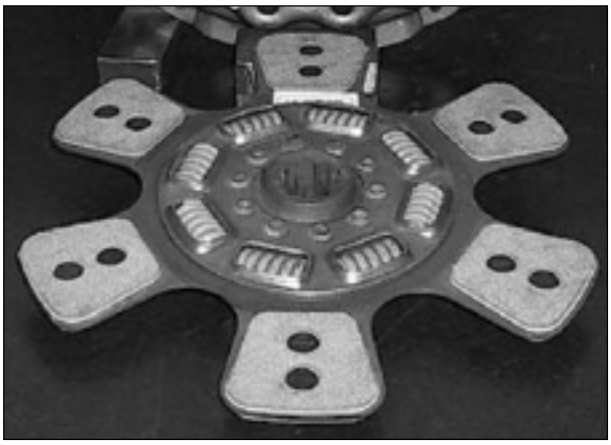


Fig 3

# DESIGN FEATURE OF 352 Ø LIPE CLUTCH

condition. The release load with Diaphragm type clutch, although the minimum value is low when fully disengaged, it is higher at the mid point of pedal movement and is considerably higher in the worn out condition and on the whole it is higher through the clutch life.

**7. Drop in clamp load with disc wear.**

Lipe coil spring design ensures low drop in clamp load with lining wear. Even with fully worn lining adequate clamp load is assured which minimizes chances of slippage with Disc wear.

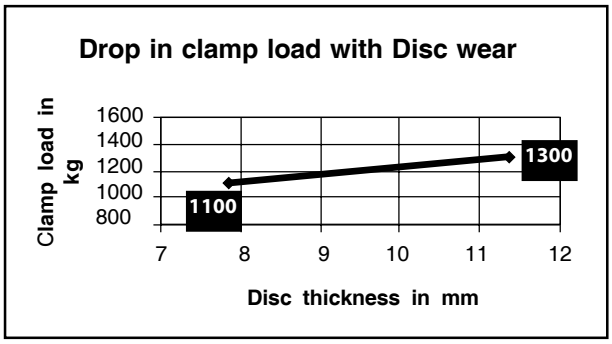



Fig 4

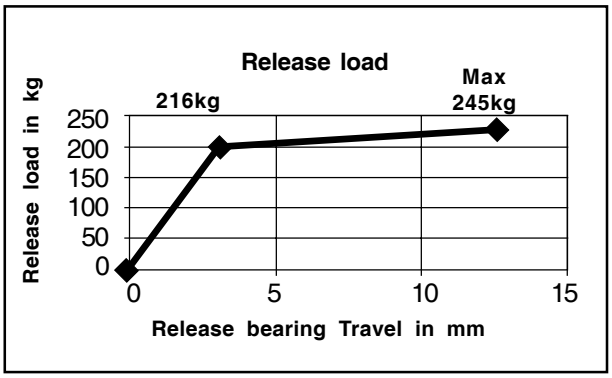



Fig 5

# 4. TECHNICAL INFORMATION

### 1. Technical Specification

| | | |
|---|---|---|
| 1 | Drive plate diameter | 349.25 mm |
| 2 | Total friction area (both sides) | 464.5 sq.cm |
| 3 | Thickness of clutch disk | |
| | a. Under load (clamped) | 11.91/11.35 mm |
| | b. Under no load (free) | 11.91/11.35 mm |
| 4 | Permissible wear per lining face | 2.05 mm |
| 5 | Number of damper springs | 8 No. |
| 6 | Average contact force (new lining) | 3120/2910 |
| 7 | Pressure plate cover | Sheet metal |

### 2. Important Tightening Torques

1. Cover Assy. bolts 4.1 - 4.7 mkg.
2. Cl. Hsg. to flywheel Hsg. bolts 4.6 mkg
3. Clutch release bearing lock nut ring 3.5 - 4 mkg

### 3. Recommended Lubricant's

| TO BE USED FOR | BHARAT PETROLEUM | HP | CASTROL | INDIAN OIL | TIDE WATER (VEEDOL) |
|---|---|---|---|---|---|
| **Clutch**<br>a) Clutch release bearing Clutch disc splines, Yoke-wear pad contact surface | Bharat MP Grease 3 | HP Lithon 3 | Castrolease AP Grease No.3 | Servo GEM 3 | Veedol AP-3 Grease |
| b) Release yoke cross shaft bushes for 352 dia clutches | | | | | |
| c) Felt pad of clutches release bearing, (if fitted) Clutch pedal & slave cylinder linkages | Lubricant with engine oil by using oil can. | | | | |

# TECHNICAL INFORMATION

**4. Maintenance**

| Sr. No. | OPERATION | FREQUENCY IN KM |
|---|---|---|
| 1. | Check clutch pedal free play and adjust if necessary (Wherever provision is there). | 9000 |
| 2. | Grease with grease gun : (ii) Clutch pedal bushing. | 9000 |
| 3. | Remove grease cup for lubricating clutch release bearing. Repack 3/4th full with grease and tighten by the few turns. | 9000 |
| 4. | Lubricate with oil can : Clutch pedal linkage slavecylinder linkages & felt pad of clutch release bearing sleeve. (few drops only). | 9000 |
| 5. | Check distance between release bearing and Gear box front cover, adjust if necessary (352 dia.). | 9000 |
| 6. | Grease with grease gun, clutch release bearing (352 dia.) | 18000 |

# 5. SPECIAL TOOL

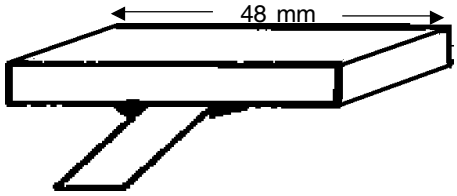
**TOOL PART No. 278258902501**
**Release travel setting gauge**




**TOOL PART No. 278258902502**
**Drift tool for locknut adjustment**



**TOOL PART No. TCT-L1872**
**Guage for checking fully worn out clutch disc**




Tata Motors part No. for tool kit
8854 5801 2515

# 6. PROCEDURE FOR CLUTCH GAP SETTING

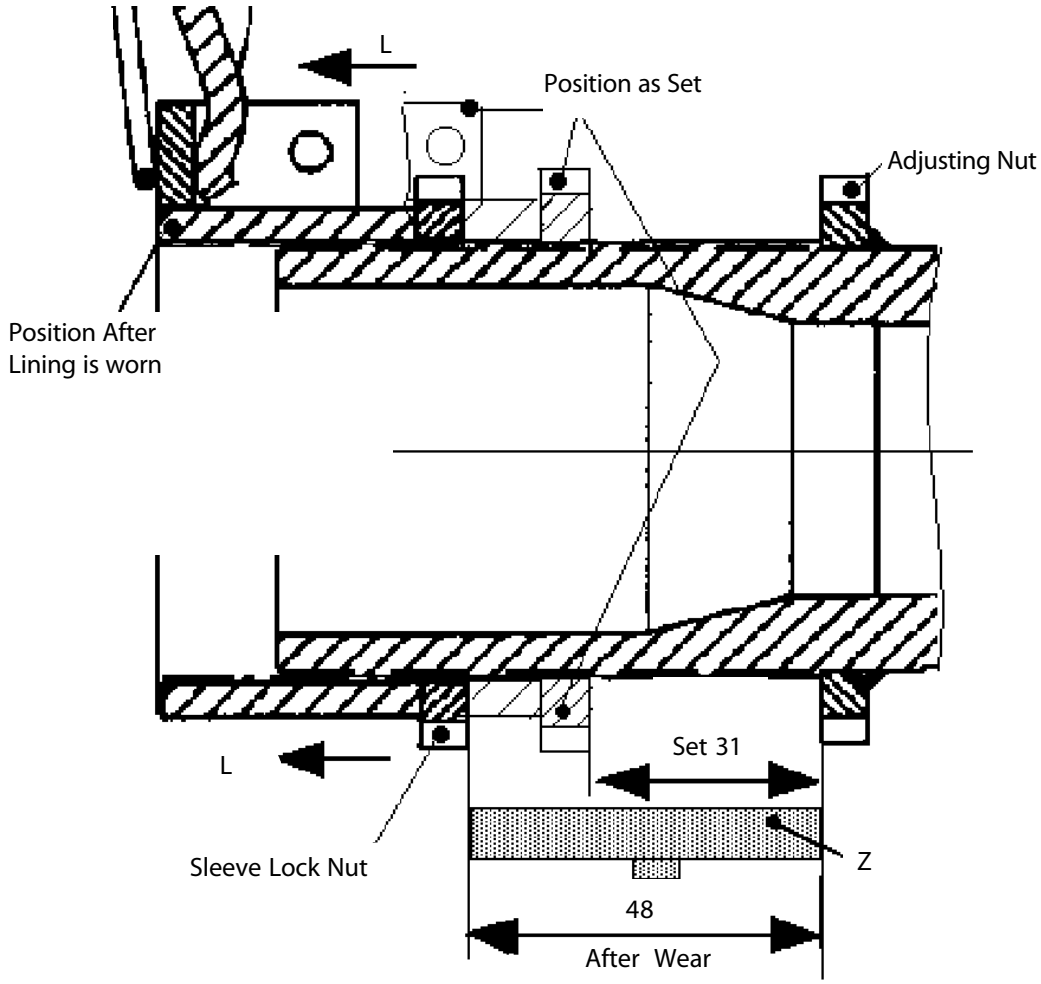



Fig 1

The 352 Clutch is set for dimension 31 mm at. There is no need for readjustment at Tata Motors at OE or service installation or at PDI. However, it is necessary to check and set the release travel clearance of 19 mm regularly at service.

**IT IS RECOMMENDED THAT THE VEHICLE IS CHECKED FOR CLUTCH BEARING SETTING EVERY 9000 KM.**

**It is also necessary that clutch is checked and reset in service during fitment of a new clutch or an old clutch or reconditioned clutch.**

**Procedure for clutch setting is outlined below :**

# PROCEDURE FOR CLUTCH GAP SETTING

Every time the vehicle is brought for servicing at every 9000 Km. or when a new or used or reconditioned clutch is installed in service, it is necessary to set the clutch release bearing as per procedure given below.

The 352 dia model shown above as it leaves the factory, in the new condition with a 31mm gap between the locking and adjusting nuts. Fig. 2

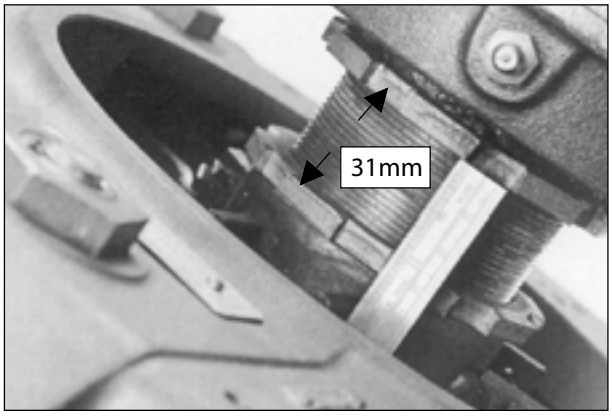



Fig 2

**CLUTCH ADJUSTMENT**

**STEP 1.**

With the inspection cover removed, the Lipe adjusting bar (Tool P No.-2782 5890 2502) is used to unlock the release bearing assembly sleeve locking-nut. (Fig. 3)

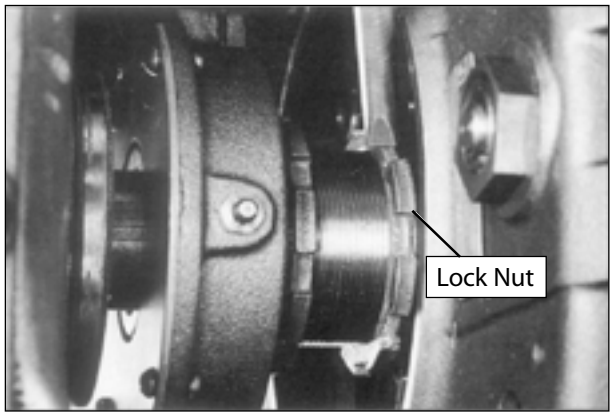



Fig 3

**STEP 2.**

The Lipe travel setting gauge part no. 2782 5890 2501 is then placed between the transmission and the release bearing assembly, to check the release travel clearance of 19.5mm**.**
Fig. 4

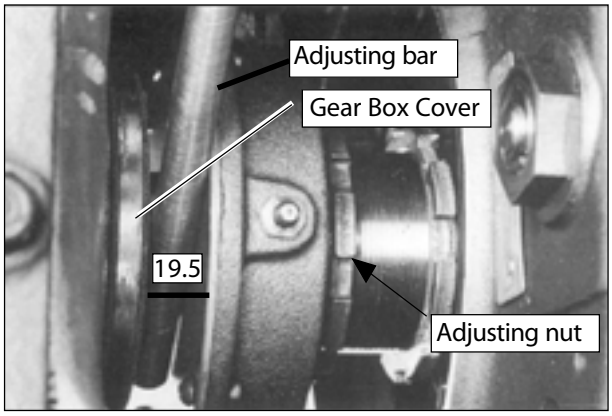



Fig 4

# PROCEDURE FOR CLUTCH GAP SETTING

**Step 3.**

Release travel clearance is set by turning the slotted adjusting nut (nearest to the release bearing). Fig. 5

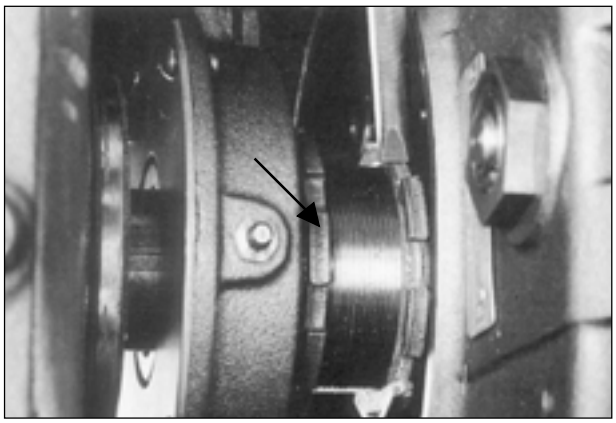


Fig 5

**Step 4.**

Completing the adjusting procedure, the release bearing assembly sleeve locking nut is locked back into position against the spider Fig. 6

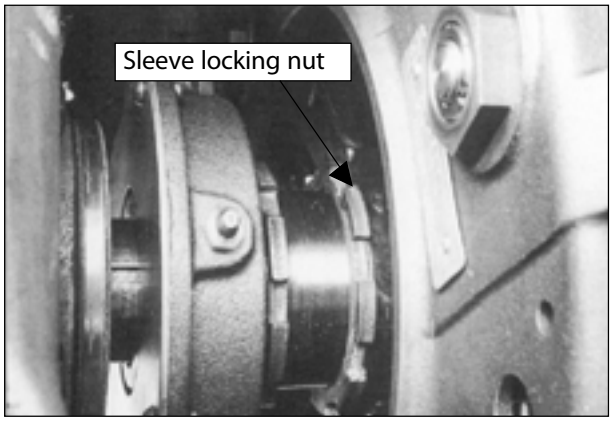



Fig 6

**WEAR INDICATION**

The unit shown is in the fully worn condition-clutch needs replacing at 48 mm nominal gap between locking and adjusting nuts. Fig. 7

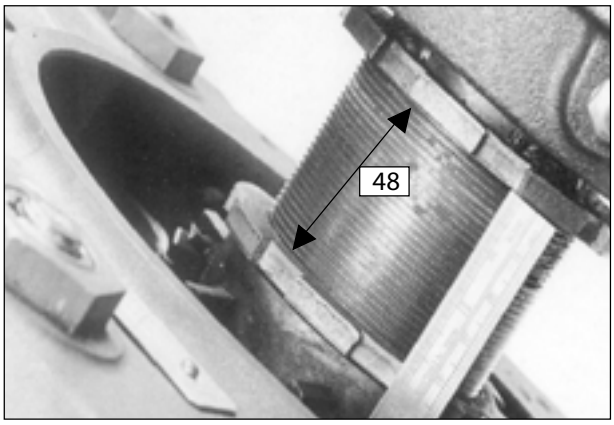



Fig 7

# 7. VEHICLE INSPECTION AND CLUTCH REMOVAL

It is recommended that checks are carried out on the vehicle as per check list given below to establish the reasons for clutch problem and to ensure that the vehicle clutch related systems are in order.

**CHECKS TO BE DONE ON VEHICLE BEFORE REMOVING THE CLUTCH. TABLE 1.**

| NO | CHECKS TO BE DONE | CORRECTIVE ACTION. |
|---|---|---|
| 1 | Check for smooth engagement and smooth return of pedal. | Pedal return should be smooth and there should be no Stick slip. Ensure the presence of pedal return spring. Ensure that the pedal linkages and bushes are greased. |
| 2 | Check the pedal free play, | Should be 5 to 10 mm. If not adjust the pedal linkages toget the required play. (If provision is there). |
| 3 | Check for full travel of the pedal to the bottom of the floor. | There should be no obstructions like foot rest etc. |
| 4 | Start the engine and check at what point of pedal travel the clutch is released and engaged. | Clutch engagement and disengagement should take place between ½ to 2/3 rd the pedal travel. |
| 5 | Check the movement of master and slave cylinders. | Movement should be smooth and should not be sticky. |
| 6 | Check if bleeding of hydraulic cylinders are done. | Bleed the system if pedal is spongy. |
| 7 | Check for the stroke of the slave cylinder by depressing the clutch pedal fully. | Should be MIN 18 mm at the slave cylinder rod which can be easily checked with a scale. |
| 8 | Make sure that setting setting has been done. | Gap between gearbox cover and clutch release bearing should be ~ 19.5 mm. |

- Note: There are two versions of 352F Lipe/setco clutches. One with 1.5" spline used with G50 gear boxes and the other with 1.75" splines used with G 600 gear boxes.
- The Clutch release yoke with Clutch housing is an integral part of G 600 gear box and the complete assembly is mounted on to the Fly wheel housing and engaged to the clutch.
- The G50 gear box is a separate unit and is mounted on the Clutch housing which is already assembled with the flywheel housing.

Disconnect slave cylinder Push rod and slave cylinder from the Clutch housing and attach to the frame (Follow the instructions of vehicle service manual).

Disconnect the transmission from the drive-line and support it on Jacks or trolley.

Rotate the clutch Release Yoke so that it clears the release Bearing. Keep the Transmission in line with the Engine and Clutch Center lines and pull it syraight back from the Engine and the Clutch, to prevent any side loads on the clutch and Release Bearing.

**After removal of Transmission and before removal of clutch from the Flywheel, fit the 3 Hold Down Bolts on to clutch, to prevent any damage to Clutch assembly during transport.**

# 8. CLUTCH INSPECTION

**1. Flywheel preparation.**

Ensure that the Flywheel friction face is free of cracks, scouring, dishing and taper. If found necessary, remove the Flywheel for re-work or replacement.

**2. Pilot Bearing :**

Check the pilot bearing and replace if necessary.

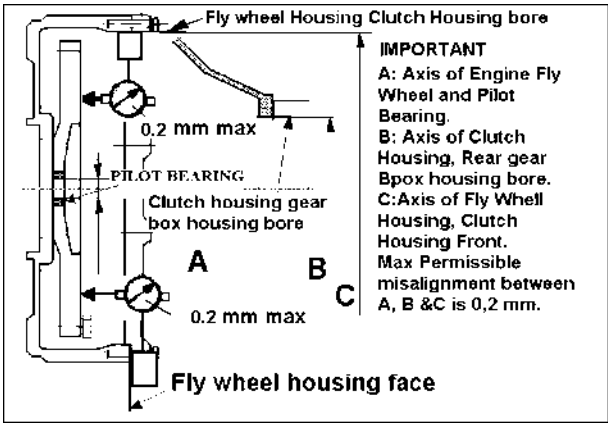



Fig 1

**3. Checks for Flywheel Misalignment :**

a. Check the run-out of Flywheel - Clutch Housing Mounting Surface with respect to Flywheel Housing. Should be as specified in Fig 2.

b. The centre line or Axis of the Engine, Flywheel , Flywheel housing, Clutch, Clutch Housing, and transmission shall be common to these units with a permissible variation of not more than 0.2 mm

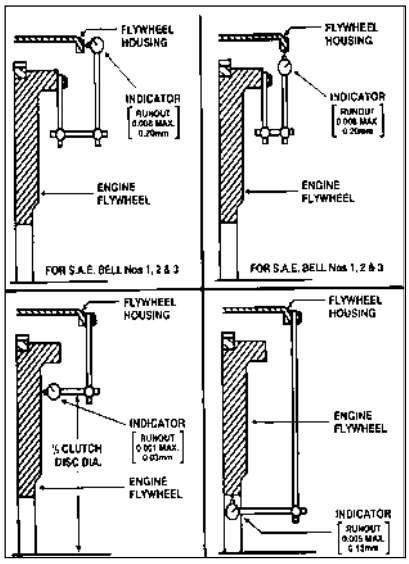



Fig 2

C. If the Flywheel is reworked by regrinding the Friction Face, It is necessary to requalify the thread depth to ensure that the Clutch mounting Bolts do not bottom. Recommended counterbore as in the sketch on right (Fig 3).

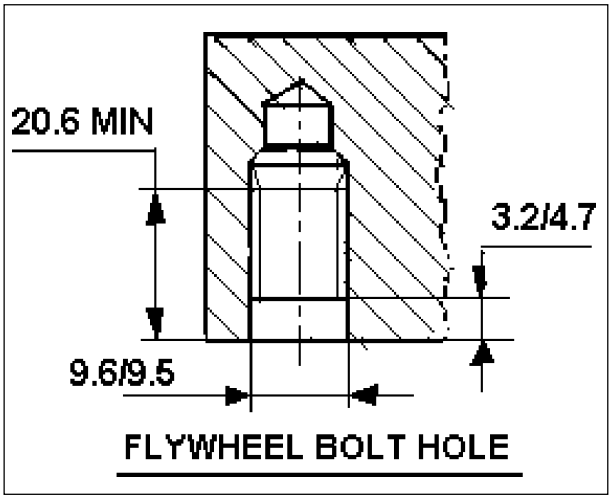



Fig 3

# CLUTCH INSPECTION

**Clutch Hydraulic System**

**Clutch release sequence actions:**

A. Pedal depressed (Fig 4).
B. Pedal linkage actuated (Fig 4).
C. Master cylinder piston movement (Fig 4).
D. Hydraulic fluid pressurized (Fig 4).
E. Slave cylinder piston movement (Fig 4).
F. Slave cylinder linkage actuated (Fig 4).
G. Clutch release yoke swivels against the release bearing housing pads (Fig 4).
H. Release Bearing Pulled (Fig 5).
I. Pressure plate lifted by the action of lever and linkages (Fig 5).

**Result: Clutch disengaged.**

**LINING WEAR - SEQUENCE OF ACTIONS (FIG2).**

J. With lining wear Pressure plate moves forward (Fig5).
K. Action of levers and linkage system moves Release bearing forward (Fig 5).
L. The release clearance originally at ~19.5 mm (at L in Fig 2) increases if the clutch setting is not carried out and release bearing is not pulled back to original 19.5mm, (Fig 5).

**Caution:**
**If clutch is not checked and reset in time this can result in Release Bearing and Bush failures.**

Please refer to Chapter 6 for procedure for clutch gap setting

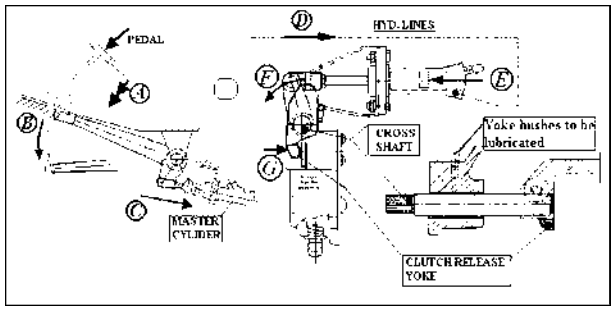


Fig. 4

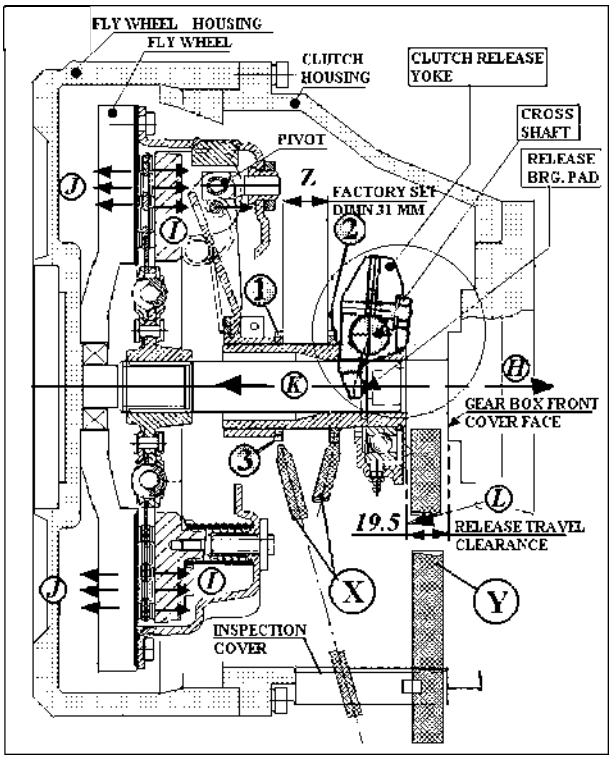


Fig. 5

# 9. CLUTCH REPAIR

**STRIPPING PROCEDURE**

There are two suggested methods of Holding cover assembly - Arbour Press or a spare flywheel.

**1. ARBOUR PRESS**

Place cover assembly and driven disc onto the above and clamp cover to arbour base . Remove the three locknuts from the cover assembly. Now slowly release the arbour press. see Fig 1.

**2. FLYWHEEL or BASE PLATE**

Place cover assembly and driven disc on the flywheel or base plate and clamp using the 12 flange holes. Undo and remove the three locknuts from the cover assembly. Now slowly release the 12 bolts. Remove flywheel ring cover, pressure springs, retainer clips from pressure plate pins, release levers, eyebolts and adjusting nuts from eyebolts. Now press or knock out the needle bearings in the eyebolts and pressure plate. (see Fig. 2)

**3. INSPECTION AND RECONDITIONING**

After the cover assembly has been stripped, clean all parts thoroughly. Inspect all parts. Discard components with visual defects i.e. worn or damaged.

**But remember " If in doubt replace with new."**

**A. PRESSURE PLATE**

1. The Pressure plate must be replaced if Friction Face is severely heat checked or it is warped in excess of 0.8mm or if there is excessive wear in the drive slots

**Note :-**

**To check if there is excessive wear locate part in a ring cover, refer to section B para 2 Ring Cover.**

2. Providing none of the above apply then the Pressure plate can be re-faced and used by re-grinding a maximum of m 0.76mm from the face. Referring to Fig. 3 Dimension 'C' is the distance from the friction face to the top of the regrind pin. (Fig. 3)

'C' Dimension at new = 48

'C' Dimension after grind = 47.2

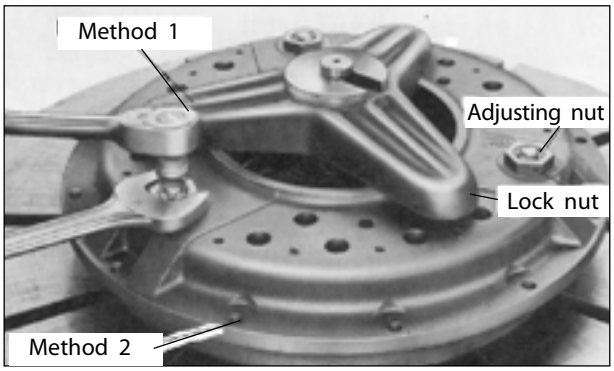



Fig 1

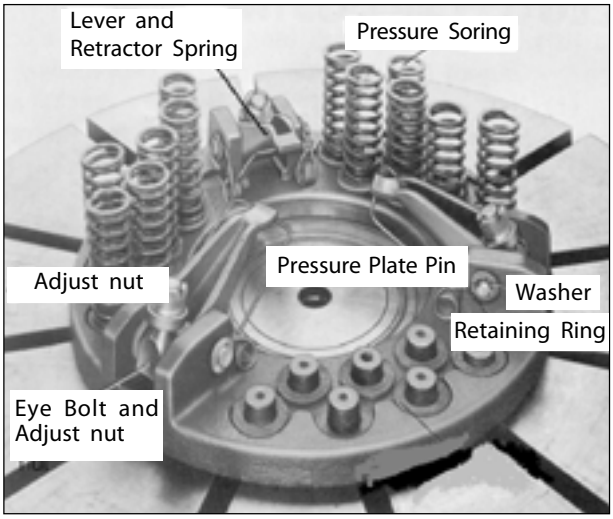



Fig 2

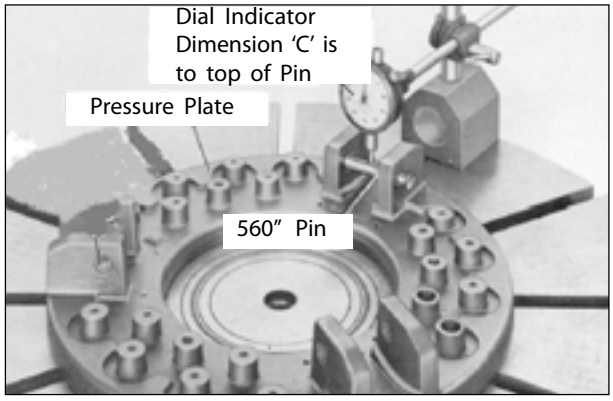



Fig 3

# CLUTCH REPAIR

**3 REGRINDING PRESSURE PLATE PROCEDURE**

First remove needle bearings. Use 3 nos regrinding blocks and pins. See (fig 4 & 5)for grinding set up.

**B. FLYWHEEL RING COVER**

1 Must be replaced if any cracks are present or drive blocks are worn or cover is distorted or damaged.

2 The 352 pressure plate is driven by engagement of driving slots to mating drive blocks in the ring cover. A check on the wear between the driving surfaces of the ring cover and the pressure plate slots should be carried out. There should be not less than 0.10mm or more than 0.25mm movement between drive blocks and slots.

**C. PRESSURE SPRING**

All pressure springs to be checked for load at working height or for free length. Limits of acceptance as below:

| Acceptance norm | Outer Spring red | Inner green |
|---|---|---|
| Load @ 43.8 mm | 55 Kg | 65 Kg |
| Free Length | 73 mm min | 72 mm min |

Springs should also be discarded if distorted and heat affected.

**D. PARTS INSPECTION**

**Needle bearings :**

Always replace the Pressure Plate and Eye bolt needle bearings using a suitable tool. It is important that the part number on the bearing case is against the flat face or shoulder of the fitting tool. This prevents damage to the bearing case when fitting.

Always replace Retractor springs and Retaining Clips. If worn damaged or loose – replace, Eye Bolts. Adjusting nuts. Release Lever, Spider, Pressure Plate Pins & Eye Bolt Pins.

**CLUTCH COVER ASSEMBLY**

Assembly can be done using either an Arbour Press or a Flywheel. See (Fig 1 and 2) above.

1 Place new driven on arbour press or flywheel. This will act as a gauge plate for setting the release levers

2 Place pressure plate on top of the driven disc friction face down.

3 Assemble the eyebolts, adjusting nuts, release levers, retractor springs, retaining clips, and, Pressure plate and Eyebolt pins.

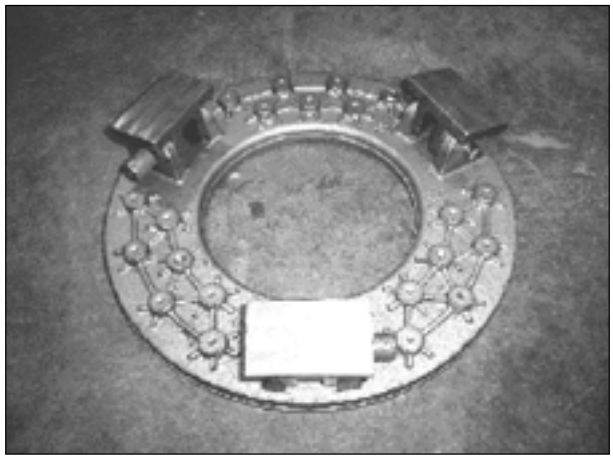


Fig 4

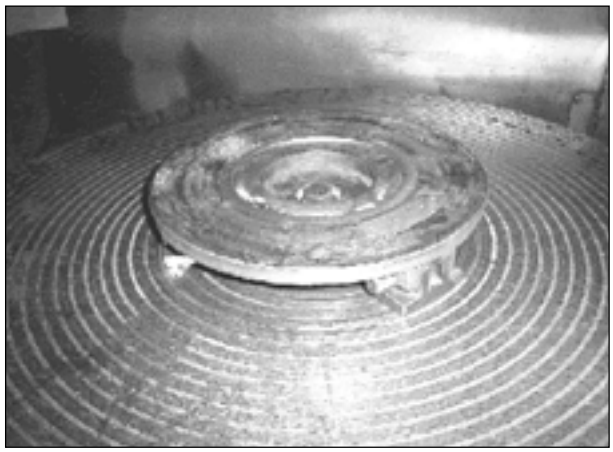


Fig 5

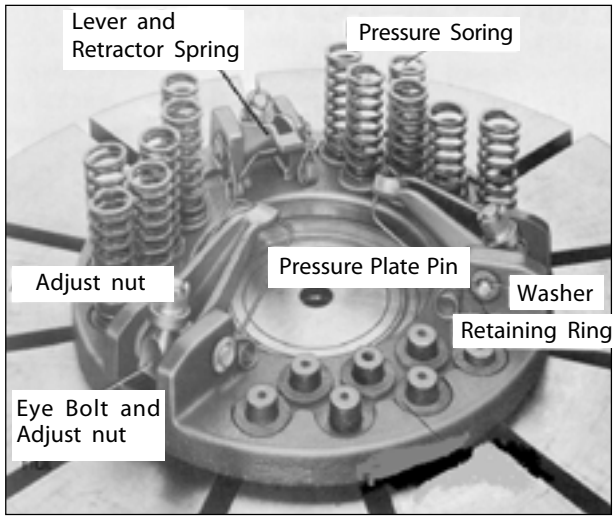



Fig 6

# CLUTCH REPAIR

4 Place the correct pressure springs and quantity over the spring bosses on the pressure plate.- See (Fig 6.)

5 The flywheel ring cover can now be pressed into position, taking care to engage the driving blocks into the mating slots of the pressure plate and the adjusting nuts / eyebolts in the holes on the ring cover as the springs are compressed. Ensure that the springs are seated correctly.

6 When the flywheel ring cover has been put into position, the locknuts can be fitted and the lever heights set.

7 The lever heights are set by turning the adjusting nuts while at the same time holding the locknuts with a spanner. The position of the 3 levers in the case of a pressed steel cover is checked from the raised section in board of the adjusting nuts on the pressing to the underside or actuating face of the release levers.

This we term dimension 'A' which is 27mm for all three levers. See ( Fig 7.)

8 Having adjusted the release lever heights to the specified height hold the adjusting nuts in position using the 2 slots and tighten up the locknuts to the required 12 mkg torque. Recheck the lever heights to ensure they have not moved.

**9 IMPORTANT**

Before releasing the clutch from the assembly fixture fit the three hold down bolts. (See Fig8). Now the clutch assembly can be removed from the arbour press or flywheel in safety

**RELEASE BEARING DISMANTLING /ASSEMBLY PROCEDURE. (FIG 9)**

1 Carefully dismantle the Spider-Release Bearing assembly from Cover assembly.

2 Remove spider and lock nut from Release bearing assembly.

3 Clean and inspect all parts.

4 Replace the release bearing if worn or damaged.

5 Reassemble Release bearing assembly – lock nut Spider.

6 Set the gap of 31 mm between lock nut and adjusting nut on sleeve. This gap to be reset on vehicle later, if required, as per clutch setting procedure.

7 Put back the Spider-Release Bearing Assembly carefully in to the cover assembly.



Fig 7

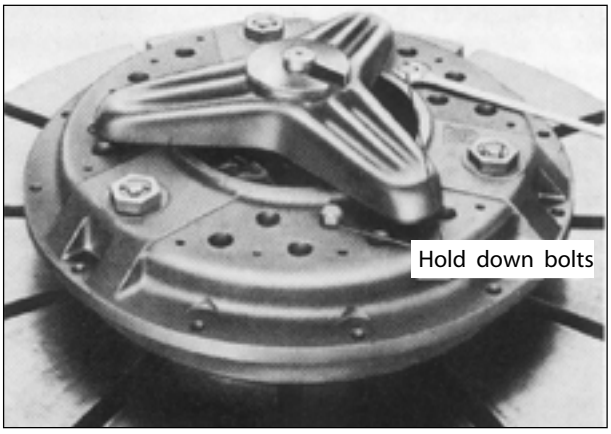



Fig 8

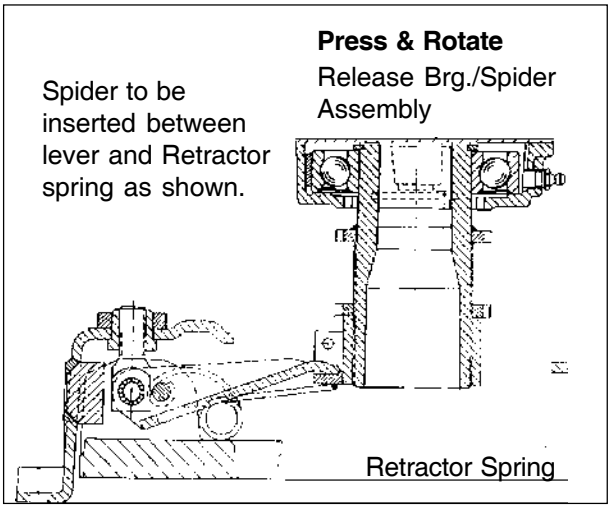



Fig 9

# 10. INSTALLATION OF CLUTCH ON CUMMINS ENGINE

Fig. 1 below shows the installation of the 352 Ø on Cummins Engine Fly wheel, with fly wheel housing, the clutch housing with clutch release yoke and the Gear Box front cover

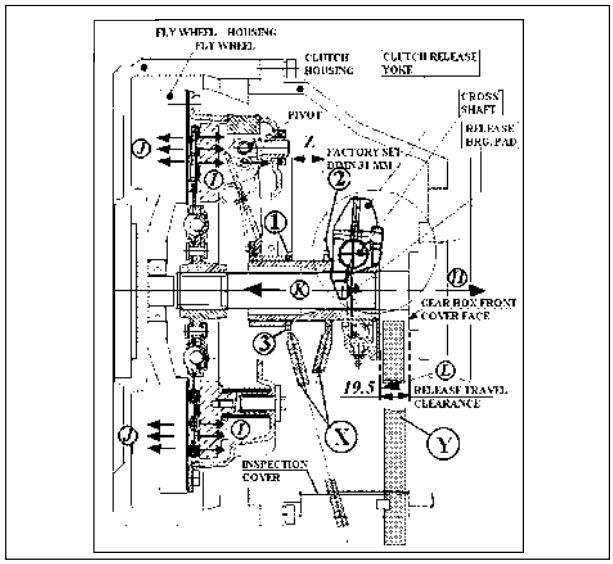



Fig 1

a. Lipe Driven Plates are Part marked and identified "Pressure Plate side". Clutch Driven Discs should be installed as shown on Fig 2.

b. Before Driven Discs are installed smear the Hub Splines with High Melting Point Grease to specification:

c. Fit 2 off guide screws on Fly Wheel and offer the Driven Disc assembly and Cover Assembly over the Alignment tool and 2 guide Screws

d. Fit cover assembly on Fly Wheel using 10 off Spring Washers and Bolts and finger tighten. Remove guide screws and fit the remaining 2 bolts.

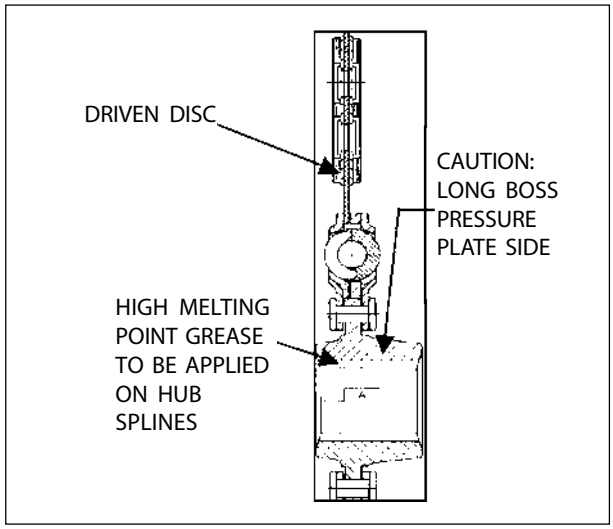
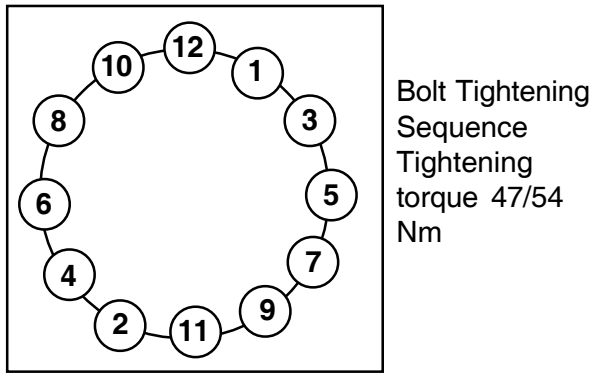



Fig 2

e. Tighten clutch mounting bolts in sequence shown in Fig. 3 to a torque of 47/54 Nm.




Bolt Tightening Sequence Tightening torque 47/54 Nm

Fig 3

**CAUTION : HOLD DOWN BOLTS REMOVAL**

After clutch fitment and before withdrawing alignment tool, ensure that the three hold down bolts are removed.

REFER TO FIG 1 FOR LOCATION OF HOLD DOWN BOLTS

# 11. TRANSMISSION INSTALLATION

**Transmission installation;**

a. Grease the clutch housing cross shaft bushing.

b. Apply High melting point Grease on the contact surfaces of the yoke and bearing housing pads(Fig 1). Ensure that the release yoke is fully raised and clears the bearing housing.

c. Move the transmission properly oriented and guide the input shaft into the sleeve bushing of Release bearing.

d. Ensure that the transmission axis is aligned to the Engine - clutch axes, and the release bearing is not subjected to any side loads.

e. Ensure that the transmission input shaft splines are aligned to hub splines and rotate the transmission shaft for ease of insertion

f. Rotate the yoke tips back in to operating position and push the Transmission fully till it enters in to the pilot bearing. Complete the rest of transmission and clutch system installation as per vehicle manufacturers recommendation.

g. New clutch or old clutch refitted or reconditioned clutch, the procedure for clutch setting is the same as explained in part 8 of the manual.

h. After completion of the setting, please refer to the chapter 7 vehicle inspection & clutch removalto be checked as per check list in Table 1 Part 4 of the manual.

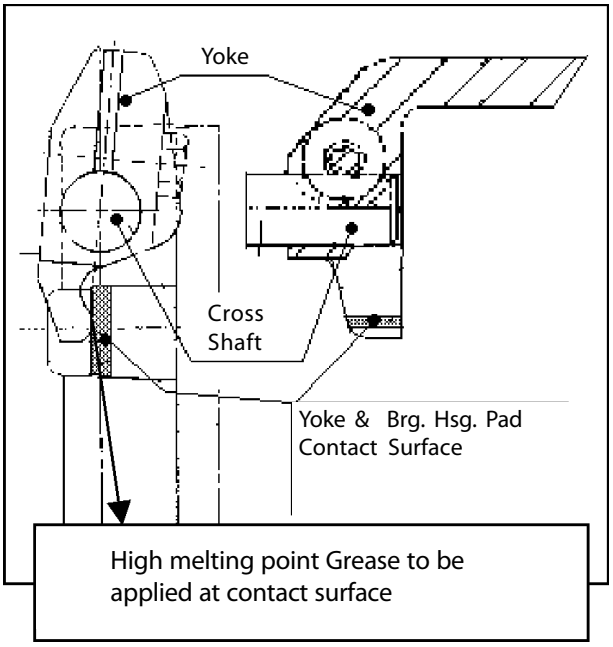



**Fig 1**

**Clutch housing of G 50 gearbox (Fig 2).**

Picture shows the clutch housing of G50 gear box with the yoke tips rotated back for installation of clutch. In G50 design the clutch housing is not a part of Gear box assembly but mounted on the engine.

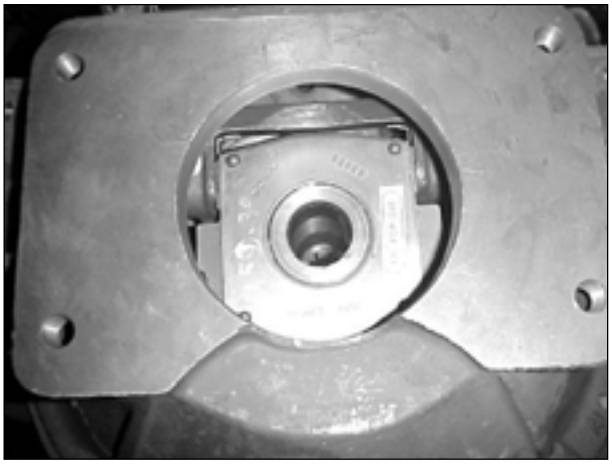


Fig 2

# TRANSMISSION INSTALLATION

**Clutch housing of G 600 gear box (Fig 3).**

In the G600 gearbox assembly clutch housing is a part of gearbox and the gear box assembly together with clutch housing is mounted on the engine fly wheel housing.
Figure shows the clutch housing with the yoke rotated to just before being mounted on engine

**Caution :**

1 **Please ensure that while mounting gear box on the clutch housing in G50 or mounting Clutch housing with gearbox on engine fly wheel housing on G 600 that the transmission shaft is inserted without any side loads on clutch release bearing.**

2 **Please refer Workshop Manual of Gearbox for Installation and removal of GearBox from vehicle. (i.e from clutch)**

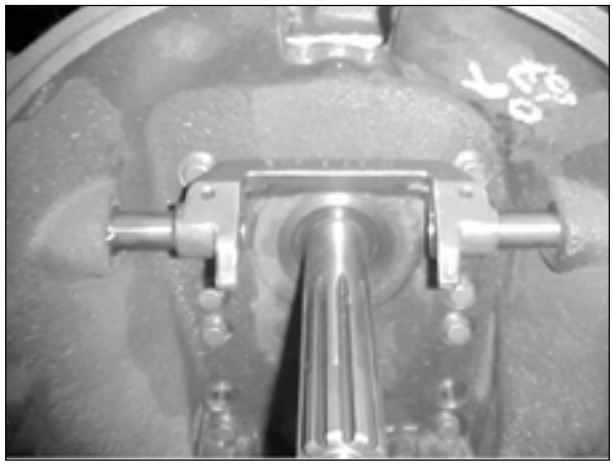
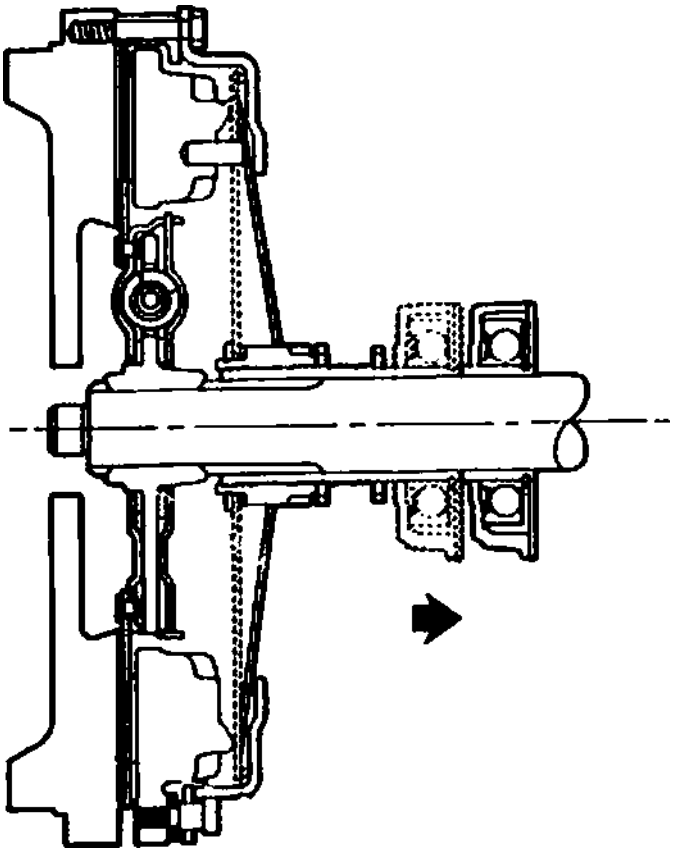


Fig 3

# WORKSHOP MANUAL
# CLUTCH - 352 Ø DIAPHRAGM PULL TYPE (VALEO)



**TATA MOTORS LIMITED**
**Customer Service**
Commercial Vehicle Business Unit
Mumbai Pune Jamshedpur Lucknow Dharwad

# 352 DIA VALEO CLUTCH

The contents given in this book are not binding, are subject to change without notice and are for illustration purpose only.

All Specifications given in this manual are in Metric System.

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# 352 DIA VALEO CLUTCH

# 1. CLUTCH CONSTRUCTION AND OPERATION

The VALEO clutch assemblies are of pull type, dry disc design and incorporate an adjustable clutch release bearing assembly. Adjustment of the release bearing assembly compensates for the disc friction wear throughout the clutch life.

**The Clutch consists of :**

a. Cover assembly,

b. Disc Assembly,

c. Release bearing assembly.

**CLUTCH OPERATION (Fig 1 & 2)**

With the Pull type clutch, depressing the Clutch Pedal pulls the Release Bearing Assembly back towards the Transmission in the direction **A**, as shown. This results in the retraction of the Pressure Plate in the direction **B** which relieves the pressure on the Driven Disc. Full disengagement occurs when the release bearing assembly is actuated. Releasing the Clutch Pedal allows the Release Bearing Assembly to travel back towards the Flywheel slowly re-engaging the clutch assembly.

When the Disc wears in service, the Pressure plate moves towards the Flywheel in direction C, and through the action of linkage mechanism the Release bearing Assembly moves forward in the direction **C**.

**Easy to adjust clutches**

Downtime is without question one of the most serious problems facing today's road transport operations, both large and small. Well aware of the importance of helping keep vehicle off-the-road time to a minimum, Valeo have gone to great length in designing a clutch range that not only exhibits reliable performance in service, but which has been proven in a multitude of fleets and operating conditions. And the story doesn't end there. Unique in-built design futures of single and twin plate designs, enables clutch adjustment to be made quickly, easily and with no fuss, Clutch adjustment takes only a couple of minutes, requires one man, and can be made in whatever position the flywheel happens to stop.

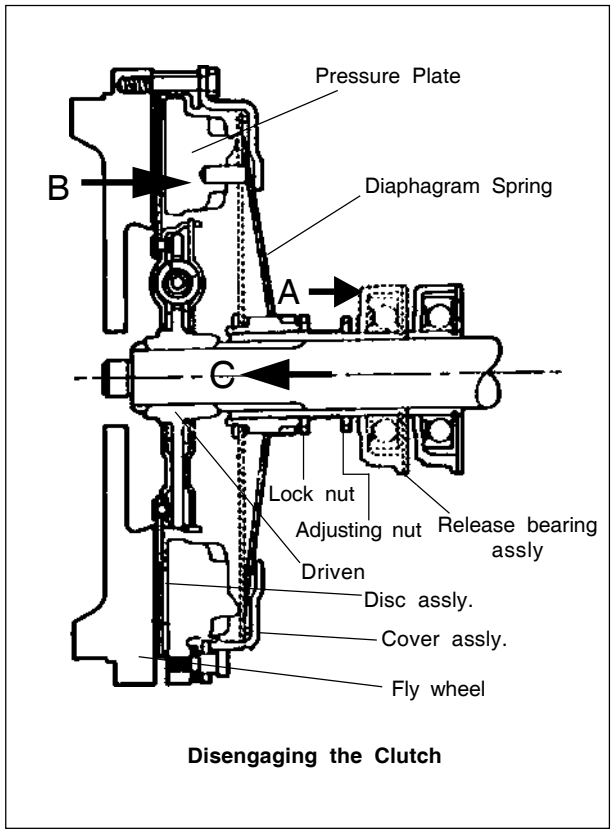



Fig 1

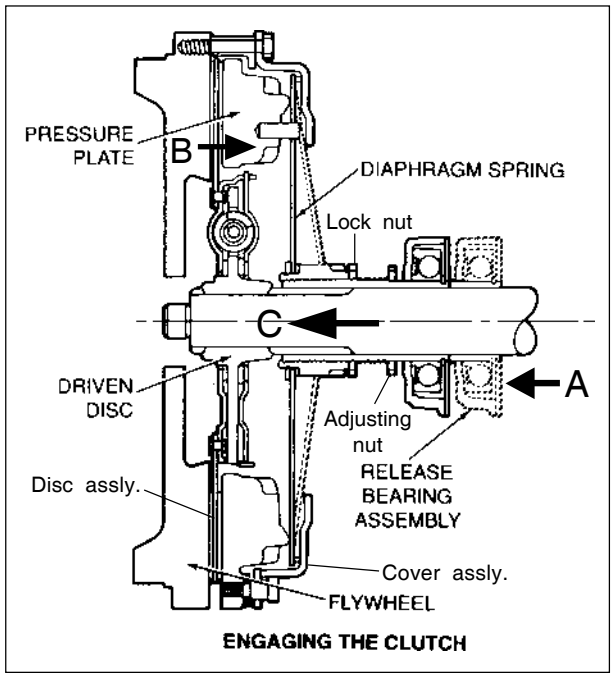



Fig 2

# CLUTCH CONSTRUCTION AND OPERATION

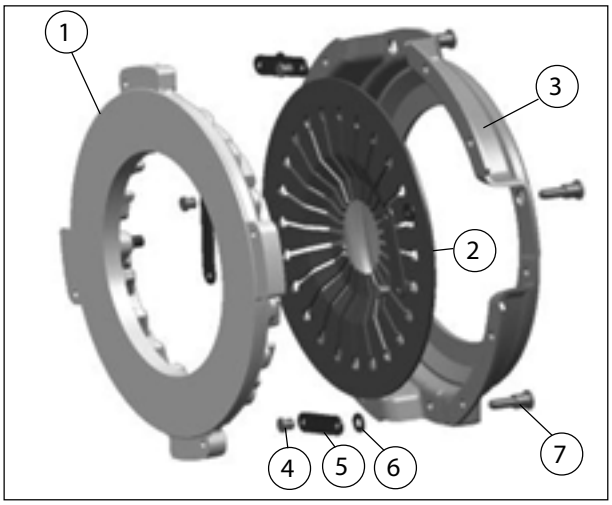
**Advantages**

1. Reduced weight
2. Low Clutch pedal effort.
3. Smooth engagement.
4. Long life.
5. Easy gear shifting.
6. Longer driveline life.
7. Lower operating temperatures
8. Reduced Maintenance
9. Easy serviceability



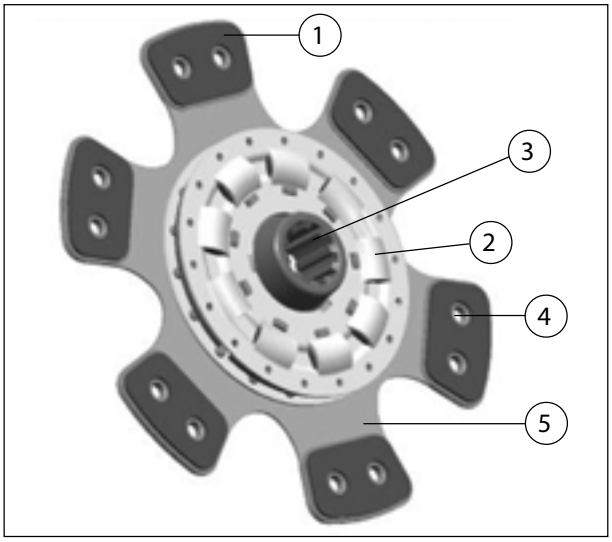
**Clutch Cover Assembly - Parts**

1. Pressure Plate
2. Diaphragm
3. Cover
4. Bolted Type
5. Drive Strap
6. Washer
7. Screw




**Clutch Plate Assembly - Parts**

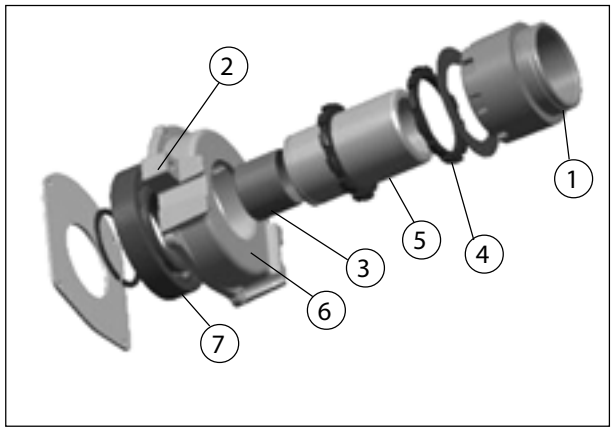
1. Friction Pad
2. Damper Spring
3. Hub Splines
4. Pad Rivet
5. Disc back side



# CLUTCH CONSTRUCTION AND OPERATION

**Clutch Release Bearing Assembly - Parts**

1. Coupler / Spider
2. Wear pad
3. Bush
4. Adjusting nut
5. Sleeve (threaded)
6. Housing
7. Bearing



# 2. DESIGN FEATURES OF 352Ø VALEO CLUTCH

**Clutch Cover**

**1. Diaphragm Technology**

- Loss of clamp load less than 10%.
- More resistance to heat abuse.

**2. Sheet metal cover**

- Lighter and more strong.
- Protection to vehicle.

**3. Pressure plate**

- Thicker pressure plate with integral cooling fins for better heat transfer and cooler operation.
- Optimised shape to resist temperature due to abuse.

**4. Diaphragm finger tips with induction heat treatment**

- Reduced wear at contact with release bearing designed for vehicle life duration.

**5. Clutch assembly and mounting**

- Fewer and less complicated parts.
- No adjustment of lever is requested.
- Reduced maintenance.
- Easy to assemble and disassemble.

**Clutch Plate**

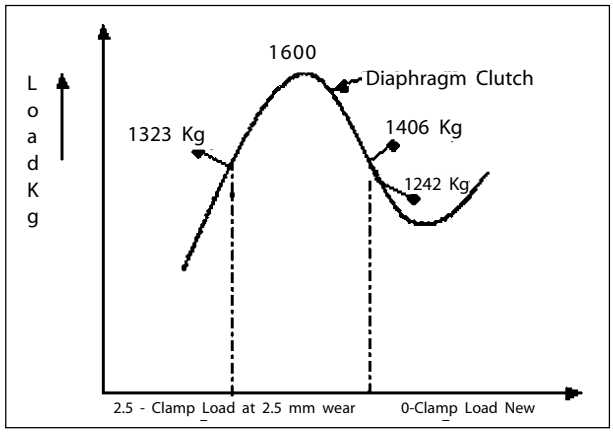
**1. Damper springs reliability**

**2. Reliability of friction pad and fixation**

# DESIGN FEATURES OF 352Ø VALEO CLUTCH

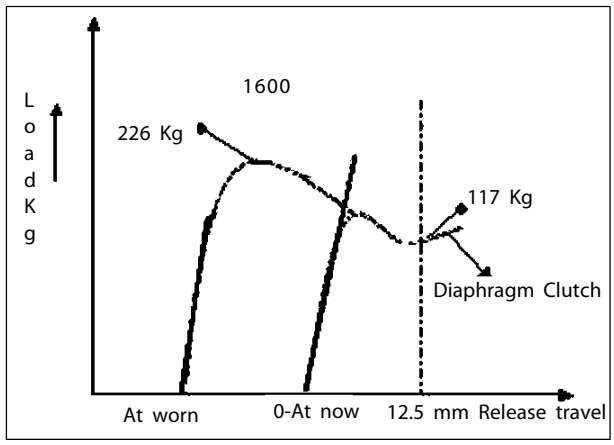
### Working of Pull Type Diaphragm Clutch Clamp Load

- More factor of safety - stiffer clamp load.
- With diaphragm clamp load increases with wear.
- Coil clutch is very sensitive to any drop in clamp load when in use.




### Release Bearing Load

- Lower release bearing load.
- As the pedal is pressed down, the pedal load continuously reduces, leading to better pedal feel & ensuring 100% disengagement before gear shifting.
- Improved control of clutch engagement.




### Pressure Plate

- Thicker pressure plate with integral cooling fins for better heat transfer and cooler operation
- Ribs add rigidity to pressure plate, giving better burst strength



# DESIGN FEATURES OF 352Ø VALEO CLUTCH

- With diaphragm design the diaphragm spring is situated far away from pressure plate face & also makes only a line contact making it suitable even for clutch plate with cerra-metallic pads.



**VALEO Diaphragm Clutch**

- High reliability
- Low pedal effort
- More life
- Easy maintenance & serviceability
- More suitable for cerra-metallic pad clutch plate
- No run-out setting is required"
- Fewer & less complicated parts (23)
- Clamp load not altered by speed

**Reliability & Robustness**



# 3. TECHNICAL INFORMATION

### 1. Technical Specification

| | | |
|---|---|---|
| 1 | Clutch disc diameter | 352 mm |
| 2 | Total friction area (both sides) | 427.32 sq.cm |
| 3 | Thickness of clutch disk<br>a. Under load (clamped)<br>b. Under no load (free) | <br>10±0.4 mm<br>10±0.4 mm |
| 4 | Permissible wear per lining face | 1.25 mm |
| 5 | Number of damper springs | 9 No. |

### 2. Important Tightening Torques

1. Cover Assy. bolts 4.1 - 4.7 mkg.
2. Clutch Hsg. to flywheel Hsg. bolts 4.6 mkg
3. Clutch release bearing lock nut ring 3.5 - 4 mkg

### 3. Recommended Lubricant's

| TO BE USED FOR | BHARAT PETROLEUM | HP | CASTROL | INDIAN OIL | TIDE WATER (VEEDOL) |
|---|---|---|---|---|---|
| **Clutch**<br>a) Clutch release bearing Sleeve, Clutch disc splines, Yoke-wear pad contact surface | Bharat MP Grease 3 | HP Lithon 3 | Castrolease AP Grease No.3 | Servo GEM 3 | Veedol AP-3 Grease |
| b) Release yoke cross shaft bushes for 352 dia clutches | | | | | |
| c) Felt pad of clutches release bearing, (if fitted) Clutch pedal & slave cylinder linkages | Lubricant with engine oil by using oil can. | | | | |

**Do not mix lubricants of different brands and optional grades**

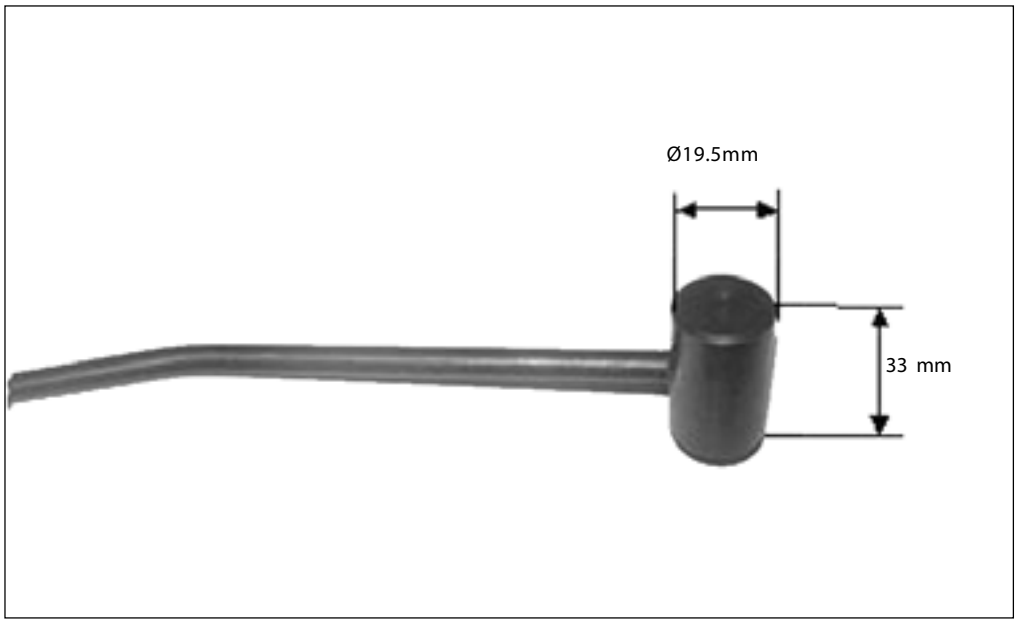
# TECHNICAL INFORMATION

**4. Maintenance**

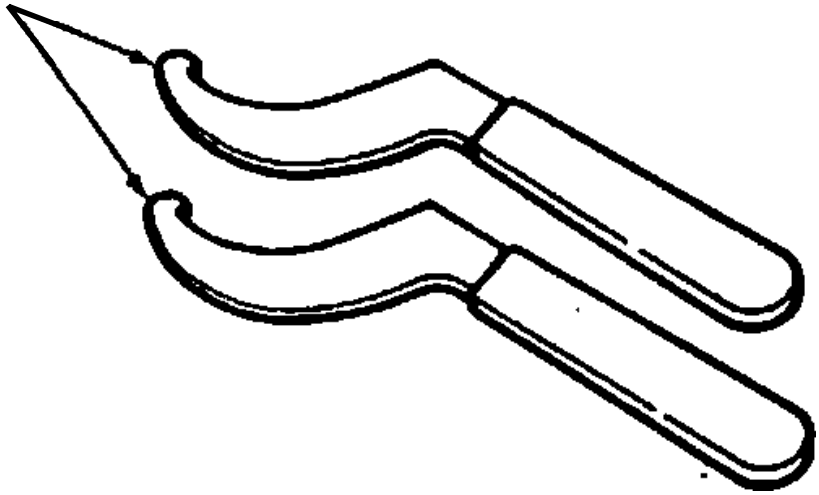
| Sr. No. | OPERATION | FREQUENCY IN KM |
|---|---|---|
| 1. | Check clutch pedal free play and adjust if necessary (Wherever provision is there). | 9000 |
| 2. | Grease with grease gun : Clutch pedal bushing and release fork pivoting point | 9000 |
| 3. | Lubricate with oil can : Clutch pedal linkage, slave cylinder linkages & felt pad of clutch release bearing sleeve. (few drops only). | 9000 |
| 4. | Check distance between release bearing and Gear box front cover, adjust if necessary (352 dia.). | 9000 |
| 5. | Grease with grease gun, clutch release bearing (352 dia.) Grease nipple provided and grease fork pivoting area. | 9000 |

# 4. SPECIAL TOOL

1. Release travel setting gauge (19.5 mm)
2. Gauge for Checking fully worn-out clutch (33 mm)




**Spanner Wrench for locknut adjustment**



# 5. PROCEDURE FOR CLUTCH GAP SETTING

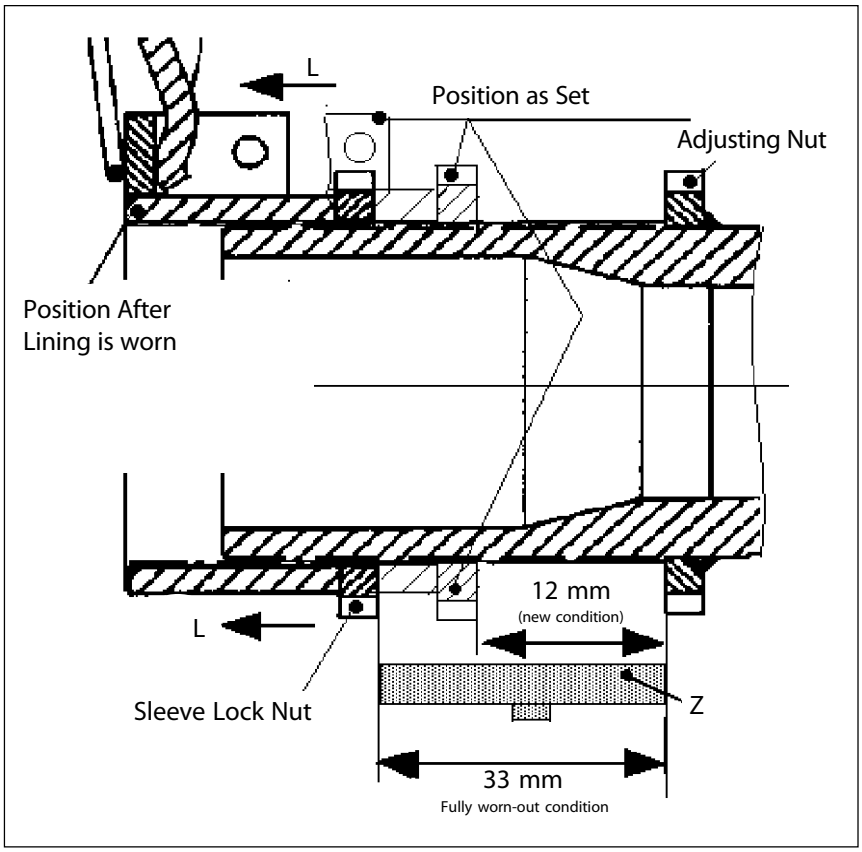
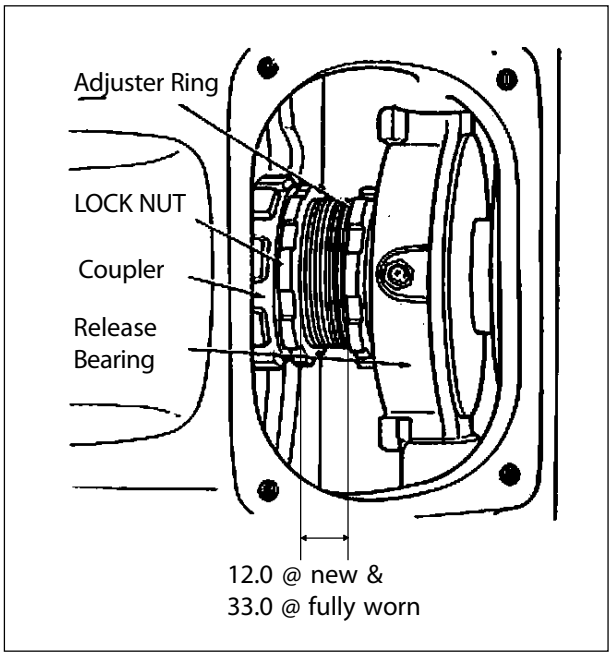



Fig 1

The 352 Clutch is set for dimension 12 mm. There is no need for readjustment at Tata Motors at OE or service installation or at PDI. However, it is necessary to check and set the release travel clearance of 19.5 mm regularly at service.

**Note :**

**The gap between the two adjusting nut is 12.0 mm at new and increases with the wear of clutch plate. The clutch disc can be used until this dimension changes to 33.0 mm indicates complete wear of clutch plate and need replacement.**



# PROCEDURE FOR CLUTCH GAP SETTING

1. Every time the vehicle is brought for servicing at every 9000 Km. or when a new or used or reconditioned clutch is installed in service, it is necessary to set the clutch release bearing as per procedure given below.

   The 352 dia model shown above as it leaves the factory, in the new condition with a 12 mm gap between the locking and adjusting nuts. (Fig. 2)

2. For severe applications, adjustment frequency to be 20 day's

3. If there had been any severe abuse for any reason adjustment requirement needs to be checked.

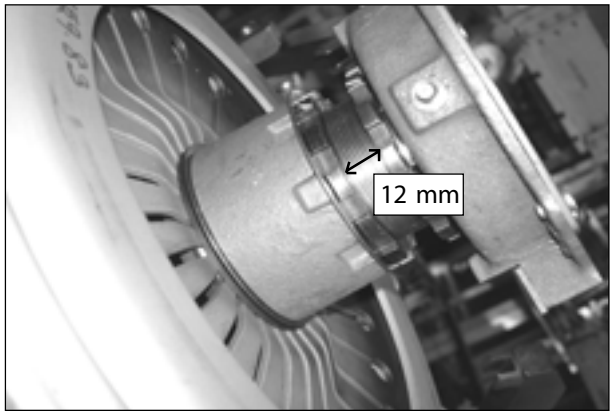


Fig 2

**CLUTCH ADJUSTMENT**

Procedure for setting Valeo Diaphragm pull type clutches is as follows.

**Step 1.**

With the inspection cover removed, use lock nut to unlock the release bearing assembly sleeve locking-nut. (Fig. 3)

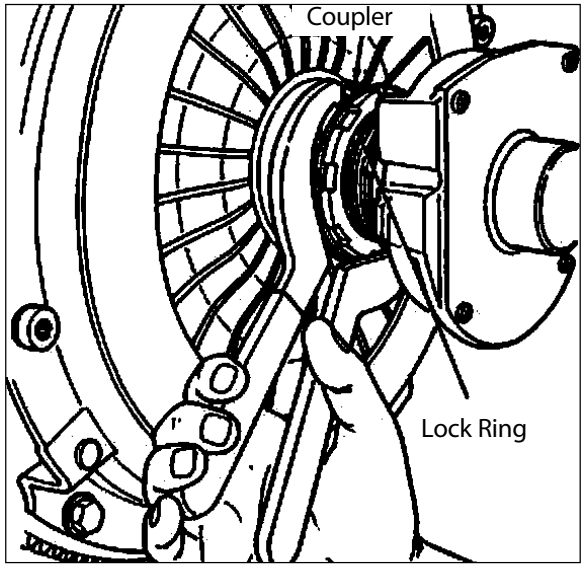


Fig 3

**Spanner Wrenches**

**Step 2.**

The release travel setting gauge is then placed between the transmission and the release bearing assembly, to check the release travel clearance of 19.5mm. (Fig. 4)

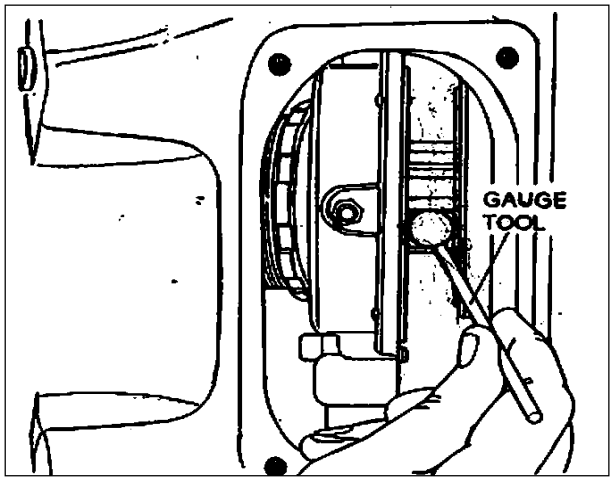


Fig 4

# PROCEDURE FOR CLUTCH GAP SETTING

**Step 3.**

Release travel clearance is set by turning the slotted adjusting nut (nearest the release bearing) by using two spanner wrench. (Fig. 5)

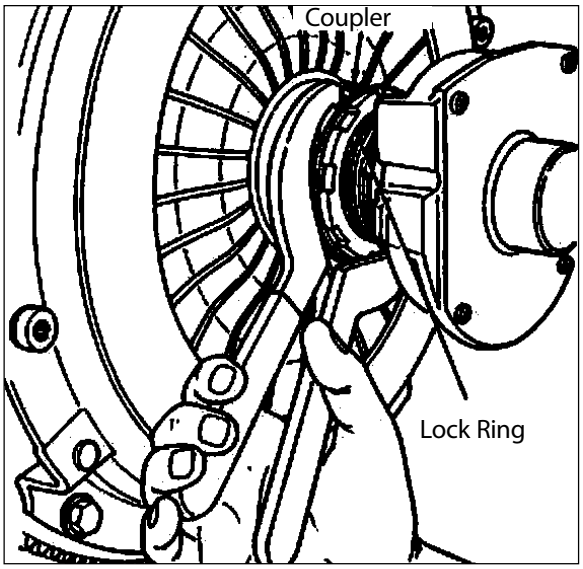



Fig 5

**Step 4.**

Recheck the gap between the release bearing to transmission using the gauge

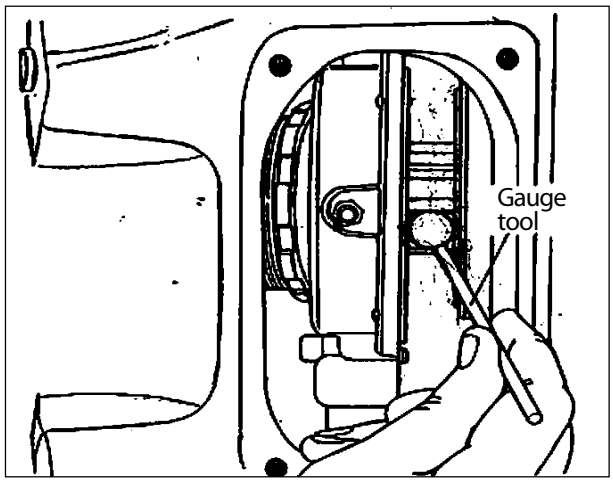



Fig 6

**Step 5.**

Completing the adjusting procedure, the release bearing assembly sleeve locking nut is locked back into position against the spider. (Fig. 7)

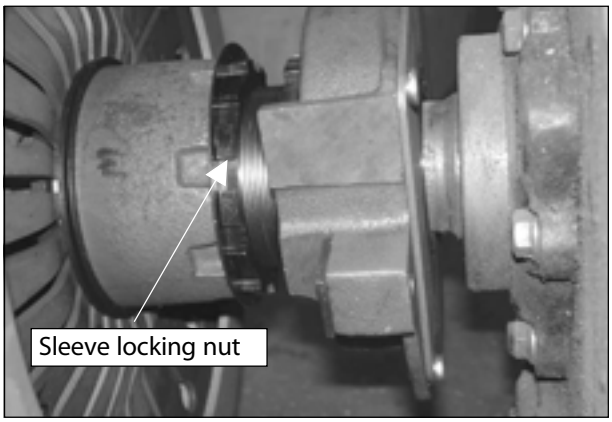



Fig 7

# PROCEDURE FOR CLUTCH GAP SETTING

**WEAR INDICATION**

Valeo's unique wear indication for friction face wear is applicable to all our pull type units.
The unit shown is in the fully worn condition-clutch needs replacing at 33 mm nominal gap between locking and adjusting nuts. (Fig. 8)

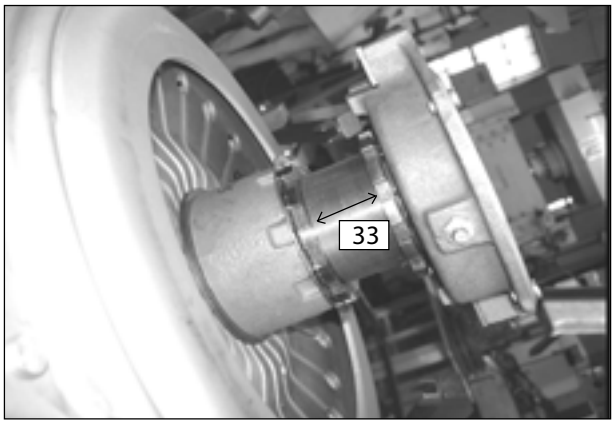



Fig 8

**Step 6.**

Push the transmission fully forward until the clutch housing pilot is seated against the flywheel housing bore. Install the transmission attaching screw and tighten.

**REFER FOLLOWING TABLE FOR THE ADJUSTMENT IN THE FIELD**

| Sl. No. | Description | Gap Between two adjustment nuts | Gap Between Release Bearing & Gear Box Housing |
|---|---|---|---|
| 1. | As New Cover Assembly & New Disc Assembly and New Flywheel | **As Received**<br>**No Adjustment** | **No Adjustment** |
| 2. | As New Cover Assembly & New Disc Assembly and Flywheel with 'A' mm skimmed | **No Adjustment** | **19.5** |
| 3. | As New Disc Assembly & Pressure Plate Skimmed by 1mm and New Flywheel | **To be adjusted** | **Adjust to 19.5 mm** |
| 4. | As New Disc Assembly & Pressure Plate Skimmed by 1mm and Flywheel skimmed by 'B' mm | **To be adjusted** | **Adjust to 19.5 mm** |
| 5. | As New Cover Assembly & used Disc assembly (thickness > 7.5mm) and New Flywheel | **To be adjusted** | **Adjust to 19.5 mm** |
| 6. | As New Cover Assembly & used Disc assembly (thickness > 7.5mm) and skimmed by 'C' mm | **To be adjusted** | **Adjust to 19.5 mm** |

# 6. CLUTCH LUBRICATION

Lubrication to be done at regular intervals in the following parts/areas.

**Clutch release bearing**

Lubricate the clutch release bearing with high melting point grease / Wheel bearing grease as shown in (Fig.9)

1. Grease Nipple on Clutch Release Bearing

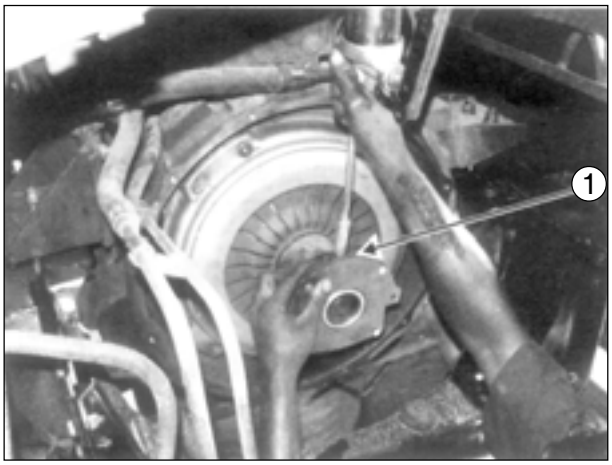



Fig 9

**Clutch Release Fork Pivoting Point / Area**

Lubricate the clutch release fork pivoting point / area with high melting point grease / Wheel bearing grease on both sides of clutch housing as shown in (Fig.10)

1. Grease nipple on Fork Pivoting point RHS
2. Slave Cylinder
3. Grease nipple on Fork Pivoting point LHS

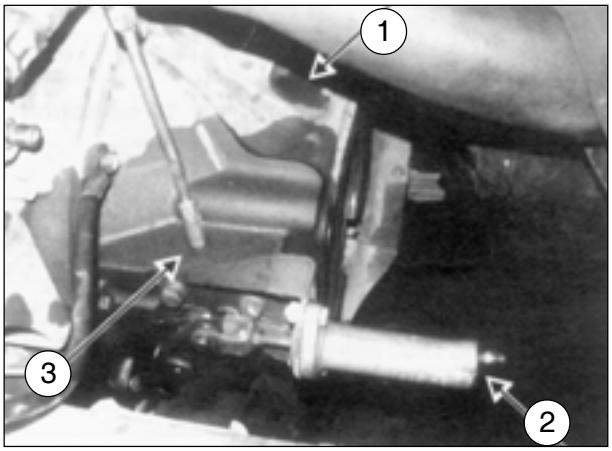



Fig 10

# 7. VEHICLE INSPECTION

It is recommended that checks are carried out on the vehicle as per check list given below to establish the reasons for clutch problem and to ensure that the vehicle clutch related systems are in order.

**CHECKS TO BE DONE ON VEHICLE BEFORE REMOVING THE CLUTCH. TABLE 1.**

| NO | CHECKS TO BE DONE | CORRECTIVE ACTION. |
|---|---|---|
| 1 | Check for smooth engagement and smooth return of pedal. | Pedal return should be smooth and there should be no Stick slip. Ensure the presence of pedal return spring. Ensure that the pedal linkages and bushes are greased. |
| 2 | Check the pedal free play, | Should be 5 to 10 mm. If not adjust the pedal linkages to get the required play. |
| 3 | Check for full travel of the pedal to the bottom of the floor. | There should be no obstructions like foot rest etc. |
| 4 | Start the engine and check at what point of pedal travel the clutch is released and engaged. | Clutch engagement and disengagement should take place between ½ to 2/3 rd the pedal travel. |
| 5 | Check the movement of master and slave cylinders. | Movement should be smooth and should not be sticky. |
| 6 | Check if bleeding of hydraulic cylinders are done. | Bleed the system if pedal is spongy. |
| 7 | Check for the stroke of the slave cylinder by depressing the clutch pedal fully. | Should be MIN 18 mm at the slave cylinder rod which can be easily checked with a scale. |
| 8 | Make sure that setting has been done. (Ref. part 6 for details) | Gap between gearbox cover and clutch release bearing should be ~ 19.5 mm. |

# 8. CLUTCH REMOVAL

**General Instructions**

Refer to the recommended clutch removal procedures in the manufacturer's service manual for the vehicle being repaired. The following procedures provide general instructions for clutch removal. Prior to removal make sure that the vehicle is stable and cannot move. Use chocks and jack stands as necessary to assure a safe work area.

1. Disconnect the transmission electrical wiring and air lines.
2. Disconnect the speedometer cable and wiring
3. Disconnect the clutch release linkage system from the transmission.
4. If a hydraulic system is used to operate the clutch, disconnect the pushrod and the spring from the release lever. Remove the slave cylinder from the support bracket on the transmission. Support the cylinder with wire attached to the frame.
5. Put marks on the yoke or the flange of the driveshaft and the output shaft of the transmission. These marks are necessary to assure the driveshaft is correctly reinstalled.
6. Remove the driveshaft. Support the rear of the engine if necessary (nodal mounting systems).
7. Support the transmission using a transmission jack.
8. Rotate the clutch release yoke so that is will clear the clutch release bearing.
9. Remove the fasteners that attach the transmission to the frame cross-member.

**⚠ CAUTION**

**Keep the transmission in line with the engine during removal. Do not allow the weight of the Transmission to hang on the input shaft. Doing so could bend the clutch disc hub or result in internal transmission damage.**

# CLUTCH REMOVAL

10. Remove the capscrews and washers that attach the clutch housing to the engine. Pull the transmission straight back from the engine until it has cleared the Pressure Plate and Cover Assembly (Fig.11) Remove the transmission from the vehicle.

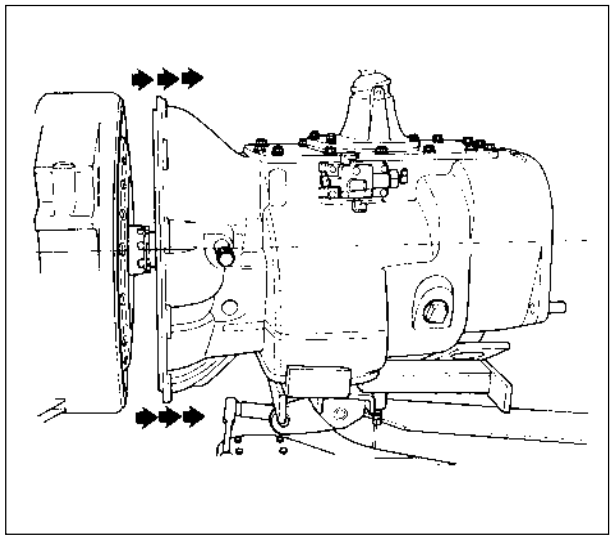


Fig.11

11. If the clutch is to be reinstalled, install a shipping clip under the head of each of the 4 allenhead capscrews that attach the drive straps to the pressure plate (Fig.12). The clips will keep the pressure plate in a partially retracted position and make pressure plate installation easier.

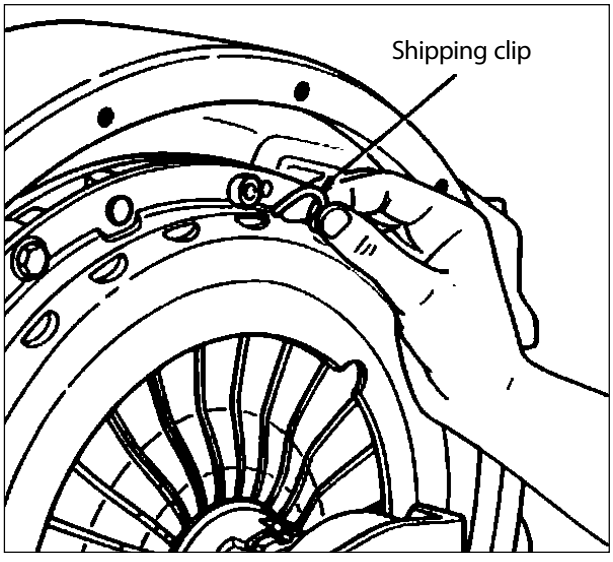



Fig.12

# CLUTCH REMOVAL

12. Insert the clutch disc alignment tool through the release bearing and clutch disc into the pilot bearing. (Fig.13)

13. Loosen, but do not remove the capscrews attaching the Pressure Plate And Cover Assembly to the flywheel. The capscrews should be loosened in an alternating Pattern. This will allow the diaphragm spring to relax in a uniform manner.

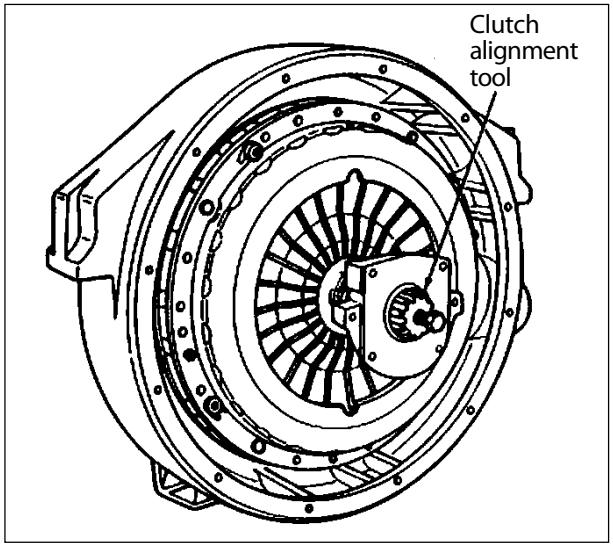


Fig.13

**⚠ CAUTION**

**Do not loosen or remove the four allen-head capscrew attaching the drive straps to the clutch pressure plate. Removal and reinstallation of these capscrews can cause the clutch to be out of balance and/or cause the clutch to drag.**

**⚠ CAUTION**

**Do not drop or handle the Pressure Plate And Cover Assembly roughly. Doing so can cause minor bends or kinks in the four drive stap assemblies. Any bends or kinks can reduce or eliminate the ability of the pressure plate to retract into the clutch cover and cause incomplete clutch release.**

14. Remove two Pressure Plate And Cover Assembly attaching capscrews, 180 degrees opposed to each other.

15. Install two alignment pins in the capscrew holes (Fig. 14)

16. Remove the remaining Pressure Plate And Cover Assembly attaching cap-screws.

17. Remove the Pressure Plate And Cover Assembly by sliding it straight back and off the two alignment pins.

18. Remove the clutch disc and clutch alignment tool.

19. If necessary, remove the pilot bearing using a bearing puller and discard the bearing.

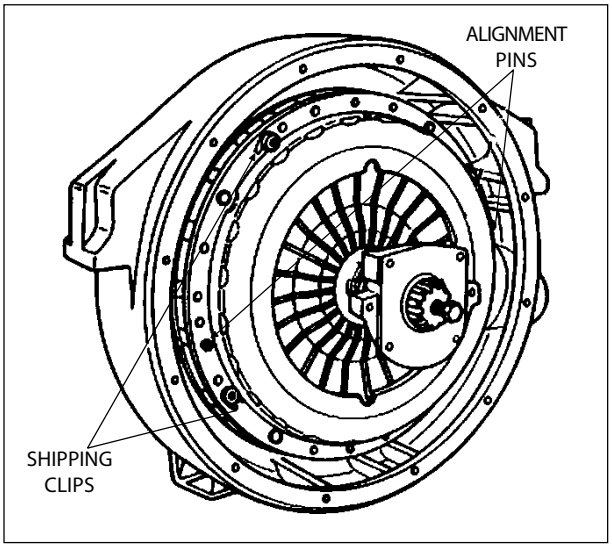


Fig.14

# 9. CLUTCH INSPECTION

**Clutch Environment**
The environment in which the clutch operates is extremely important to proper function. There are three major points to the environment check. They are:

a. Alignment of the engine and transmission

b. Presence of oil leakage or foreign materials

c. Components condition

**Alignment Considerations**
Alignment is extremely important to proper clutch operation. Improper alignment can result in incomplete clutch release, transmission gear slipout, clutch disc breakage or input bearing failure. For proper operation, the engine and transmission must be in line and the flywheel perpendicular to the input shaft. The procedures outlined in this manual are general in nature. When checking for possible misalignment, refer to the specific engine manufacturer service manual for exact procedure and specifications.

The basic instrument required to take readings for misalignment is a dial indicator. Accuracy of the readings is essential when identifying and correcting alignment problems. All surfaces must be clean before readings are taken.

**IMPORTANT :** When taking readings, rotate the engine by hand. DO NOT crank the engine with the starter. Remove spark plugs on gasoline engines and release the compression on diesel engines where possible to make engine rotation easier.

**Engine :** Make a general inspection of the engine and determine if there are any oil or coolant leaks that could contaminate the clutch. Correct as required.

**Crankshaft :** Measure the endplay of the crankshaft and compare the result to the engine or vehicle manufacturer's specifications. Correct as required. To perform the check, attach the dial indicator base to the flywheel (Fig.15) housing and place the indicator pointer against the flywheel . Then, force the crankshaft forward and reward with a prybar.

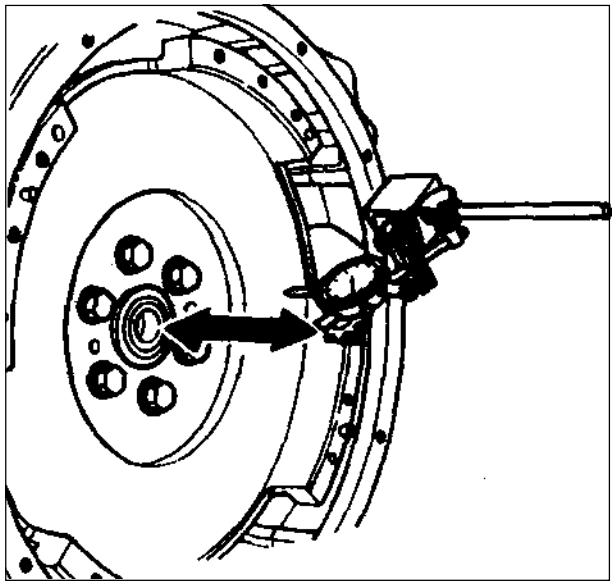


Fig.15

**Flywheel**

1. Inspect the flywheel for excessive wear or heat damage. Sometimes minor wear or damage can be corrected by resurfacing the flywheel should be resurfaced if any of the following conditions exist :

   Heat Checking - Do not use the flywheel if the heat checking is evident after resurfacing.

   Metal Flow - Indicates that metal has actually melted due to excessive heat.

   Wear - Look for any detectable step in the flywheel surface caused by clutch contact.

   For flywheel wear limits and resurfacing specifications, please refer to the engine manufacturer's regulations.

**Note :**

If the flywheel has been resurfaced, check to be certain the capscrews can be threaded in by hand to a point deeper than is required to install the Pressure Plate And Cover Assembly.

# CLUTCH INSPECTION

2. Measure the **axial runout** at the outer diameter of the flywheel. Secure the dial indicator base to the engine flywheel housing near the outer edge and place the dial indictor tip on the flywheel (Fig. 16) Turn the engine over by hand and observe threading on the dial indicator. Measure at four places, 90 degrees apart. Force flywheel rearward when taking each measurement to take up crankshaft endplay. Typical runout limits are :

   -14-inch clutch-0.007-inch (0.178 mm) max

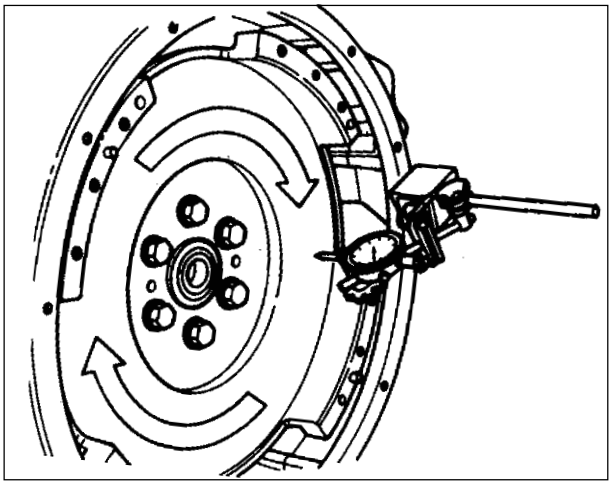


Fig.16

3. Measure the **radial runout** of the pilot bearing bore with a dial indicator Secure the dial indictor to the flywheel housing and position the pointer of the dial indicator (Fig.17) to contact the pilot bearing bore surface. Turn the engine over by hand while observing the dial indicator. A typical runout limit is :

   *0.005-inch (0.127 mm)

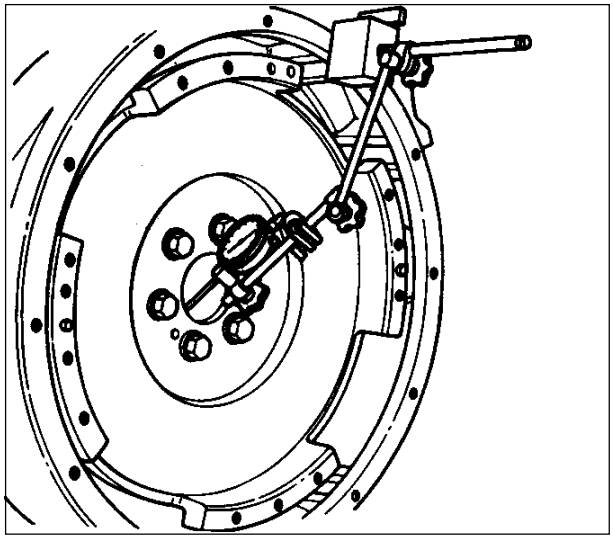


Fig.17

# CLUTCH INSPECTION

**Flywheel Housing**

1. Inspect the flywheel housing pilot bore for wear. The pilot lip of the transmission clutch housing can wear into the flywheel housing. This can be caused by the transmission attaching bolts becoming loose (caused by road and enigne vibrations over a long period) or high mileage. Any appreciable amount of wear on either housing will cause misalignment.

   This wear will usually be in the area of the 3 to the 8 o'clock position(Fig.18). Refer to the engine or vehicle manufacturer's allowable wear limits.

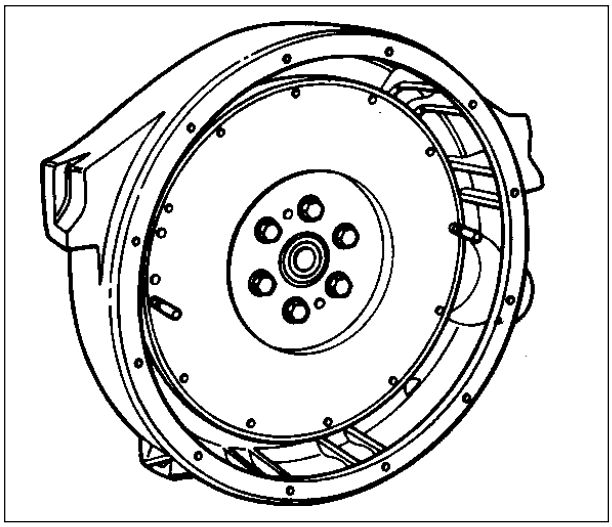


Fig.18

2. Measure the housing pilot bore **radial runout** by attaching a dial indicator base to the flywheel (Fig.19) Position the gage pointer against the housing pilot and zero the gage. Rotate the engine by hand. Mark the high and low points of the housing pilot as indicated by the dial indicator reading as the flywheel turns. The total redial runout is the difference between highest plus and minus readings. The typical maximum limit is 0.008 - inch (0.203 mm). Refer to the engine or vehicle manufacturer's specifications and recommended corrective actions if runout exceeds specification.

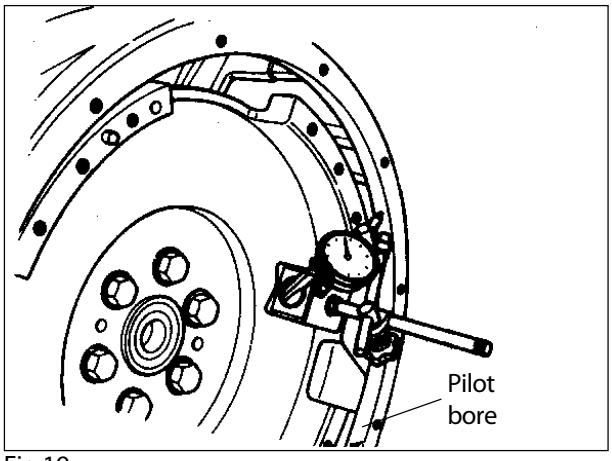



Fig.19

3. Measure the rear face **axial runout** by positioning the dial indicator pointer against the flange face of the flywheel housing. Rotate the flywheel back record dimension at four places, each 90 degrees apart (Fig.20)Force the flywheel back to take up crankshaft endplay prior to taking each measurement. Rotate the engine again and mark the high and low points as in step 2. Typical maximum allowable limit is 0.008-inch (0.203 mm). Refer to the enigne or vehicle manufacturer's specifications and recommended corrective actions if runout exceeds specification.

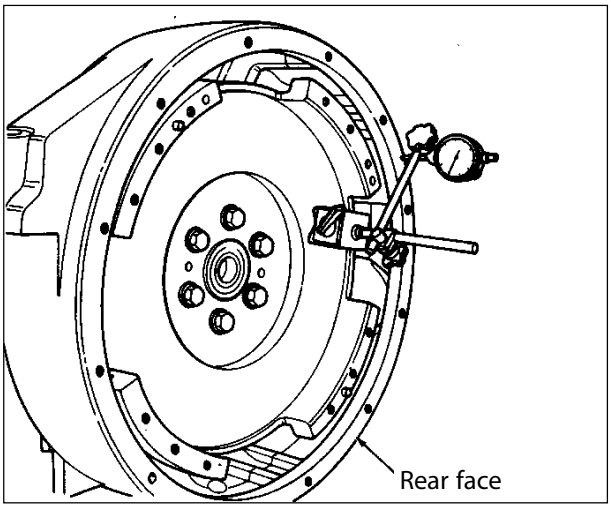



Fig.20

# CLUTCH INSPECTION

**Clutch Housing**

1. Inspect the clutch housing front pilot for excessive wear in the same manner as was described for the flywheel housing. Wear in this area can result in enigne to transmission misalignment. Refer to the transmission or vehicle manufacturer's specifications for allowable wear limits.

2. If the inspection shows signs of wear, measure the rear pilot bore radial runout (Fig.21). Refer to the transmission or vehicle manufacturer's specification and recommended corrective actions if not within specifications.

3. Check for wear or damage to the clutch housing mounting flange. Replace clutch housing if required.

4. Inspect the clutch release yoke cross shaft bushings for wear and lubrication. Replace as necessary.

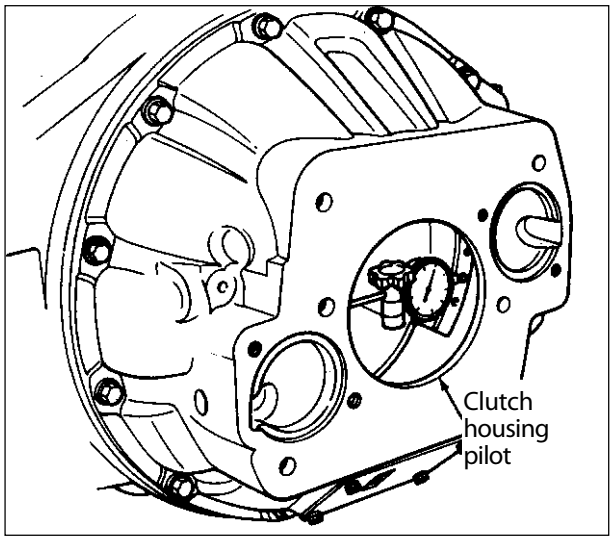


Fig.21

**Clutch Release Yoke and Cross Shafts**

1. Inspect the clutch release yoke contact tips for excessive wear (Fig.22). Replace as necessary.

2. Inspect the cross shafts for bushing wear and end spline damage and wear. Replace as necessary.

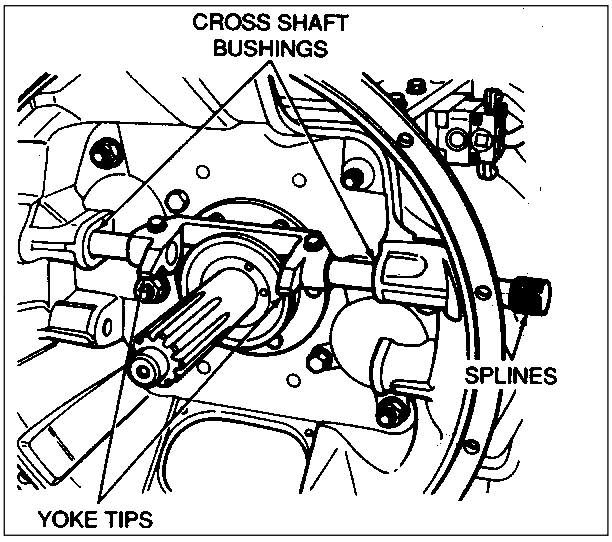


Fig.22

# CLUTCH INSPECTION

**Transmission**

1. Inspect the input shaft for wear or damage of the splines, release bearing contact area and pilot bearing arbor (Fig.23) . Service as necessary.

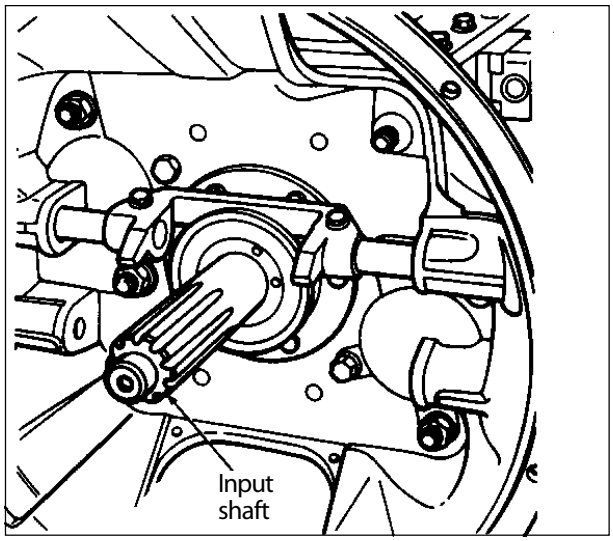



Fig.23

2. If applicable, check the input shaft front bearing retainer for excessive clutch brake wear (Fig.24). Refer to the transmission or vehicle manufacturer's specifications and recommended corrective actions.

3. Inspect for oil leaks that could contaminate the clutch. Correct as required.

   Once the integrity of the clutch environment has been confirmed and all corrective actions are completed, clutch installation can begin.

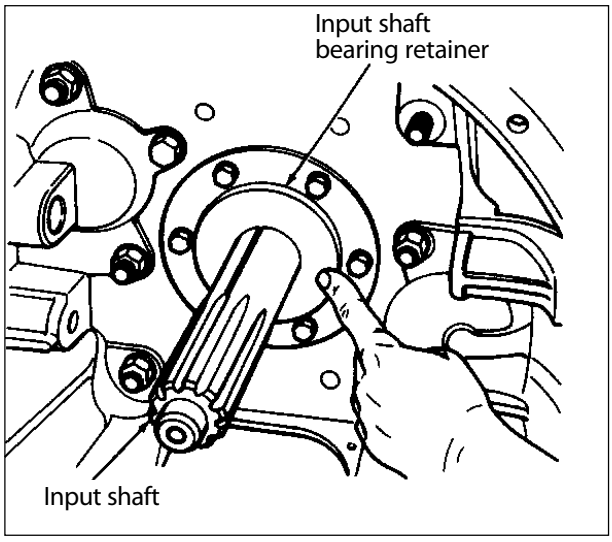



Fig.24

# CLUTCH INSPECTION

**PRESSURE PLATE AND COVER ASSEMBLY**

1. Inspect the pressure plate friction surface for wear by placing a straight edge across the width of the friction face (Fig.25). A gap in the worn area of 0.030-inch (0.75mm)or more indicates the Pressure Plate and Cover Assembly should be replaced

2 If **reusing** the Pressure Plate and Cover Assembly with a **new** disc, inspect the pressure plate for warpage or uneven wear by placing a straight edge across the entire diameter of the plate. If the gap at the inside wear diameter exceeds the gap at the outside wear edge by 0.008-inch(0.20mm), there is excessive concave warpage and that Pressure Plate and Cover Assembly should be replaced if the gap at the outside diameter exceeds the gap at the inside edge of the clutch wear area.

3. Inspect the pressure plate for heat damage such as discoloration, surface checking or cracks, slight coloration or light checking is normal. Deep checking or cracks indicate the Pressure Plate and Cover Assembly should be replaced.

4. Examine the drive strap assemblies for bend's or kinks. Normal drive strap units form a smooth, gently curving "S" shape when viewed from the edge, with all laminations fitting tightly tigether (Fig.26). Bent or kinked drive straps will shown an bolt attachments and or notceable gaps between laminations.

**⚠ Cautions :**

**Do not use a clutch with damaged drive straps as clutch release problems can result.**

5. Check the stamped steel cover mounting flange and for distortion due to shipping damage or incorrect vehicle installation. Pressure Plate and Cover Assembly assemblies with this condition must be replaced.

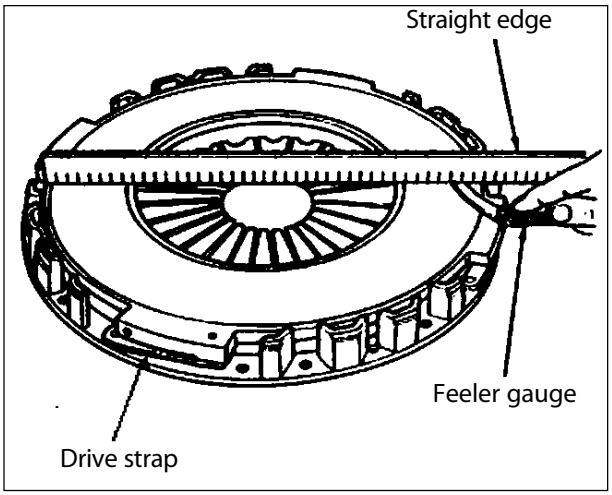



Fig.25

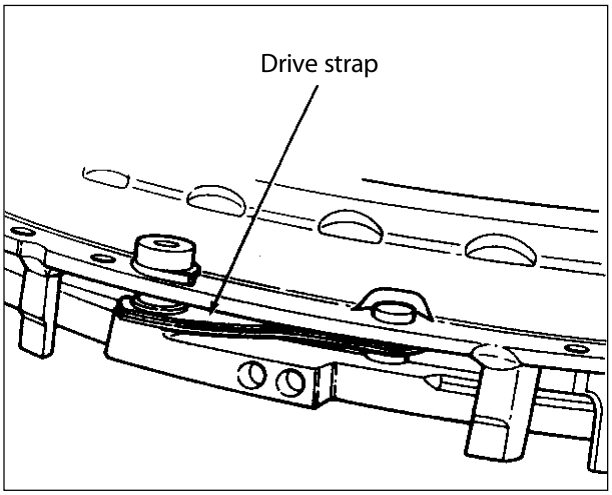



Fig.26

# CLUTCH INSPECTION

**Clutch disc**

The clutch disc must be checked for wear or damage and should also be closely examined for contamination. Make sure that the damping springs are not loose in the hub. If the springs have any axial (back and forth) movement they are loose. Check the hub splines for wear or damage and make sure that the hub is firmly fastened to the disc.

Perform the following checks on the clutch disc.

1. Inspect the friction material for signs of excessive wear or heat or heat damage. Disk thickness should be checked with calipers or an outside micrometer (Fig.27). Minimum disc thickness.

   -14 - inch clutch - 0.295 - inch (7.5mm)

2. slide the clutch disc onto the transmission input shaft to look for evidence of sticking or binding splines. Clean and correct source of interference or replace clutch disc.

3. Lay the clutch disc on a new Pressure Plate and Cover Assembly or flywheel to check for bent cerametallic paddle arms. Using a feeler gauge, check the gap between the friction material pads and the Pressure Plate and Cover Assembly or flywheel face (Fig.28). The gap must not exceed 0.30-inch (0.75mm)

4. Examine the clutch disc for a bent hub by looking for unusually heavy and uneven friction material wear.

   Check the clutch disc for signs of driveline torsional vibration or shock loading damage such as broken springs, cracked damper retainer plates or damaged splines. (Fig.29).




Fig.27

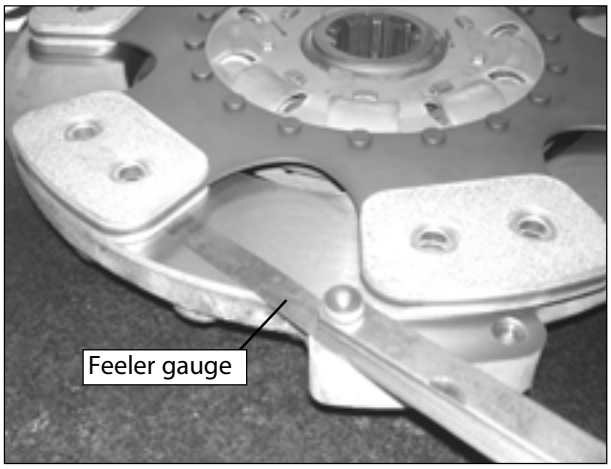



Fig.28

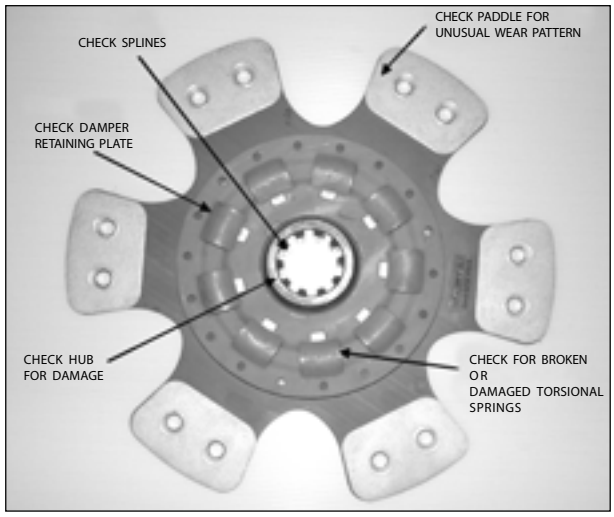
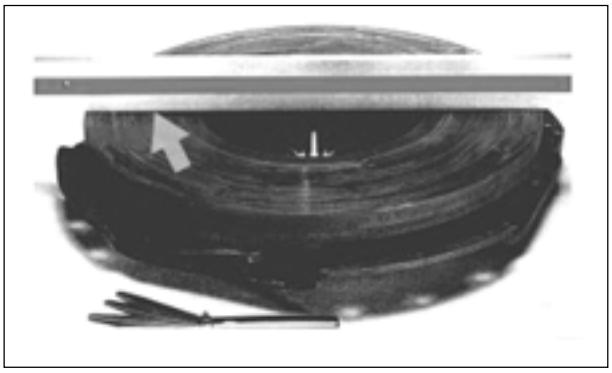



Fig.29

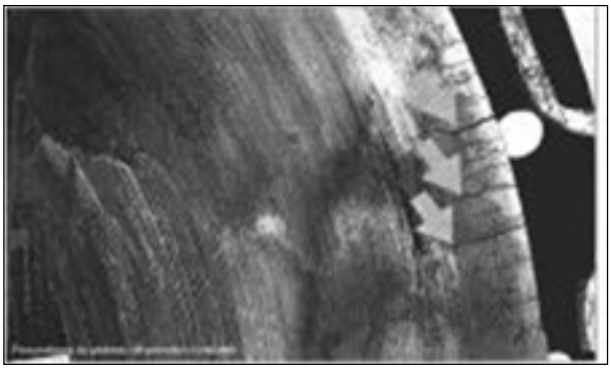
# CLUTCH INSPECTION

**Heat / Metal Flow / Wear Inspection**

1. Inspect PP for warpage by placing a straight edge across the entire diameter of the PP. If the gap at the inside wear diameter exceeds the outer wear edge by 0.20mm, there is excessive warpage, requires replacement of PP

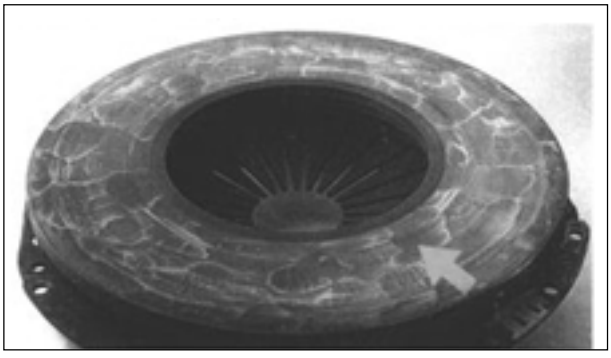


2. Inspect PP for heat damages such as discoloration, surface checking or cracks. Slight coloration or light checking is normal. Deep checking or cracks indicates PP and diaphragm should be replaced



3. Examine the drive straps for bend or kinks. Normally drive strap units form a smooth curving "S" shape when viewed from the edge, with all lamination fitting tightly together. Bent of kinked drive straps will show an area of sharp bending next to the rivet or bolt attachment and / or noticeable gaps between lamination. If drive strap are damaged it needs to be replaced.

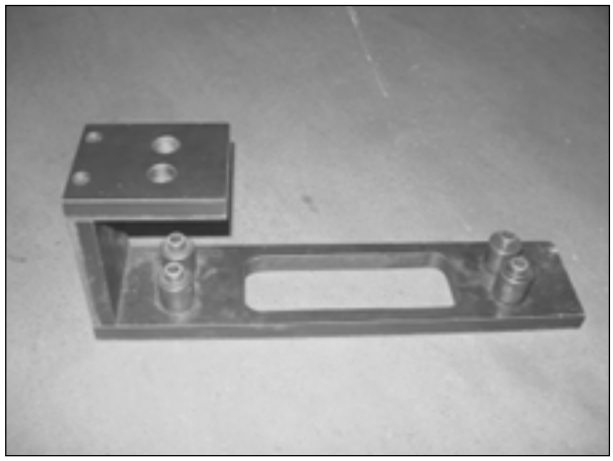
4. 1mm (max) material skimming on pressure plate friction area is allowed in case of minor thermal cracks or scoring.



# 10. CLUTCH DISC REPAIR

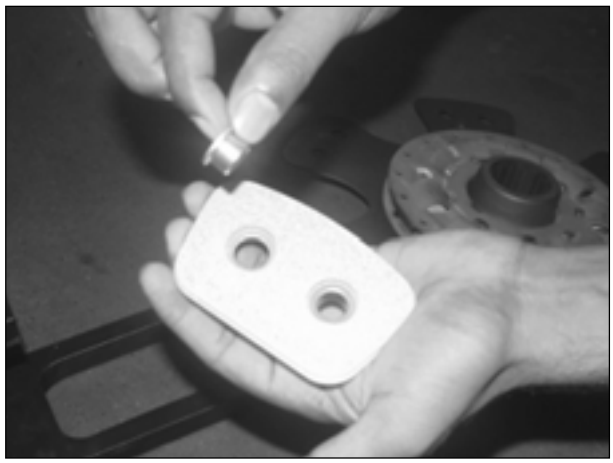
**Required tools**

1) 1/2 " drill for removing old rivets
2) Riveting fixture
3) Hammer



1. Place the fixture in a flat surface

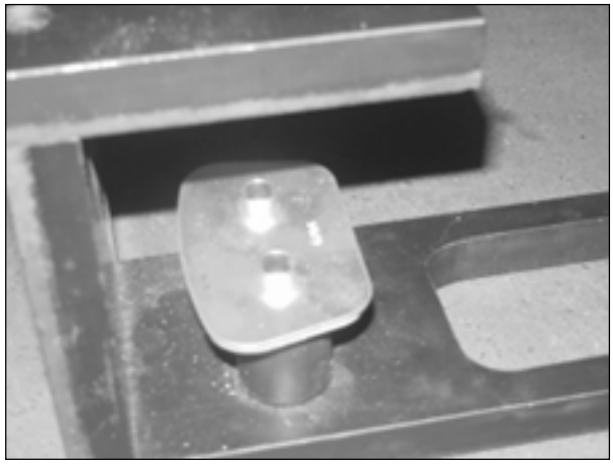
2. Take a new disc pad and rivets. Insert the rivets as shown.



**Note:-**

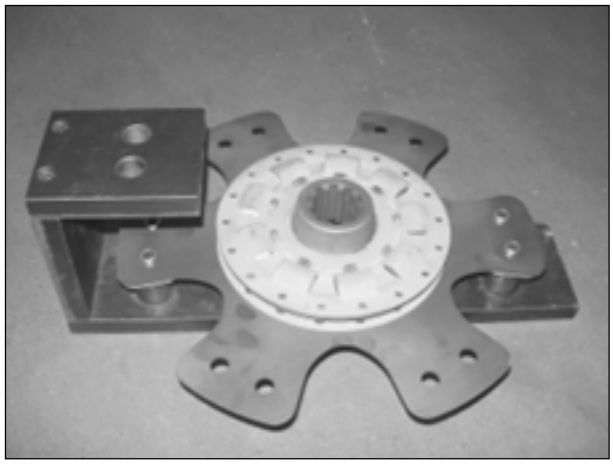
Always use new pads for entire assembly

3. Place the rivets on the locators in the fixture and place the pad with metal plate on top side.

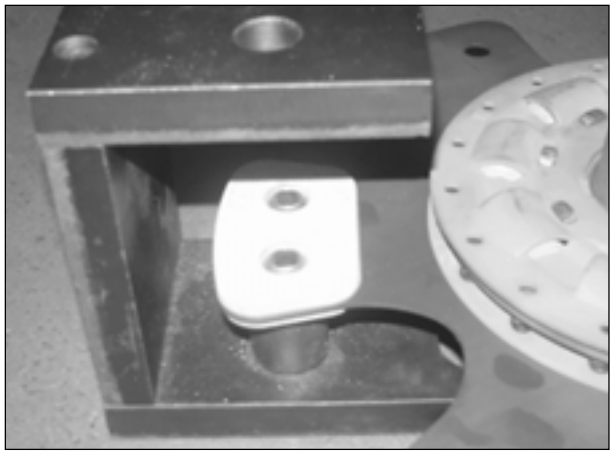


# CLUTCH DISC REPAIR

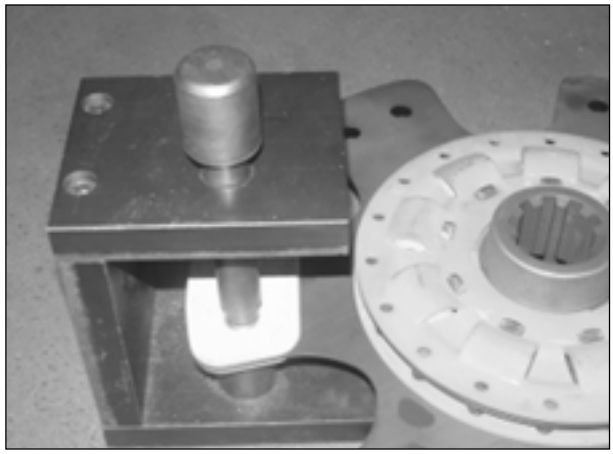
4. Keep the disc sub assy on top of the pad as shown.



5. Place second pad on top of the disc back as shown.

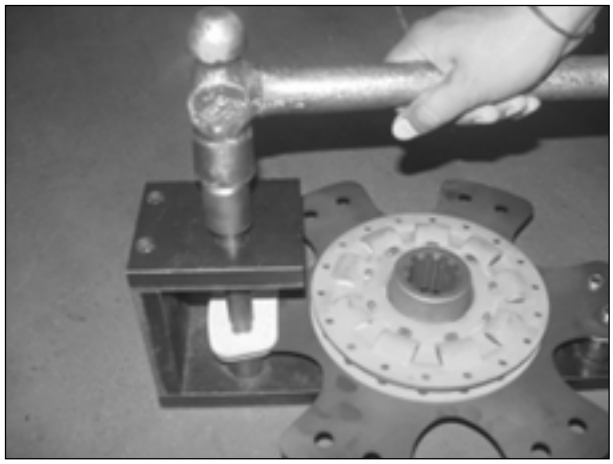


6. Place the rivet punch on the fixture as shown.

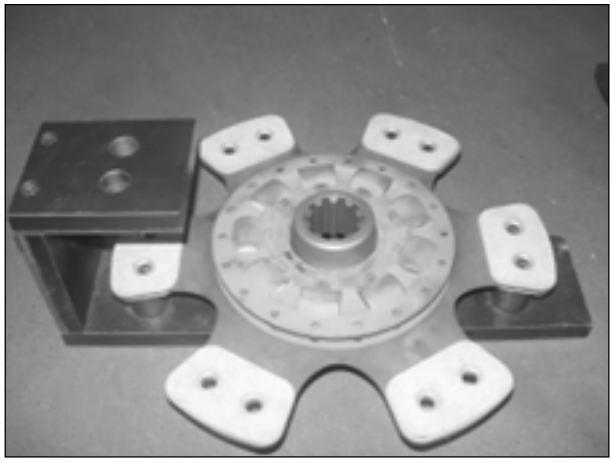


# CLUTCH DISC REPAIR

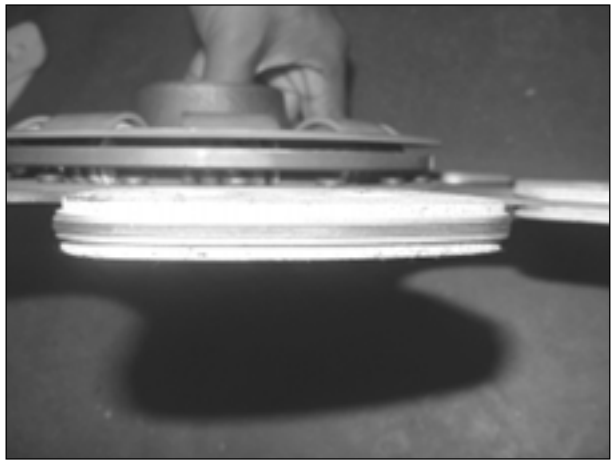
7. Rivet with a hammer by applying impact force on the rivet punch. Do not over load the rivets.



8. Complete riveting of all pads.

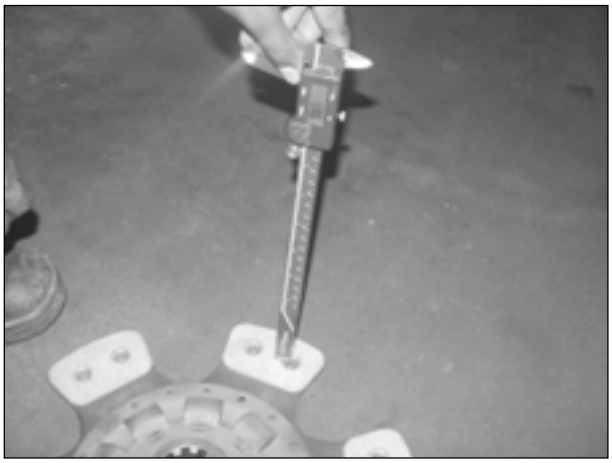


9. Check and ensure that no gap exists between the pad and disc back. Over loading during riveting may cause gap.



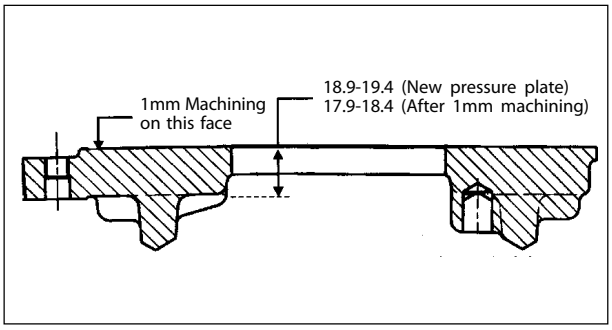
# CLUTCH DISC REPAIR

10. Check wear depth (friction face to rivet face) on the riveted side. It should be 1.25 mm minimum. Also check the disc thickness (should be 10mm +/- 0.4).

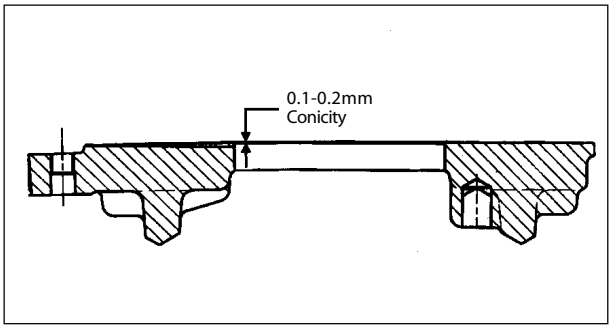


**Instruction on Pressure Plate Skimming**

1. Machining on Pressure Plate




2. During Machining ensure there is 0.1-0.2mm taper (Conicity) between outer & inner sides of the pressure plate. Refer Sketch (No Convexity allowed)



# 11. CLUTCH INSTALLATION

### A) FLYWHEEL PREPARATION

Used flywheel should be properly inspected for heat checks, warpage, scoring or cracks as outlined in the inspection Section. Flywheels having these conditions may need to be resurfaced or replaced depending on engine or vehicle manufacturer's specifications and recommended corrective measures.

The inside and outside diameter of the clutch disc wear pattern on the flywheel should be measured and compared to the new clutch disc. If the new clutch disc facing go beyond the current flywheel wear pattern, check to be certain that no wear step exists at the edge of the flywheel wear pattern. If a wear step does exist, the flywheel MUST be resurfaced or replaced.

If no resurfacing is necessary, the flywheel face should be cleaned with emery paper to remove traces of old friction material. Following this, the friction surface should be thoroughly cleaned using a brake/electrical surface cleaning solvent.

**NOTE ;** New flywheels usually have an Anti-corrosion protection material applied to the surface. This must be removed thoroughly using a brake/ electrical/clutch surface cleaning solvent.

Clutch mounting holes should be checked to ensure that the threaded holes are deep enough to allow the clutch mounting capscrews to be threaded by hand to a point deeper than is required to install the clutch. In addition, check to make sure the capscrew does not extend through the flywheel enough to contact the engine. Complete rotation of the flywheel may be necessary to assure there is no contact.

Install a new pilot bearing in the flywheel by pushing only on the outer race of the bearing (Fig.1). Pushing on the inner race will damage the bearing. It is recommended that a high quality bearing with high temperature grease and high temperature seals are used to ensure long life. See SAE recommended practice J1731.

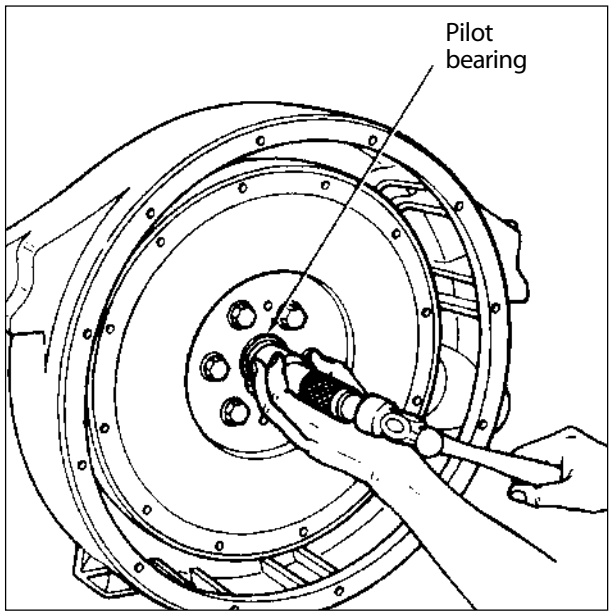


Fig. 1

# CLUTCH INSTALLATION

**B) PRESSURE PLATE AND COVER ASSEMBLY INSTALLATION**

1. If the Pressure Plate And Cover Assembly is being reused it should be inspected for heat checks, warpage, excessive wear, scoring and cracks as outlined in the Inspection Section. If these conditions exist, the Pressure Plate And Cover Assembly must be replaced.

2. Acceptable used Pressure Plate And Cover Assemblys should have the friction surface cleaned using brake cleaning solvent to remove any trace of oil or grease.

3. The normal service unit consists of a Pressure Plate And Cover Assembly with a new release bearing installed. To reuse an existing release bearing make sure the ball bearing is free of rolling roughness, the bore bushing is in good condition, the yoke contact wear pads are not excessively or unevenly worn and the barrel threads are not damaged. Release bearings are usually replaced by threading the old bearing out of the coupler and threading in the new part. All Valeo clutches

Use the same size release bearing barrel threads (there are different internal diameters -1 1/2, 1 3/4 or 2-inch bushing). To install a new or used coupler on a Pressure Plate And Cover Assembly, use the procedure outlined in steps 4 through 13, if the service Pressure Plate And Cover Assembly already has the release bearing installed go the step 14.

**NOTE :** Installation of a coupler on Pressure Plate And Cover Assembly requires the use of an arbor press or equivalent.

4. Stand the bare coupler vertically on an arbor press working surface using the rear notched end face as a base.

5. Place the specified size and number of shim washers on the coupler pilot.

14-inch Clutch-1 Shim (0.8mm) (0.031-inch)

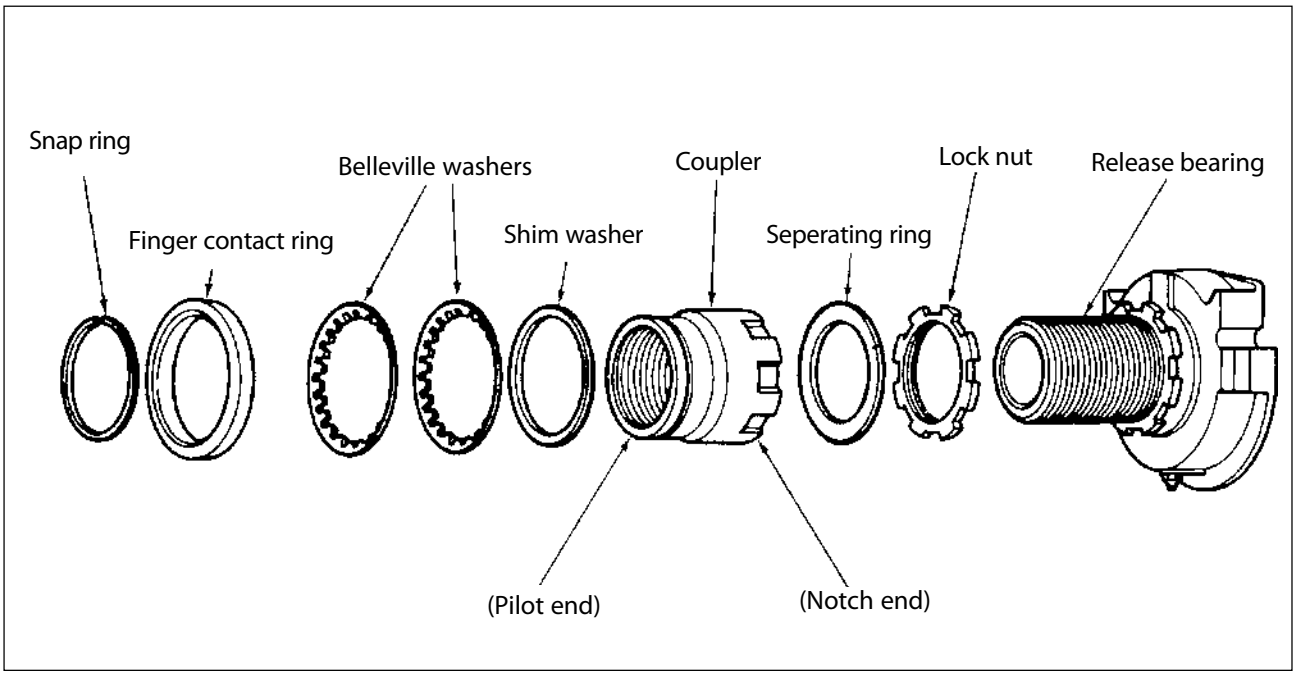



Fig. 2 Clutch Release Bearing Assembly Disassembled

# CLUTCH INSTALLATION

6. Place two (2) toothed Belleville washers on the coupler pilot with the teeth pointing down toward the shim washers (Fig.3)

7. Set the bare Pressure Plate And Cover Assembly on the coupler pilot end with the pressure plate side (enigne side) facing up. The Pressure Plate And Cover Assembly should be positioned so that the diaphragm finger tips are resting on the solid edge of the Belleville washer.

**NOTE :** For ease assembly, a shipping clip should be in place between each of the four drive strap attaching screw heads and the Pressure Plate And Cover Assembly cover. If this is not the case, assemble the Pressure Plate And Cover Assembly over a disc onto a flywheel and evenly and slowly tighten each Pressure Plate And Cover Assembly mounting screw in a crisscross pattern just enough to allow shipping clips or an equivalent to be installed. Then remove the Pressure Plate And Cover Assembly and continue with release bearing installation.

8. Place the finger contact ring on the coupler pilot with the rounded face down contacting the diaphragm spring fingers. The flat face with the counter bore at the ID will be up.

9. Place the round wire snap ring on the exposed end of the coupler pilot (Fig.4)

10. Using the arbor press ram, push down on the finger contact ring at one point enough to deflect the Belleville washers and start the open end of the round wire snap ring into its groove. Continue in this manner around the coupler until the snap ring is fully seated into its groove. Continue in this manner around the coupler until the snap ring is fully seated into its groove.

11. Thread the adjustment locknut on the release bearing barrel (Fig.2)

12. Install a separating ring on the barrel.

13. Thread the release bearing assembly into the coupler deep enough so that it will not hit the transmission when it is installed.

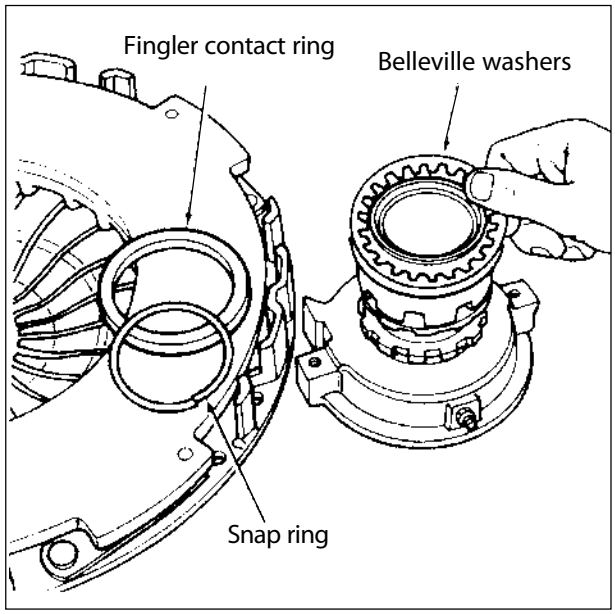



Fig.3

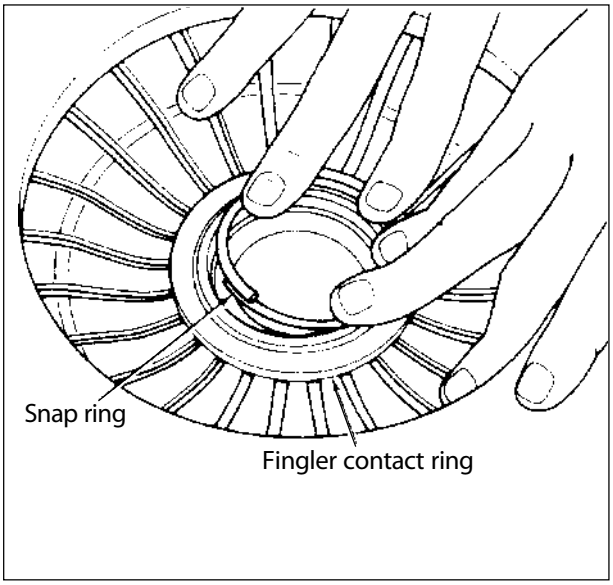



Fig.4

# CLUTCH INSTALLATION

14. Clean the friction surface of new and acceptable used Pressure Plate And Cover Assemblys throughly with a brake surface cleaning solvent to remove all grease, oil or protective film.
15. Install two alignment pins into two flywheel mounting holes that are 180 degrees apart (Fig. 5)
16. The flatter side of the clutch disc goes toward the flywheel. With the disc correctly oriented, insert the clutch disc alignment tool through the splines on the disc. Next, insert the pilot arbor of the alignment tool into the flywheel pilot bearing and slide the clutch disc against the flywheel (Fig.6)
17. Place the clutch Pressure Plate And Cover Assembly and release bearing over the clutch disc alignment tool and onto the two alignment pins installed in the previous step (Fig.7). Do not allow the weight of the Pressure Plate And Cover Assembly to hang on the release bearing and clutch disc alignment tool.
18. Slide the clutch forward against the clutch disc and flywheel.
19. Place thick hardened flat or lock washers on each of the Pressure Plate And Cover Assembly attaching capscrews.
20. Start each clutch attaching capscrew and washer assembly by hand and thread it in until the screw contacts the clutch housing cover.

**NOTE :** For the 14-inch, two of the attaching capscrews are used to center the clutch on the flywheel. These Two capscrews fit into two close fitting smaller pilot holes located 180 degrees apart on the Pressure Plate And Cover Assembly. These "Pilot" holes are identified by one or more of the following three methods.

- The letter 'L" near the hole
- A dot of YELLOW paint with a minimum diameter of 6mm near the hole.
- A small hole, next to the pilot capscrew hole installing these two "Pilot " capscrews first eases installation of the remaining of the remaining six clutch attaching capscrews.

DO NOT tighten the attaching capscrews until all screws have been hand started.

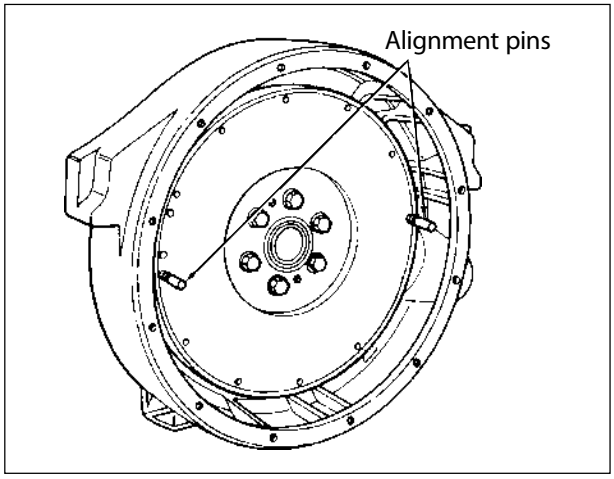


Fig.5

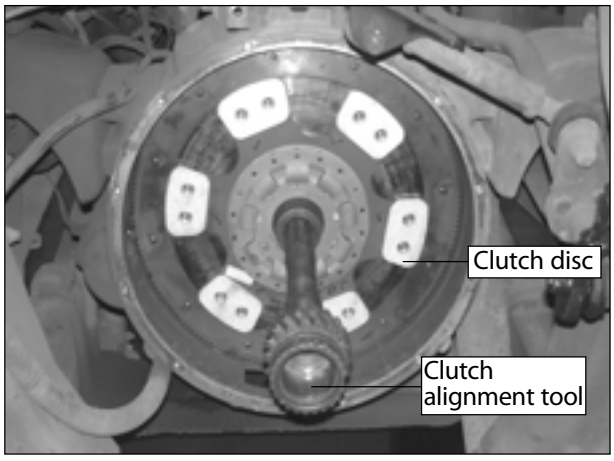


Fig.6

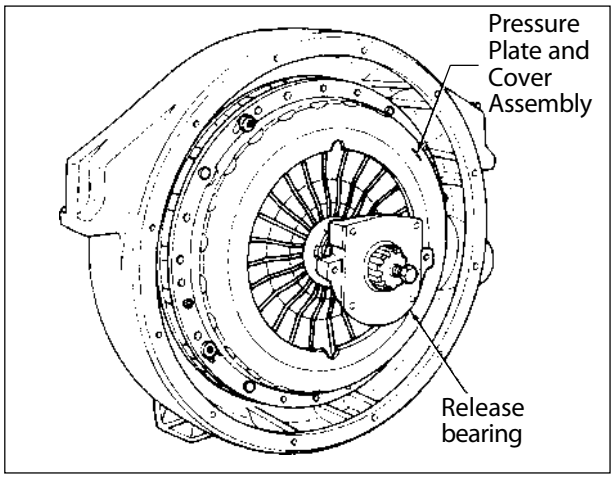


Fig.7

# CLUTCH INSTALLATION

21. Remove the two PRESSURE PLATE AND COVER ASSEMBLY alignment pins and replace them with two attaching capscrew and washer assemblies.
22. Use a standard ratchet to initially tighten all capscrews in the recommended sequence (Fig.8)
23. When tight, torque all capscrews to the sepcified torque (Fig.9)

**NOTE :** Do not loosen the four allen-head capscrews that attach the drive straps to the clutch pressure plate. Serious clutch damage/ malfunction will result.

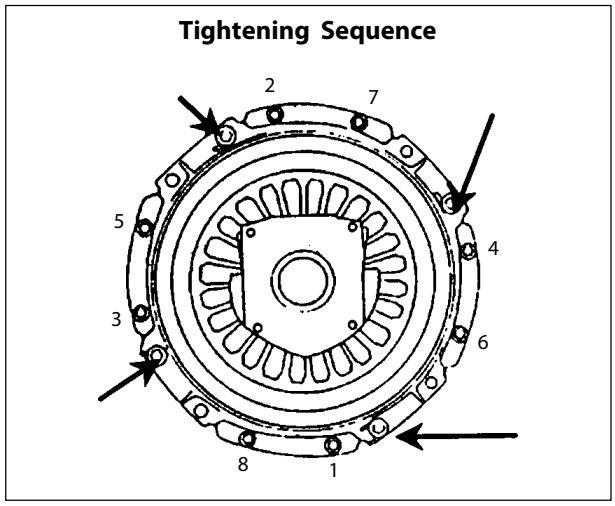



Fig.8

| Clutch Pressure Plate and Cover Assembly to Flywheel Mounting Screw Torque | | | | |
|---|---|---|---|---|
| **Clutch Size** | **F/W Type** | **Capscrews (Min. Grade 5)** | | |
| | | **Size** | **Quantity** | **Instal. Torque lbs.-ft. (Kgm)** |
| 14″ | Flat | 3/8″-16x1.25″ | 8 | 25-35 (3.5-4.8) |
| Clutch Release bearing locknut ring torque, for all clutch sizes 30-35 lbs.-ft. (3.5-4 Kgm) | | | | |

Fig.9

24. As the clutch attaching screws are tightened, the four shipping clips should become loose and my fall out (Fig.10). Be sure all four shipping clips are removed and that none of them drops inside the clutch. These clips should be saved for possible reuse during future clutch removal operations.
25. Remove the clutch alignment tool.

**⚠ CAUTION**

**Do not apply any type of lubricant to the bushing in the bore of the release bearing. The bushings are impregnated with graphite for lubrication. Grease or oil will only collect dust and dirt forming a sticky paste that can result in clutch**

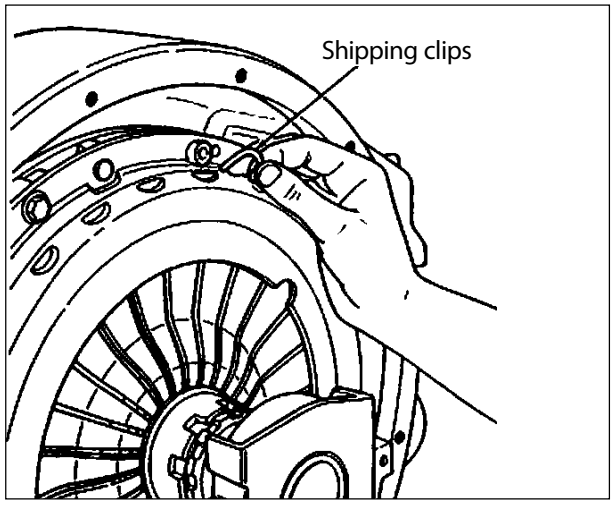



Fig.10

# 12. TRANSMISSION INSTALLATION

**drag.**

1. Lubricate the clutch housing cross shaft busing. Confirm that the grease fittings accept grease and are positioned so they may be easily greased at regular maintenance intervals. Lubricate the clutch release bearing housing and place a small amount of grease on the release bearing yoke contact pads. See Section 5, Lubrication and Maintenance in this manual.

2. If a clutch brake is used, install it on the transmission input shaft. Slide the clutch brake back into a position which will allow the release yoke contact fingers to be rotated up as high as possible (Fig.11). This will allow the yoke tips to pass over the top of the release bearing during transmission insertion. If a clutch brake is not used, simply rotate the release yoke contact tips as high possible.

3. Move the tansmission, properly oriented, to a point close behind the clutch and flywheel. Be sure the release yoke tips are fully raised up and the clutch housing inspection cover is removed.

**⚠ CAUTIONS**

**Never let the weight of the transmission hang on the input shaft and clutch during transmission installation. The clutch disc and input shaft can be damaged if this occurs**.

4. Adjust the transmission position so that the input shaft can just enter the rear end of the clutch release bearing. Adjust the transmission support so the transmission is as close as possible to perfect alignment with the engine crankshaft centerline (Fig. 12)

5. Move the transmission forward to insert the input shaft into the clutch disc spline. Be sure the clutch release yoke tips pass over the top of the clutch release bearing as the transmission is moved toward the engine. Continually readjust the transmission orientation as necessary to maintain alignment with the engine. Do not force the transmission forward. Any blockage or restriction must be located and corrected.

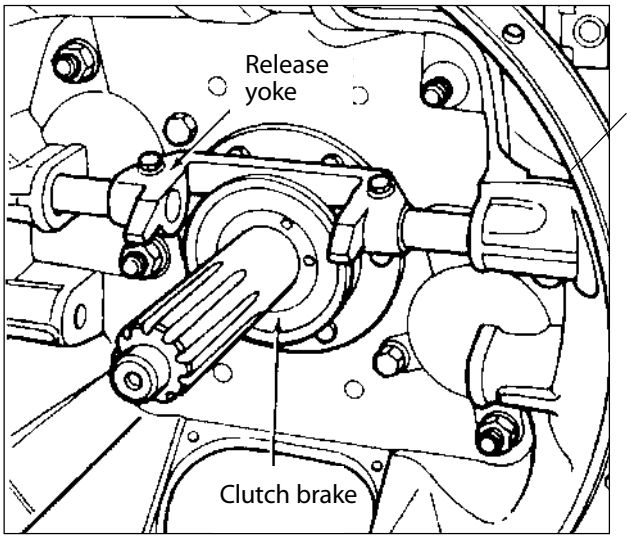
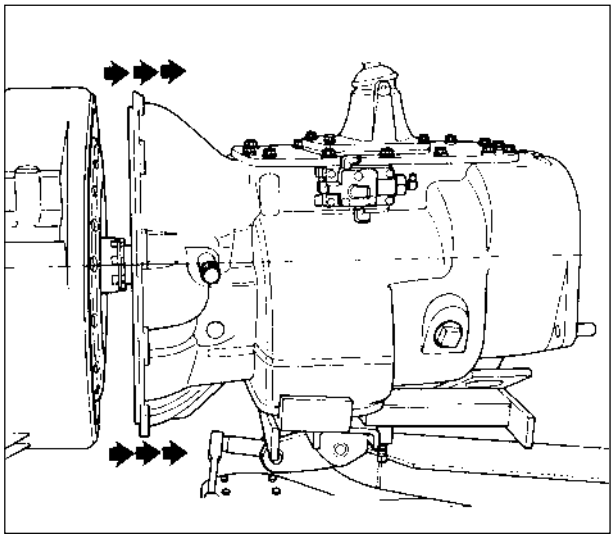


Fig.11


Fig.12

# TRANSMISSION INSTALLATION

6. Place the transmission in direct drive or over drive. Rotate the transmission output shaft as necessary to correctly align the clutch disc spline with the transmission input shaft spline during insertion.

7. Rotate the clutch release yoke tips down into the normal position as soon as they are in front of the clutch release bearing. If the release yoke tips are not rotated down to the normal working position, the release yoke bar can block full insertion of the transmission.

8. Push the transmission fully forward until the clutch housing bore. Install the transmission attaching capscrews and tighten according to the vehicle manufacturer's specifications.

**⚠ CAUTION**

Never use the transmission capscrews to pull the transmission into position. If the transmission does not completely and easily move into position, remove transmission and correct source of binding.

9. Reinstall transmission rear mounting support if applicable.

10. Remove the transmission jack or lifting device from the transmission.

11. Connect the air lines and electrical connectors to the transmission.

12. Connect the shifting assembly to the transmission.

13. Adjust clutch release bearing travel gap. See Section 11 of this manual for new clutch initial adjustment procedure.

14. Connect the clutch external linkage. Make sure all clutch pedal return springs are properly installed. Adjust the linkage for proper free play if necessary. See Section 11 of this manual for clutch release linkage adjustment procedure.

15. If a hydraulic release system is used for the clutch, reconnect slave cylinder and pushrod. Refer to specific vehicle service manual for installation procedure.

16. Lubricate the clutch release system. See Section 5 of this manual for lubrication points and recommendations. Reinstall the clutch housing hand hole access cover plate.

**NOTE** : If vehicle operation in unusually dusty condition in anticipated, The release bearing housing should be completely filled with grease on a new clutch to help keep dust from entering and contamination the bearing. Also, all clutch housing dust entry points should be blocked off. In extreme cases, a regulated compressed air line can be introduced at the top of the clutch housing to keep dust from entering.

17. Connect the driveshaft to the output yoke on the transmission. Ensure the alignment marks ( made when driveshaft was removed) on the output yoke and driveshaft are aligned.

18. Road test the vehicle and check for proper operation.

# TRANSMISSION INSTALLATION

**Clutch housing of G 600 gear box (Fig 13).**

In the G600 gearbox assembly clutch housing is a part of gearbox and the gear box assembly together with clutch housing is mounted on the engine fly wheel housing.
Figure shows the clutch housing with the yoke rotated to just before being mounted on engine

**Caution :**

1 **Please ensure that while mounting gear box on the clutch housing in G50 or mounting Clutch housing with gearbox on engine fly wheel housing on G 600 that the transmission shaft is inserted without any side loads on clutch release bearing.**

2 **Please refer WM of Gearbox for Installation and removal of GB from vehicle. (i.e from clutch)**

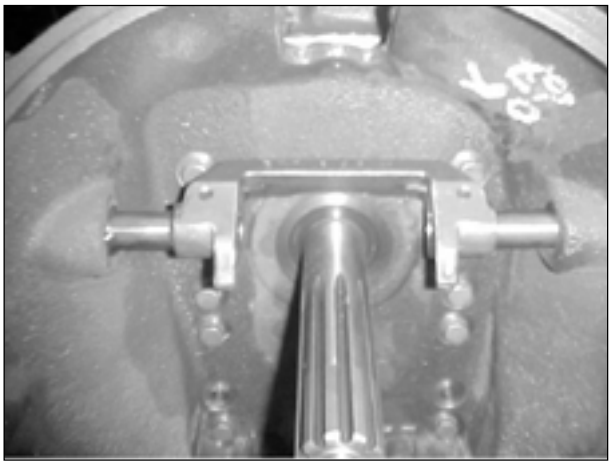


Fig.13

# 13. SERVICEABILITY

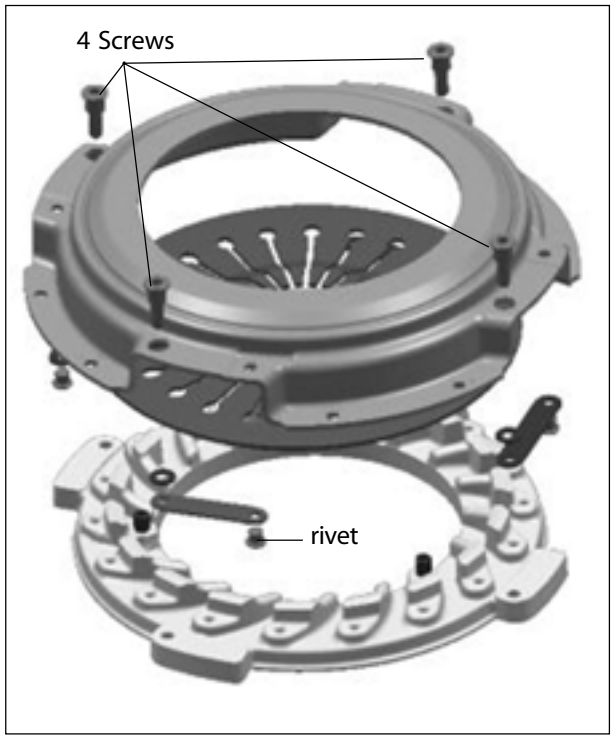
**Service Kits**

- Cover assembly - all parts except cover are available as spares
- Disc assembly - friction pads & pad rivet will be available as spares

**Servicing - Cover Assembly**

**Dis-Assembly**

- Remove release bearing by unthreading the sleeve from coupler
- Put the cover assembly on the table as the end pressure plate facing downword coupler.
- Mount the lever with 2 bolts on the dummy flywheel as it can't rotate while unscrewing allen key screws.
- Now remove the 4 allen screws connecting pressure plate with sheet metal cover
- For bolted type loosen the 4 rivets to remove the drive strap.



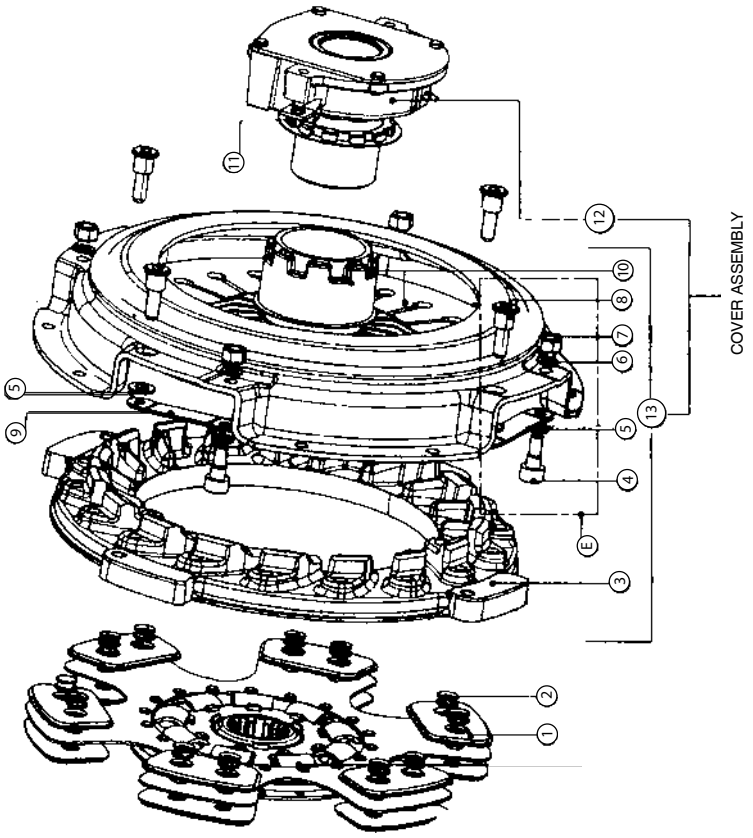

**Re-Assembly**

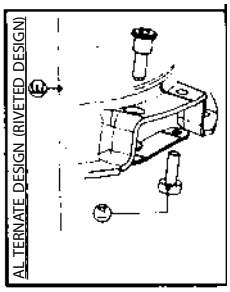
- Attach the (3x3) drive strap to the cover using cover rivets. "Note : maintain alignment of the straps to facilitate assembly of pressure plate at the next stage. Remove release bearing by unthreading the sleeve from coupler
- Put the cover subassembly over the pressure plate with diaphragm, using the drive strap fixing screws, fix cover subassembly to pressure plate. "Note : do not tighten fully the drive strap fixing screws
- Put the cover sub assembly & clutch plate on to a dummy flywheel and fix it using the cover flywheel mounting bolts
- Now tighten fully the drive strap fixing screws
- Before removing the cover assembly from the dummy flywheel, put the shipping clips
- Check for the shape and condition of the drive strap as illustrated in the cover assembly inspection method

# SERVICEABILITY

**Service - Kit part Details**

| Kit No. | DESCRIPTION | Qty. | TELCO PT.NO. |
|---|---|---|---|
| 13 | COVER SUB ASSY. | (1) | 275425400125 |
| 10 | DIAPHRAGM SUB ASSY. | (1) | 275425408706 |
| 12 | RELEASE BEARING ASSY. - 1.75" | (1) | 275425600102 |
| | RELEASE BEARING ASSY. - 1.5" | (1) | 275425600103 |
| | PRESSURE PLATE (WITH ROLL PIN) | (1) | 275425400126 |
| 3 | WEAR PAD | (2) | 257425606701 |
| | DISC PAD KIT : (Cons. of....) | | 275425206303 |
| 1 | DISC PAD | (12) | |
| 2 | PAD RIVET | (12) | |
| | DRIVE STRAP KIT : (Cons. of.....) (BOLTED DESIGN) | | 275225400112 |
| 4 | BOLT M10X1.25 | (4) | |
| 5 | WASHER -M10 | (8) | |
| 6 | SPRING WASHER -M10 | (4) | |
| 7 | NUT - M10X1.25 | (4) | |
| 8 | SHOULDER BOLT - M10X1.25 | (4) | |
| 9 | DRIVE STRAP | (12) | |
| | DRIVE STRAP KIT : ( Cons. of..) (RIVETED DESIGN) | | 275225400113 |
| 14 | RIVET | (4) | |
| 5 | WASHER -M10 | (4) | |
| 8 | SHOULDER BOLT - M10X1.25 | (4) | |
| 9 | DRIVE STRAP | (12) | |



# 14. DO'S AND DONT'S

**Do's**

1. Gently engage the clutch while the engine is at idle and start increasing the throttle only after the clutch is fully engaged
2. Start the truck in a gear low enough to allow a smooth and quick clutch engagement
3. Minimise clutch engagement slip time to avoid excessive generation of heat
4. Use the clutch when performing normal upshifts and down shifts"
5. Make every effort to match the engine speed to the transmission input shaft speed during upshifts and downshifts to avoid drivetrain shock loads
6. Every time new clutch is installed, properly "bed in" the new clutch plate pads

**Don'ts**

1. Start the truck with high engine rpm and long clutch slip times or the clutch will overheat
2. Start the truck with very short (abrupt) clutch slip times that shock the drive line
3. Upshift or downshift before reaching the correct engine rpm because this will shock load the drive line
4. Rest your foot on the clutch pedal. This will start to disengage the clutch and could cause slippage

5 Coast down hill with the clutch disengaged and the transmission in gear. Safe vehicle control will be lost and maximum clutch disc rpm operating limits could be exceeded

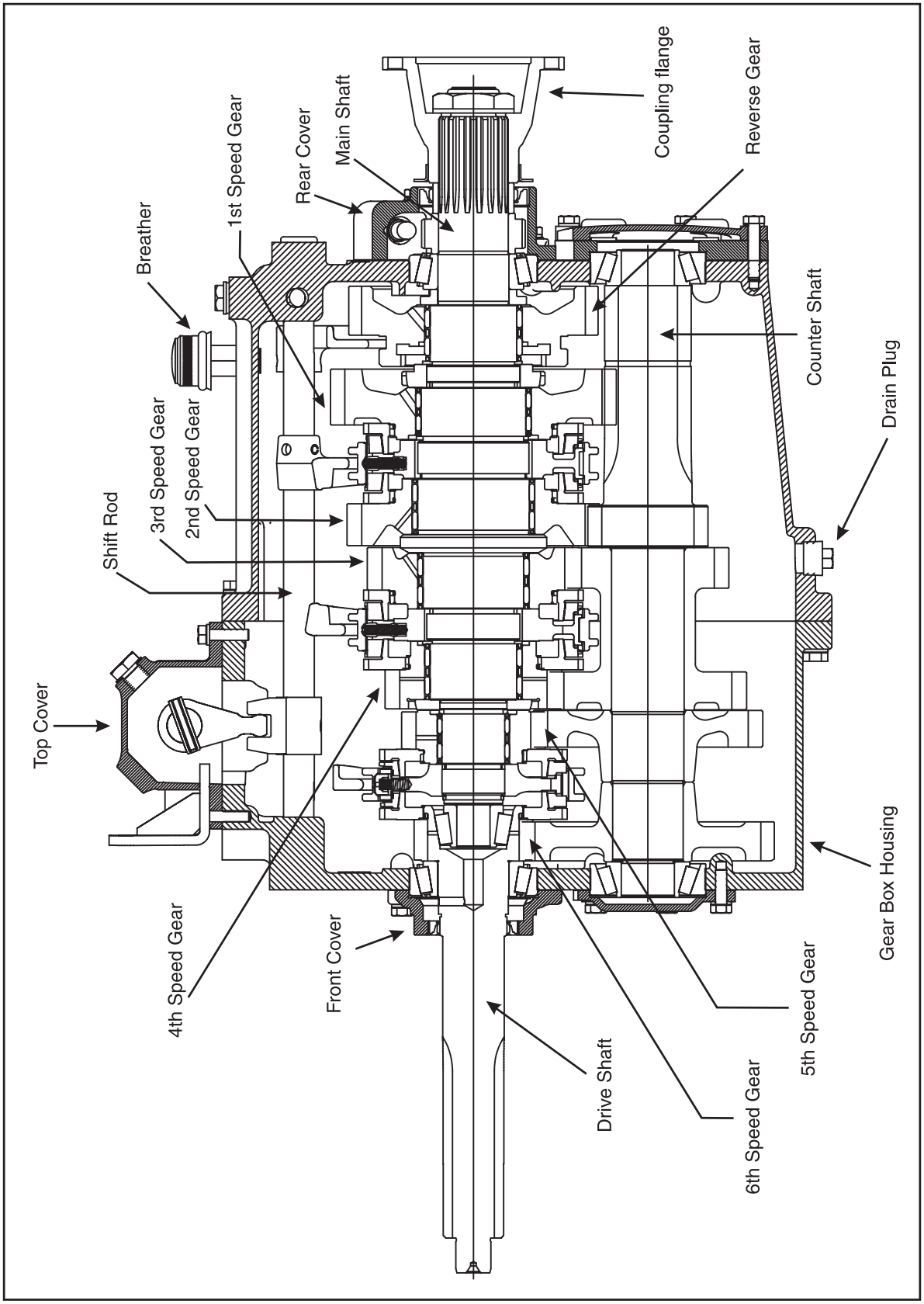
6. Slip the clutch to hold the truck in place on a hill. This will quickly overheat the clutch

# Transmission 26

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## SECTIONAL VIEW OF GEARBOX G600



## TECHNICAL SPECIFICATION

**MODEL** TATA G600 with PTO Provision

**GEAR RATIOS** Six forward and one reverse

| Gear Pair | | Ratios |
|---|---|---|
| 1st | - | 6.58 |
| 2nd | - | 3.79 |
| 3rd | - | 2.29 |
| 4th | - | 1.49 |
| 5th | - | 1.00 |
| Over Drive | - | 0.77 |
| Rev | - | 5.66 |

**TIGHTENING TORQUES IN mkg.**

| | |
|---|---|
| Main Shaft Coupling Flange Nut (M32 Threads) | 36-40 |
| Coupling Flange / Propeller Shaft Nuts / Bolts | 7 |
| Centre Bearing Bracket mounting Bolts | 5 |
| Gear Shift Lever Bracket mounting bolts | 3 |
| Turning Tube / Connecting Flange mounting nuts / Bolts | 3 |
| Housing Interface Bolts | 6 |
| Top Cover bolts/screws | 2.5 |
| Front Cover bolts/screws | 2.5 |
| Rear cover bolts/screws | 2.5 |
| Rear cover lower (inner) bolts/screws | 6 |
| Reverse Idler Cover bolts/screws | 1.5 |
| Filler plug | 1.5 |
| Drain plug | 6 |

**NOTE :** When choosing torque wrench, remember that it should not be subjected to torque exceeding three-fourth of its capacity. Before tightening, clean the threads and apply a little oil.

**LUBRICATION AND MAINTENANCE :**

| | | |
|---|---|---|
| Oil Specification | : | Use multigrade oil conforming to SAE 80W90 grade 7% Anglomol-6097 by weight and API GL4 specifications. |
| Recommended Oil Brands | : | 1] Castrol - Castrol Hypoy LL 80W90<br>2] BPC - Telco Spirol S 80W90 |
| Oil Filling Capacity (W/O PTO) | : | 7.5 Litres |
| Oil Filling Capacity (With PTO) | : | 8.5 Litres |
| Maintenance | : | Change the multigrade oil first at 3,000 km, then at 36,000 km and thereafter at every 36,000km. |

**NOTE :** The recommended oil brand is mentioned on a label pasted on the gearbox housing near the filler plug.

## SPECIAL TOOLS



1. 2751 5890 26 21
   Drift for installation of oil seal of front cover.



2. 2751 5890 26 22
   Drift for installation of Taper roller bearing of drive shaft ( Inner race ).



3. 2751 5890 26 23
   Puller reverse idler shaft.



4. 2751 5890 26 25
   Puller Taper roller bearing Drive shaft.



5. 2751 5890 26 26
   Drift for outer race of taper roller bearing of drive and main shaft.



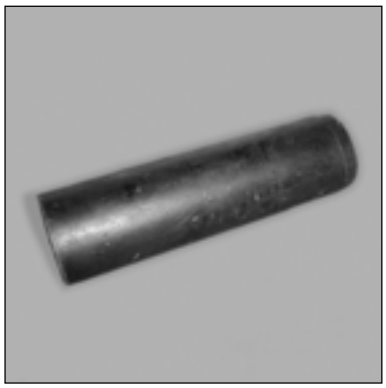
6. 2751 5890 26 27
   Drift for outer race of Taper roller bearing Counter shaft.



7. 2751 5890 26 28
   Puller pilot Taper roller bearing main shaft.



8. 2751 5890 26 29
   Mandrel for clutch disc alignment - 1.7"



9. 2640 5890 3512
   Drift installation of Taper roller bearing of main shaft (Inner race)

## SPECIAL TOOLS



10. 2751 5890 26 31
Spacer pilot Taper roller bearing main shaft.



11. 312 589 25 33
Puller - Taper roller bearing main shaft with spacer.



12. 312 589 12 39
Drift for oil seal.



13. 2576 5890 3522
Puller for coupling flange.



14. 2640 5890 35 11
Handle to be used with Drift
2751 5890 26 21,
2751 5890 26 26,
2751 5890 26 27,
2654 5890 3507.



15. 2576 5890 02 19
Trolley for aggregate handling.



16. 2576 5890 35 09
Holder for coupling flange.



17. 2505 5890 31 01
Puller for inner race of counter shaft bearing.



18. 2641 5890 26 01
Drift for installing Needle roller bearing in top cover.

## GEAR SHIFTING MECHANISM

G600 6 Speed gearbox is fitted with full remote gear shifting arrangement. Gear shift lever projects up through engine hood in a very convenient position close to driver's seat. Gear shifting block is fastened on the engine cylinder head.

The selection and shifting motions of gear shift lever is transmitted through Turning tube, Link rod and Shifting lever to the Selector & Shifter shaft in Top cover. One of the ends of Link rod acts as pivot for the Link rod and it swings in the area around the other end. Selection motion of the gear shift lever causes Selector shifter shaft to move in and out of the top cover. Shifting motion of gear shift lever causes selector shifter shaft to rotate.

There are four shifter shafts for shifting to Reverse, $1^{st}/2^{nd}$, $3^{rd}/4^{th}$ & $5^{th}/6^{th}$ gears. Respective Shifter forks & shifter dogs are fixed on to the Shifter shafts by means of Spiral pins.

Interlocking is accomplished by means of balls and interlock pins. Two interlock pins are used; one each in $1^{st}/2^{nd}$ & $3^{rd}/4^{th}$ shifter shafts. A total of three interlock balls are used. One ball each is placed in the recess in housing between Reverse & $1^{st}/2^{nd}$ shifter shafts, $1^{st}/2^{nd}$ & $3^{rd}/4^{th}$ shifter shafts, and $3^{rd}/4^{th}$ & $5^{th}/6^{th}$ shifter shafts.

All the shifter shafts are held in position by means of spring loaded detents. A total of four detent assemblies are used.

When the gear shift lever is moved for shifting, the rotary motion of the selector & shifter shaft causes the shifter finger also to rotate. The rotary motion of shifter finger is further translated to sliding movement of the shifter dog. As both shifter dog & shifter fork are fixed on shifter shaft, the shifter fork also slides along with the shaft leading to engagement of shifter sleeve with the synchro ring and completes the shifting.

### SYNCHRONISER

The use of synchronising device as a speed equaliser will enable the driver to carry out quick, safe and noiseless gear changes without double declutching during up shifting and also without actuating the accelerator pedal during down shifting, even on downhill gradients and in difficult situations.

The easier gear changes obtained with a synchroniser will reduce the driver fatigue and also improve his/her driving tactics, which is of great advantage in heavy traffic. The function of synchroniser is based on the principle, that a satisfactory gear change can only be achieved after the parts to be coupled have obtained equal rotational speed. During each gear change, engagement of the sleeve with the teeth on the synchro ring must be delayed until the difference in speeds is eliminated.

The synchroniser is designed so that the synchronising cone, when pressed against one externally toothed synchronising ring, executes a rotary motion, which is limited by stops on the synchroniser ring. Due to this movement, the chamfered tooth flanks of the synchroniser ring will be pressed against chamfered teeth of the shifter sleeve and prevent any further movement of the shifter sleeve. Only after the conical friction surfaces have caused the parts to be coupled to run at equal speeds with the persistent pressure on the shifter sleeve affects the return of the synchroniser cone to its original position. The locking effect is released and the shifter sleeve can be pushed into the teeth on the synchroniser ring.

# REMOVAL OF GEARBOX AND SHIFTER LINKAGE FROM VEHICLE

## SPECIAL TOOLS

| | |
|---|---|
| Trolley, for aggregate handling<br>Adopter trolley for gearbox | 2576 5890 02 19 |

1. Remove the gearbox drain plug and drain the lubricating oil. Clean and refit drain plug.
2. Unscrew propeller shaft from gearbox coupling flange fastening screws.
3. Unlock and unscrew castle nuts and remove centre bearing bracket from cross member.
4. Lower propeller shaft with centre bearing assembly and rest it on ground.
5. Disconnect Speedo cable from gearbox (Fig. 2).
6. Disconnect link rod ball joint from link rod mounting bracket on gear box assembly and turning tube ball joint mounting from shift lever (Fig. 1).
7. Mount adopter trolley on aggregate handling trolley 2576 5890 02 19.
8. Support gearbox on adopter trolley. Unscrew clutch housing mounting screws.
9. Disconnect gearbox along with clutch housing from flywheel housing and lower it down with the trolley.

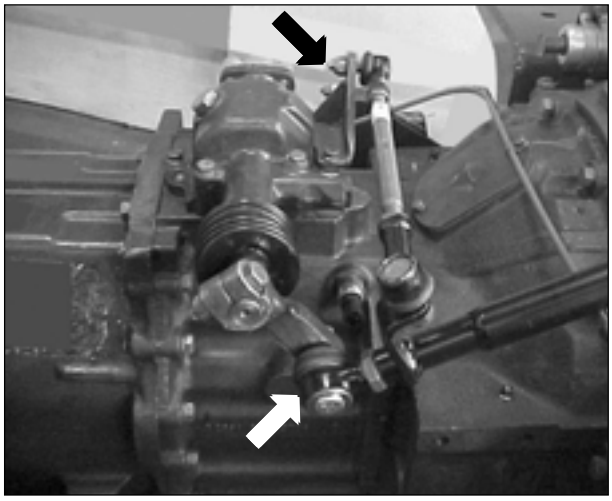


Fig. 1

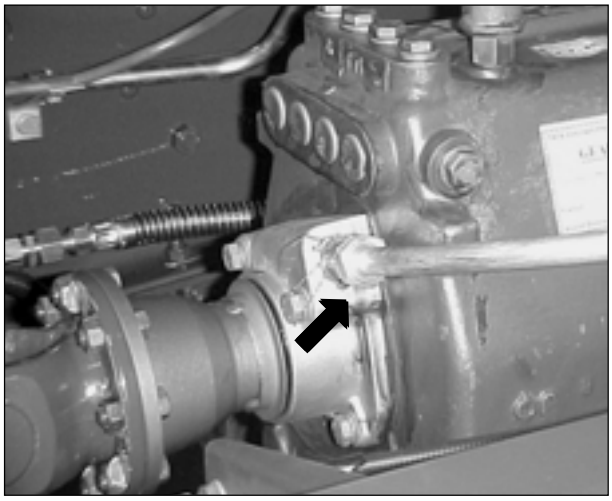


Fig. 2

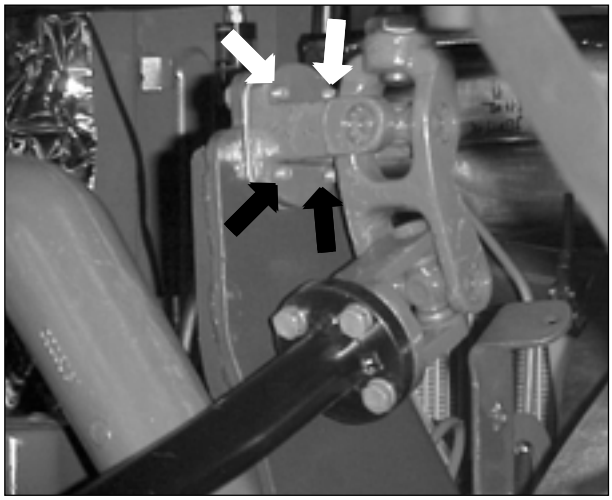


Fig. 3

10. Unscrew 4 Nos mounting screws of gear shift lever universal joint from bracket mounted on cylinder head and remove the shifter linkage assembly (Fig. 3).

## DISASSEMBLY OF GEARBOX

### SPECIAL TOOLS

| | |
|---|---|
| Work stand for gearbox | 2753 5890 3701 |
| Holder for coupling flange | 2576 5890 35 09 |
| Puller for reverse idler gear shaft | 2751 5890 2623 |

1. Mount the gearbox on work stand 2573 5890 37 01 (Fig. 2).
2. Unscrew the mounting bolts of top cover along with the link rod mounting bracket.
3. Two dowel pins locate the top cover on front half housing. Tap gently on the cover and remove the entire top cover assembly.
4. Remove the reverse indicator switch.
5. Remove the breather along with adaptor.
6. Remove all the detent assemblies (i.e. sealing plugs, springs, detent bodies) (Fig. 3).
7. Knock out the spiral pin of reverse gear shifter fork by using a suitable pin and hammer. This can be accessed from the breather mounting hole on top of the rear half housing (Fig. 4).

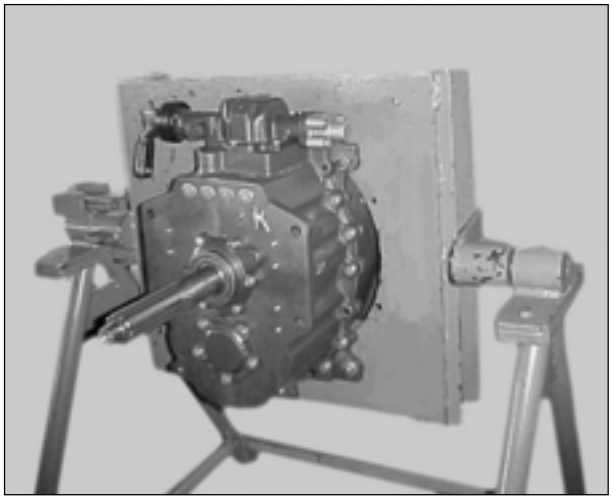


Fig. 2

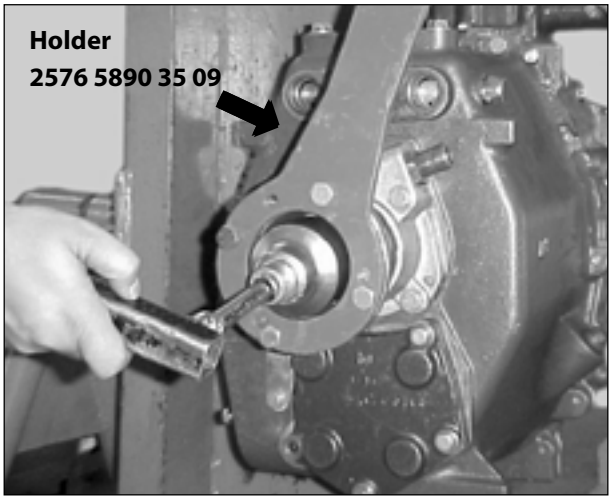



Fig. 1

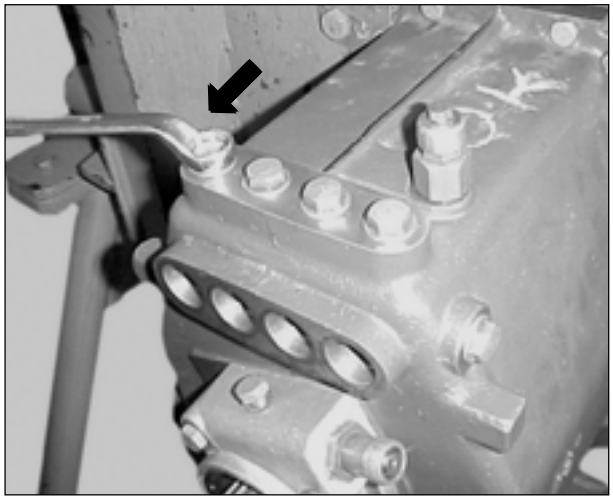


Fig. 3

## DISASSEMBLY OF GEARBOX

8. Lock the mainshaft by engaging into any gear.
9. Unstake coupling flange lock nut from the groove in the main shaft and remove it.
10. Pull out the coupling flange from the main shaft.

**Note :**

*Gearbox coupling flange nut can also be removed from the mainshaft using holder **2576 5890 35 09**, for locking against the rotation. This method will be useful for extraction of the coupling flange nut without removing the top cover when the gearbox is on the* **vehicle.** (Fig. 1)

11. Shift gears to neutral position.
12. Take out the speedo gear.
13. Remove the outer rear covers (lower) on the counter shaft.
14. Remove the reverse idler cover by unscrewing all the fasteners.
15. Remove reverse idler shaft locking plate (Fig. 5).
16. Unscrew the two housing joint bolts which are screwed on to the front half from the rear side close to the top cover mounting area.
17. Turn the gearbox with drive shaft end upwards on the stand.

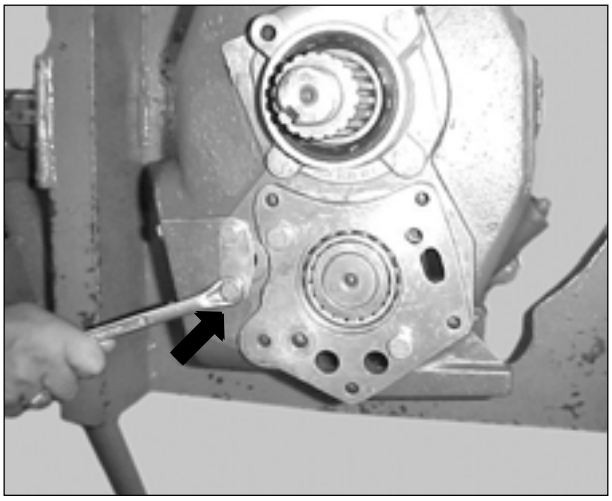


Fig. 5

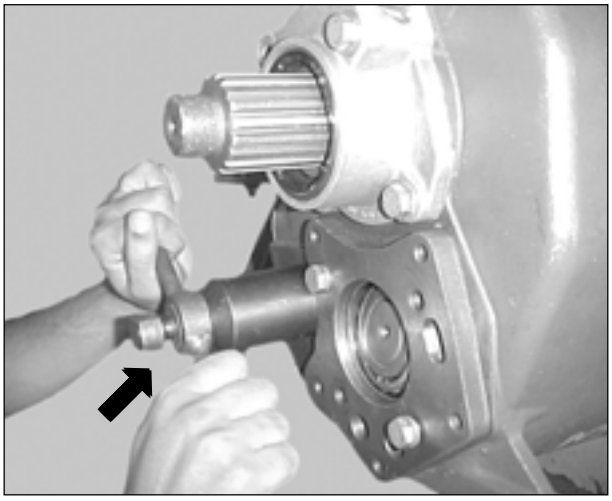


Fig. 6

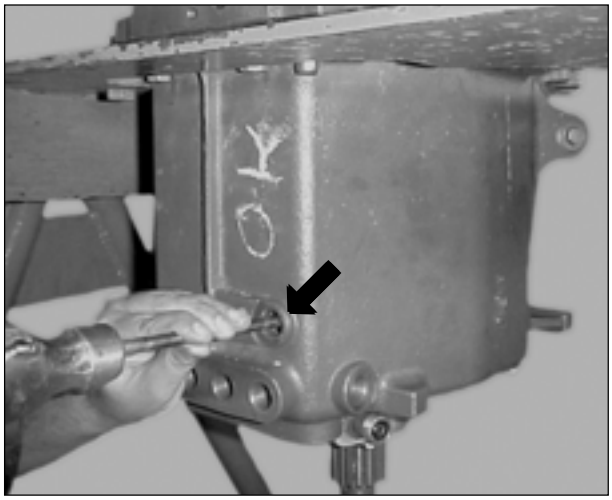
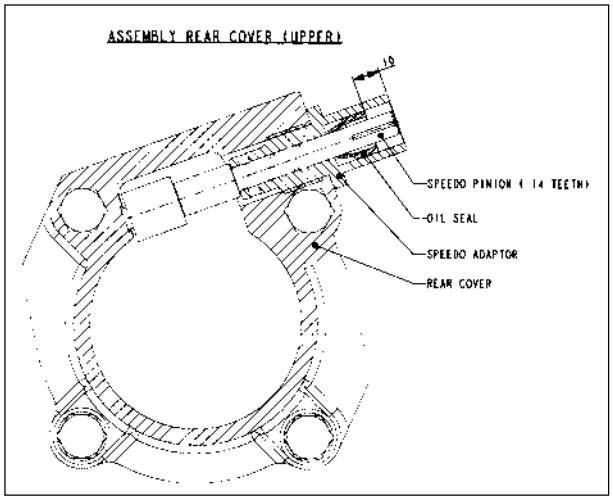


Fig. 4



## DISASSEMBLY OF GEARBOX

18. Unscrew fasteners of both the front covers from housing front half.
19. Remove covers and pick out adjusting shims. Care to be taken while removing front cover upper along with the oil seal.
20. Unscrew all the housing joint bolts.
21. Gently tap on the front half housing to remove it.
22. Knock out the reverse idler shaft by using a long rod and hammer. Pick the reverse idler gear along with spacer, thrust washer & roller cages. (Fig. 7)

**Note :**

Reverse idler shaft can also be removed by using puller 2751 5890 26 23 while the gearbox is in horizontal position on the stand. This method is to be used when only the reverse idler gear and shaft needs to be removed for inspection or for replacement (Fig. 6).

23. Carefully lift the entire counter shaft assembly and remove from the housing.
24. Remove the drive shaft assembly and pick the synchronising cone.
25. Gently pull out the reverse gear shifter shaft along with the dog.
26. Knock out the spiral pin of $3^{rd}/4^{th}$ shifter fork. Place a wooden block between the shaft and gears to avoid deformation of shaft (Fig. 8).
27. Pull the $3^{rd}/4^{th}$ shifter shaft along with the dog (Fig. 9).
28. Pick the interlock pins and balls using a pin.
29. Lift out the main shaft assembly by using tackle. Remove the tackle from the main shaft assembly.

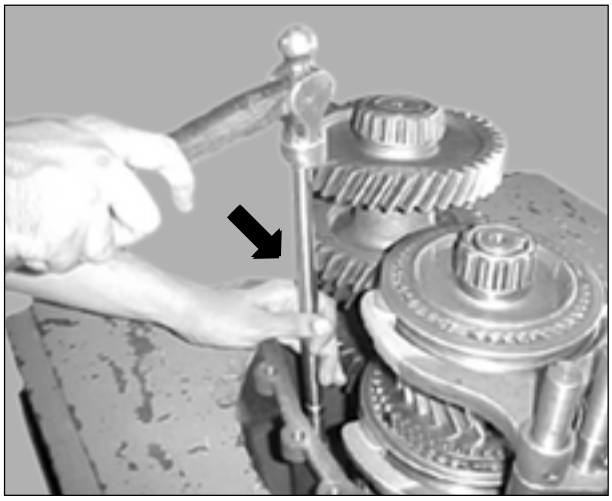


Fig. 7

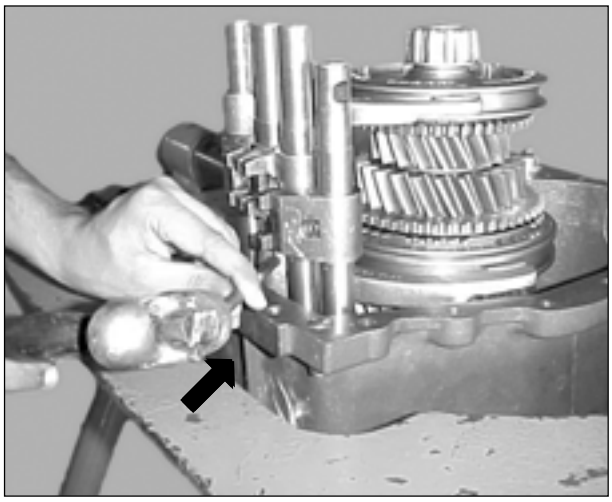


Fig. 8

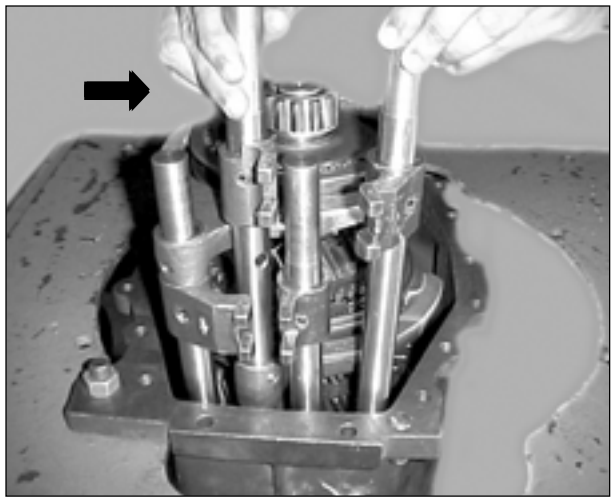
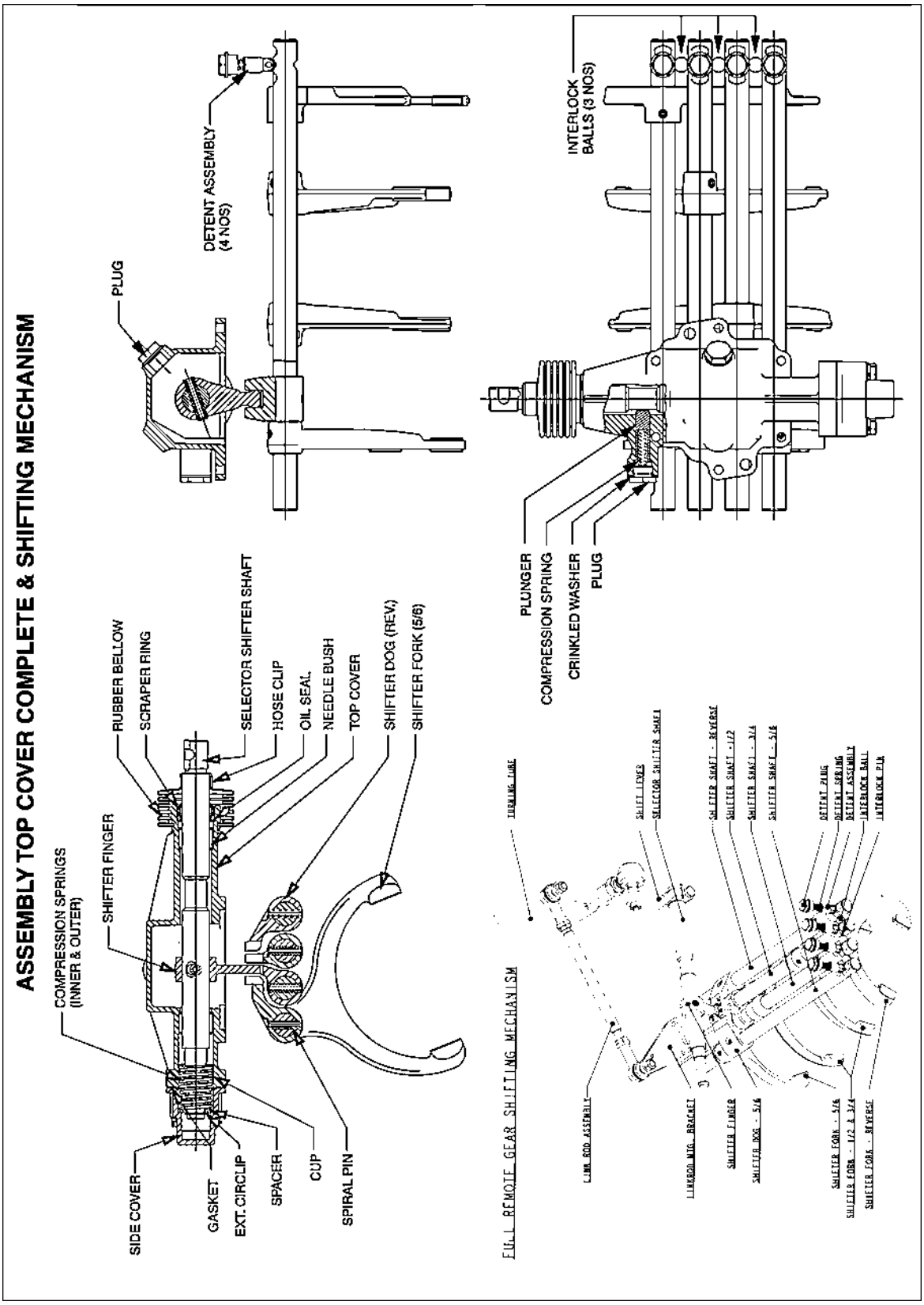


Fig. 9


ASSEMBLY TOP COVER COMPLETE & SHIFTING MECHANISM
COMPRESSION SPRINGS (INNER & OUTER)
SHIFTER FINGER
RUBBER BELLOW
SCRAPER RING
SELECTOR SHIFTER SHAFT
HOSE CLIP
OIL SEAL
NEEDLE BUSH
TOP COVER
SHIFTER DOG (REV.)
SHIFTER FORK (5/6)
SIDE COVER
GASKET
EXT. CIRCLIP
SPACER
CUP
SPIRAL PIN
PLUG
DETENT ASSEMBLY (4 NOS)
INTERLOCK BALLS (3 NOS)
PLUNGER
COMPRESSION SPRING
CRINKLED WASHER
PLUG
FULL REMOTE GEAR SHIFTING MECHANISM

## DISASSEMBLY, INSPECTION AND ASSEMBLY OF DRIVE SHAFT

| SPECIAL TOOLS | |
|---|---|
| Drift for installing taper roller bearing | 2751 5890 26 22 |
| Puller for taper roller bearing removal | 2751 5890 26 25 |

**DISASSEMBLY :**

1. Place the drive shaft assembly on a plain horizontal table.
2. Extract the taper roller bearing using suitable puller 2751 5890 26 25 (Fig. 1).

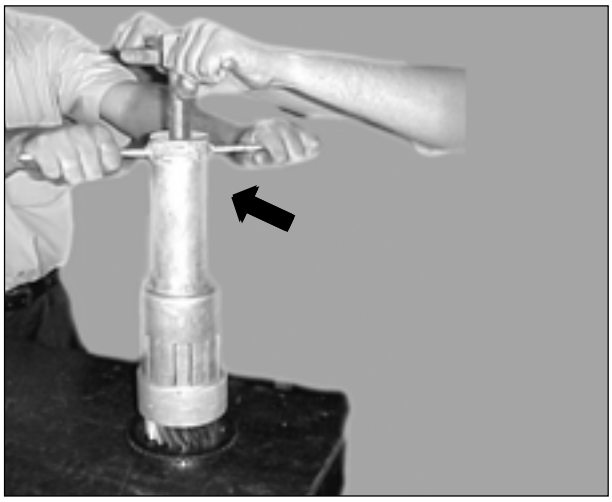


Fig. 1

**INSPECTION :**

1. Drive shaft teeth for pitting, scoring, over heating marks.
2. Bearing seat for rotation marks.
3. Oil seal seat for lip contact and surface finish.
4. Spline end for damages.
5. Pilot bearing mating inner conical surface for any damage / rotation marks.
6. Synchro ring dog teeth for burrs, wear etc.
7. Bearing for scoring, pitting.

**ASSEMBLY :**

1. Place the drive shaft assembly on a plain horizontal table.
2. Press the taper roller bearing using drift and 2751 5890 26 22 (Fig. 2).

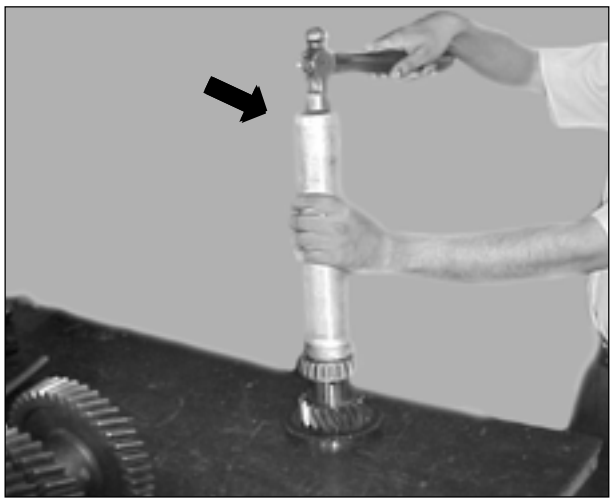


Fig. 2

## DISASSEMBLY OF MAINSHAFT

### SPECIAL TOOLS

| | |
|---|---|
| Puller<br>Puller for pilot taper roller bearing removal from main shaft | 2751 5890 26 28 / 26 31 |
| Puller for taper roller bearing on main shaft with spacer | 312 589 25 33 |

1. Rest the main shaft assembly at output end in coupling flange.
2. Dismantle the pocket bearing inner race by using pilot TRB puller 2751 5890 26 28 &

   MS Spacer 2751 5890 26 31 (Fig. 1).
3. Remove the 5th/6th engaging gear circlip by using a circlip plier (Fig. 2).
4. Remove the 5th/6th engaging gear assembly by holding the shifter sleeve and retention pins together. Pick carriers, retention pins and compression springs.
5. Remove 5th gear assembly along with needle cage. Pick the corresponding synchro cone and put an identification tag.
6. Remove the circlip holding the spacer.
7. Pull out the 4th gear assembly along with the spacer by holding the synchro ring using a suitable 2 leg puller. Pick the 4th gear needle cage. Pick 4th gear synchro cone and tag it (Fig. 7).
8. Remove the circlip of 3rd/4th engaging gear.

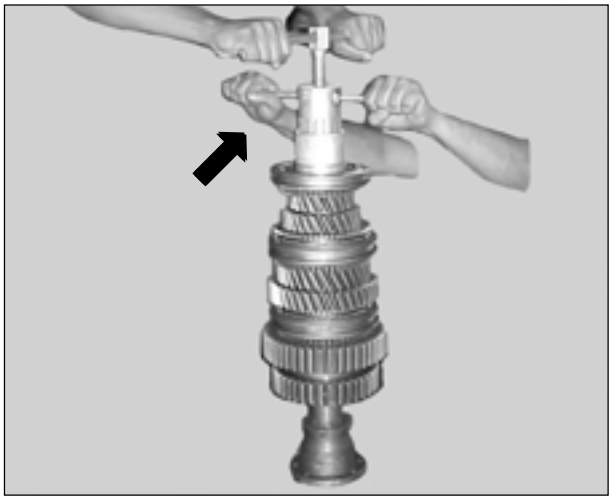


Fig. 1

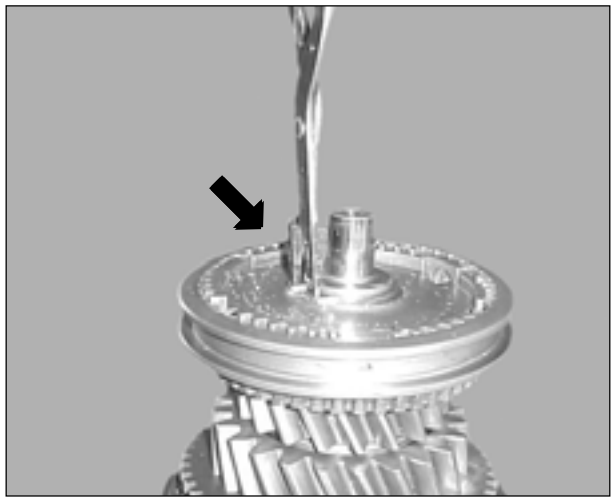


Fig. 2

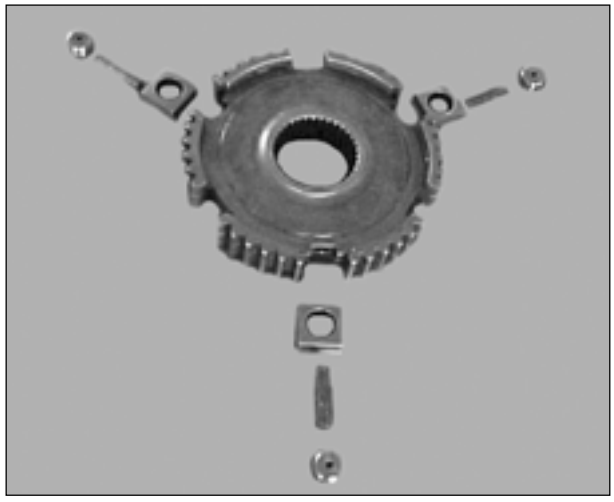


Fig. 3

## DISASSEMBLY OF MAINSHAFT

9. Remove the 3rd/4th engaging gear assembly by holding the shifter sleeve and retention pins together. Pick retention pins and compression springs.
10. Remove 3rd gear assembly along with needle cage. Pick the corresponding synchro cone and put an identification tag.
11. Remove the coupling flange and hold the assembly rear end upwards in a bench vice with soft grips.
12. Pull out the reverse gear, selection spacer and taper roller bearing using a suitable 2 leg puller 312 589 25 33. Pick needle cage of reverse gear and tag it (Fig. 6).
13. Pick taper roller bearing and identify it with a tag.
14. Remove reverse engaging gear after removing the circlip holding it.
15. Remove 1st speed gear assembly along with the needle cage. Identify the cone with a tag.
16. Remove circlip holding the 1st/2nd engaging gear.
17. Remove the 1st/2nd engaging gear assembly by holding the shifter sleeve and retention pins together. Pick retention pins and compression springs.
18. Remove 2nd speed gear assembly along with the needle cage. Identify the cone with a tag.

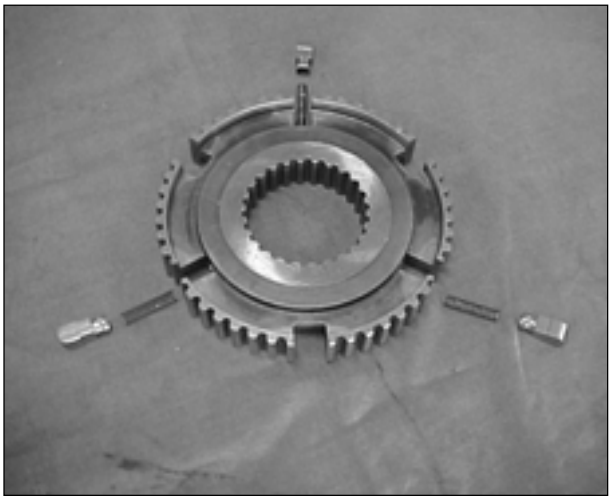


Fig. 5

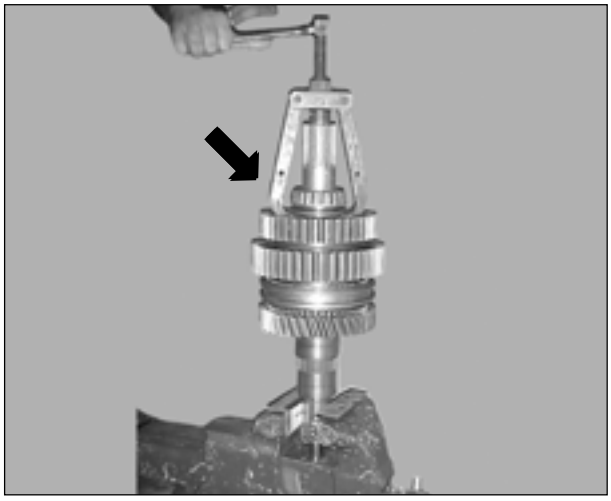


Fig. 6

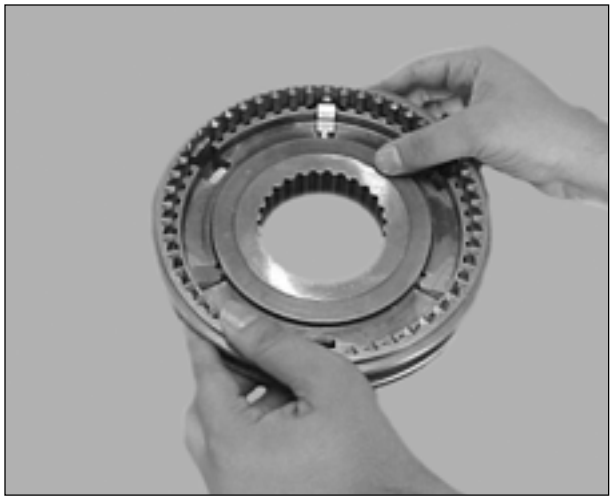


Fig. 4

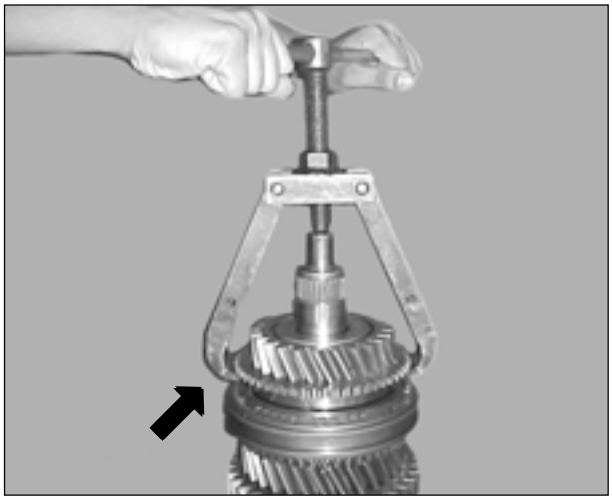


Fig. 7

## DISASSEMBLY, INSPECTION AND ASSEMBLY OF COUNTERSHAFT

| SPECIAL TOOLS | |
|---|---|
| Puller for inner races of taper roller bearings | 2505 5890 31 01 |
| Drift for installing inner races of taper roller bearings | 2751 5890 26 22 |

To disassemble the counter shaft gears requires a 30/50 tonne hydraulic press.

### DISASSEMBLY

1. Extract inner races of both front and rear end bearings using the puller 2505 5890 31 01 Put an identification tag for both so as not to mix them up. Bearings can be reused if found suitable (Fig. 1).
2. Support the counter shaft assembly on press using suitable sheave plates or 'V' plates under the constant mesh gear and press the shaft through the gear.
3. Similarly support the assembly under 5th gear and press the shaft through the gear.
4. Press out the shift version gear in the same manner.
5. Carefully clean any burrs or scores from the shaft using a fine oil stone taking care not to remove more material than required otherwise the interference fit of the new gears on the shaft will be impaired.

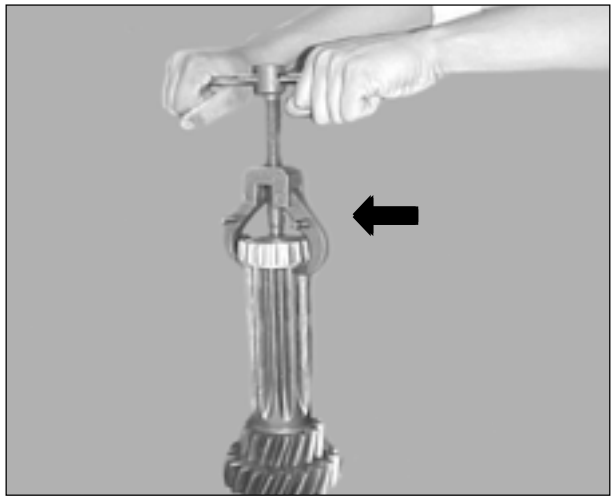


Fig. 1

### INSPECTION

Check the following:

1. Gear teeth for breakage, scoring, pitting marks, cracks etc.
2. Taper roller bearings for scoring, pitting and over heating marks.
3. Bearing seats for scoring, over heating marks etc.

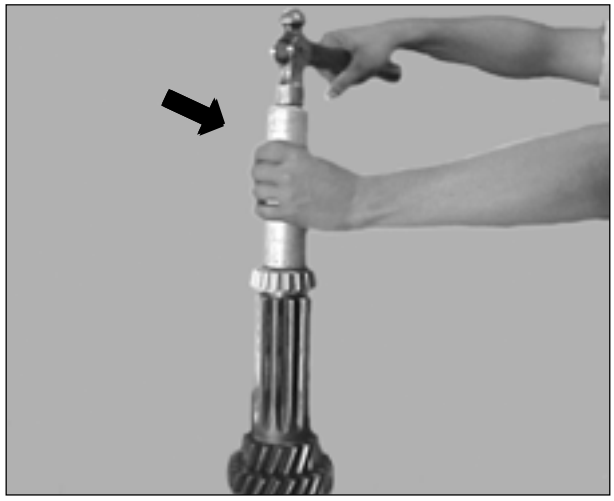
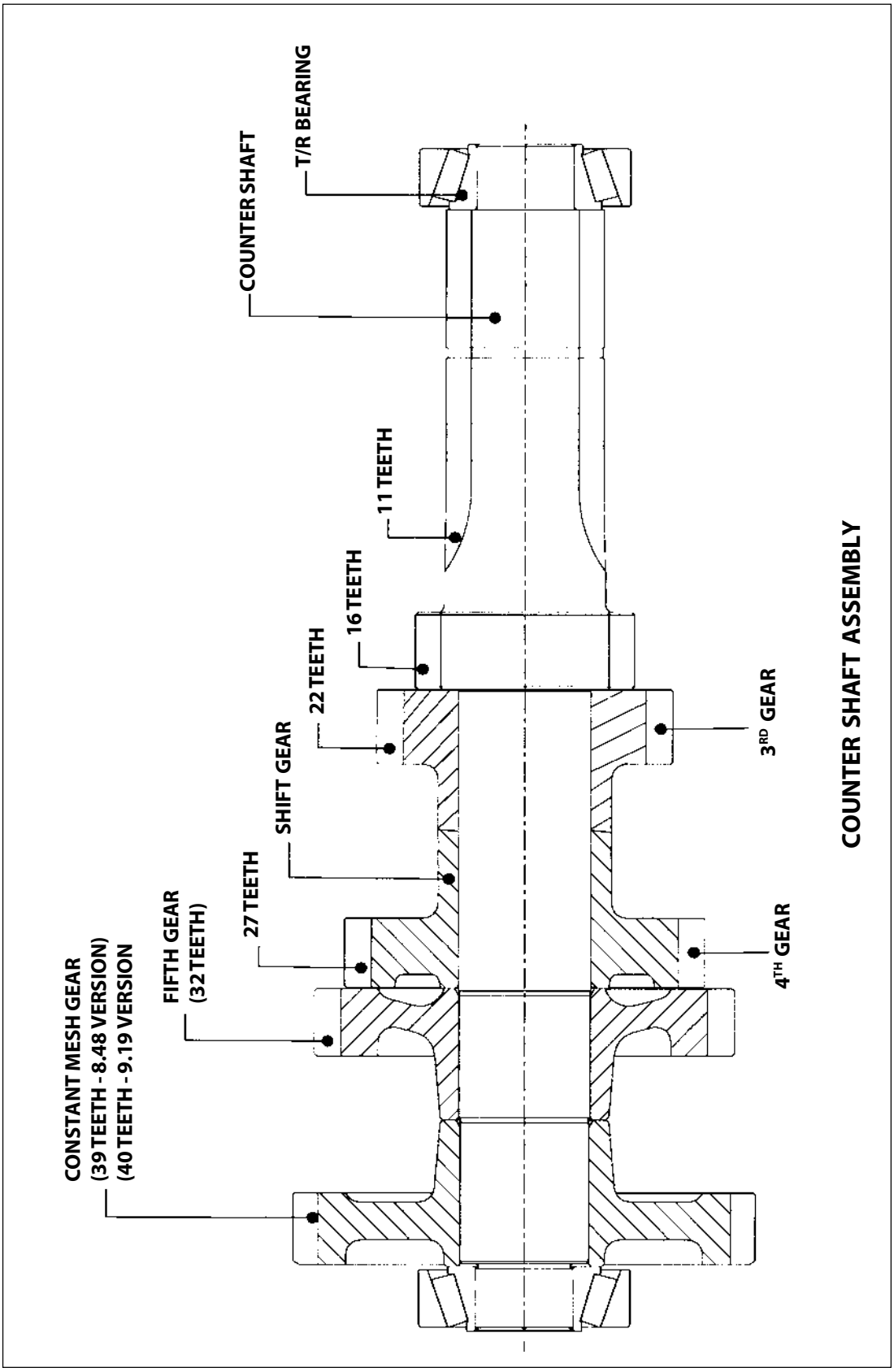


Fig. 2

### ASSEMBLY

1. Heat constant mesh gear, 5th speed gear and shift version gear to 100-125° C in hot oil.
2. Locate and press twin gear, 5th speed gear and constant mesh gear in the order till they rest firmly in position.
3. Install taper roller bearing inner races using drift 2751 5890 26 22 (Fig. 2).


T/R BEARING
COUNTER SHAFT
11 TEETH
16 TEETH
22 TEETH
SHIFT GEAR
3RD GEAR
27 TEETH
FIFTH GEAR
(32 TEETH)
4TH GEAR
CONSTANT MESH GEAR
(39 TEETH - 8.48 VERSION)
(40 TEETH - 9.19 VERSION
COUNTER SHAFT ASSEMBLY

## DISASSEMBLY, INSPECTION AND ASSEMBLY OF REAR COVER

**SPECIAL TOOLS**

| | |
|---|---|
| Drift for installing rear cover oil seal | 312 589 12 39 |

**DISASSEMBLY**

1. Unscrew the adaptor and pick the speedo pinion shaft (Fig. 1).
2. If required remove the speedo oil seal.

**INSPECTION**

Check the following:

1. Speedo pinion for scoring, burrs etc.
2. Shaft end for bend, twist or any other damages.
3. Main shaft oil seal for uneven/excessive wear, lip cracks etc.
4. Speedo oil seal for uneven/excessive wear, lip cracks etc.

Replace the damaged components.

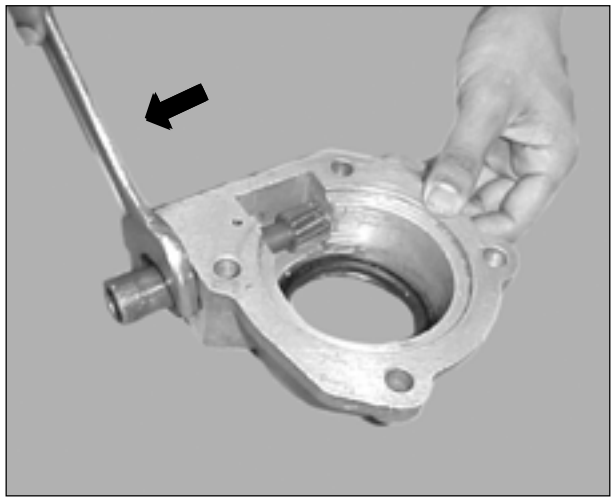


Fig. 1

**ASSEMBLY**

1. Install the speedo oil seal in the adaptor using a drift Please note that the oil seal is to be pressed face to face of aluminium cover.
2. Place the speedo pinion in position in the cover and screw the adaptor.
3. Install main shaft oil seal using the drift 312 589 12 39 (Fig. 2)

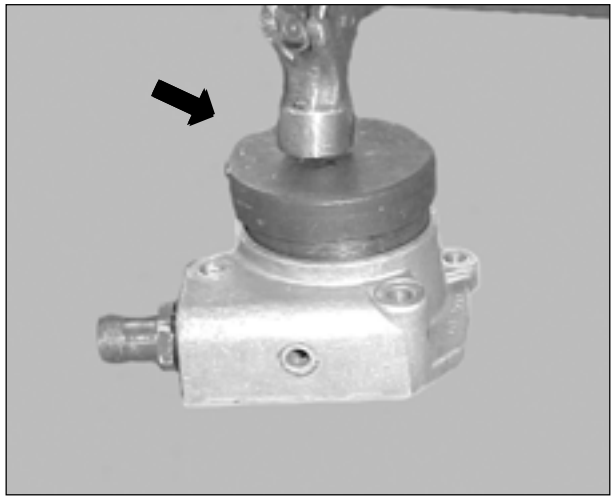


Fig. 2

## INSPECTION OF SHIFTER SHAFTS, FORKS, DOGS & DETENT ASSEMBLY

Check for following :

1. Wear marks on shifter fork pads.
2. Burrs, damages, wear of shafts, forks, dogs and detents.
3. Condition of spiral pin mounting holes in forks & dogs for burrs and bulging.
4. Condition of interlock balls and pins.
5. Free rotation of detent roller.

## INSPECTION OF GEARBOX AGGREGATES

Check the following :

**GEARBOX HOUSINGS**

1. For cracks.
2. Bearing bores for rotation marks, burrs.
3. Shifter shaft cap bores for burrs/damages/scoring marks.
4. R.I shaft bore for burrs and any other damages.
5. Filler plug and drain plug threaded portions for damages.

**DRIVE SHAFT, MAIN SHAFT AND COUNTER SHAFT**

1. Gear teeth for wear, breakage, pitting, scoring and over heating marks.
2. Bearing seats for rotation marks.
3. Splines for breakage, burrs and wear on sides.
4. Cracks.
5. Drive shaft and main shaft oil seal lip contact area for wear.
6. Lock nut mounting threads for damage. Ease the threads with new nuts.
7. Main shaft diameters & collar faces for scoring, rubbing, overheating marks.

**REVERSE IDLER GEAR AND SHAFT**

1. Gear teeth and shaft for wear, breakage, pitting and scoring marks.

**MAINSHAFT GEARS, NEEDLE CAGES**

1. Check bores in all the gears for pitting, scoring and overheating marks.
2. Check faces of all the components for wear, overheating marks.
3. Needle cages for smooth running. Check needles for pitting, breakage and free rotation in cage.

**SPRINGS IN SYNCHRO ELEMENTS**

Check for permanent setting of springs, cracks, bends etc.

## INSPECTION OF GEARBOX AGGREGATES

| Designation | Spring outside diameter (mm) | Wire diameter (mm) | Free length (mm) | Stiffness | |
|---|---|---|---|---|---|
| | | | | Load in kg. | At length (mm) |
| Compression spring ($1^{st}$ / $2^{nd}$ /$3^{rd}$/$4^{th}$ ) | 6.05/6.25 | 1.25 | 34 | 8.0 | 27.9 |
| Compression spring ($5^{th}$/$6^{th}$) | 6.4/6.6 | 1.0 | 29.2 | 3.2 | 21.5 |

**SYNCHRONISING CONES AND RINGS**

1. Wear - Place synchro cone centrally above the synchro ring. Establish contact by radially turning the two cones uniformly and in parallel. The gap between synchro cone and ring should be 1.2 minimum. This should be measured at two opposite points using a feeler gauge. If the measured gap is less than 1.2 mm, install new synchro cone.
2. Cracks, uneven wear and overheating marks on synchro cones and rings.
3. Check synchro cone for lug wear, lug breakages.
4. Replace defective components.

## ASSEMBLY OF MAIN SHAFT

Control dimension from rear face of rear half housing to pocket bearing butting face on main shaft 389.4/389.6

| SPECIAL TOOLS | |
|---|---|
| Drift for installing rear end taper roller bearing | 2640 5890 35 12 |
| Drift for installing pilot bearing | 2751 5890 26 22 |
| Instruments for selection of main shaft spacer thickness | |
| Feeler gauges for circlip thickness measurement | |

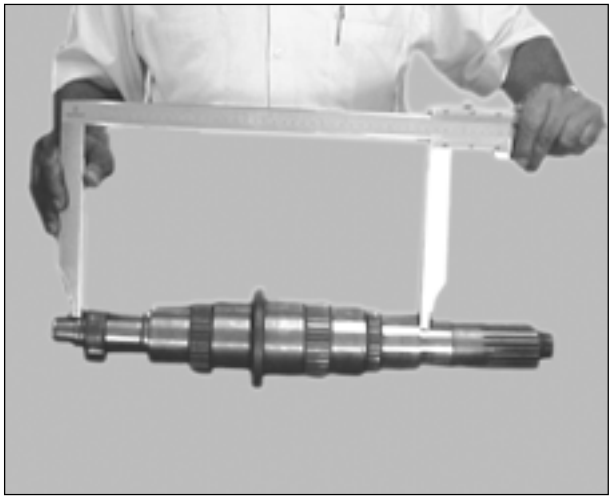


Fig. 1



Fig. 2

**SPACER SELECTION :**

| | |
|---|---|
| Control dimension (Fig. 1) | 389.5±0.1 |
| Rear cover (upper) depth along with gasket | A |
| Bearing width | B |
| (from inner race which butts on main shaft to outer race which is located in rear cover) (Fig. 2) | |
| Distance on main shaft from spacer butting face to pilot bearing butting face | C |
| Spacer thickness | = 389.5 + (A) - (B) - (C) |
| Spacer thickness available = | 10.80mm to 11.60 mm in the steps of 0.10 mm |

## ASSEMBLY OF MAIN SHAFT

1. Measure the rear cover depth "A" along with gasket using a depth gauge (Fig. 1).
2. Measure the bearing width "B".
3. Measure the dimension "C" on main shaft.
4. Spacer thickness will be = 389.5 + (A) - (B) - (C) (Fig. 2).

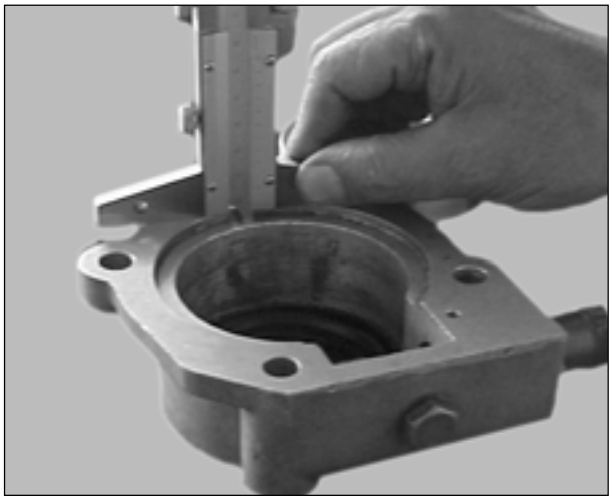


Fig. 1

**ASSEMBLY PROCEDURE:**

1. Hold the main shaft vertically by placing it in the coupling flange. Such that threaded end is upwards.
2. Install the 3rd gear assembly along with needle cage. Lubricate the needle cage by applying oil. Check for free rotation of the gear on shaft.
3. 1st/2nd & 3rd/4th Engaging gear assembly:
   - (i) Place engaging gear on a table.
   - (ii) Place shifter sleeve on engaging gear such that the three recesses for retention pin in engaging gear are exactly above the central, machined tooth of shifter sleeve.
   - (iii) Insert compression springs and retention pins into blind holes of engaging gear. In the centre of the shifter sleeve width, three splines are chamfer grooved at the equi spacings. This has been done for permitting radial insertion of engaging gear into the shifter sleeve in such a manner that the retention pin will hold the assembly locating the entire width of the chamfered teeth grooves.
   - (iv) Push retention pin by means of a screw driver and guide into chamfered teeth.
   - (v) Move the shifter sleeve slowly so that the retention pins and springs take their respective positions.
   - (vi) Place synchro cone with the bigger lug positioned in the corresponding bigger slot in engaging gear.

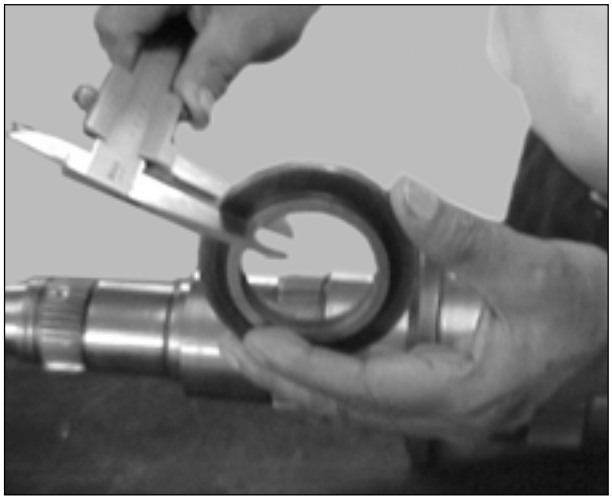


Fig. 2

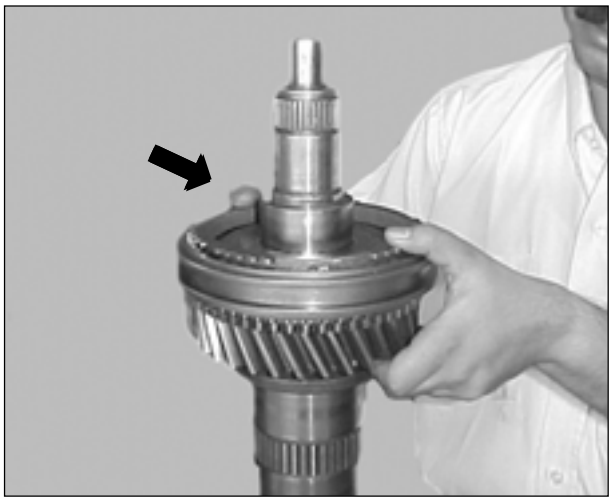


Fig. 3

## ASSEMBLY OF MAIN SHAFT

(vii) Turn the assembly upside down and place the other synchrocone.

4. Install 3rd/4th engaging gear assembly with the bigger step towards collar of main shaft (Fig. 3).

5. Lock the engaging gear assembly axially by inserting the circlip into the groove. Select circlip which fits snugly in the groove (1.80 +2.40 mm ± 0.02 in steps of 0.1 mm).

6. Install the 4th gear assembly along with needle cage and ensure free rotation of the gear. Lubricate the needle cage (Fig. 4).

7. Install the 4th gear spacer by hammering it on the shaft using a suitable drift (Fig. 5).

8. Lock the spacer by inserting circlip of correct thickness (2.40 to 2.90 mm ± 0.02 in steps of 0.1 mm)

9. Install 5th gear assembly along with needle cage and ensure free rotation of the gear. Lubricate the needle cage.

10. 5th/6th Engaging gear assembly:

    (i) Place the engaging gear on a table.

    (ii) Place the shifter sleeve on the engaging gear such that the central missing tooth with groove (or the 5 dia hole) is aligned with the spring locating blind hole in the engaging gear.

    (iii) Insert compression springs, carriers and retention pins in the corresponding slot in engaging gear and push the retention pin by using a screw driver.

    (iv) Move the shifter sleeve over the engaging gear slowly such that the springs, carriers and retention pins are firmly held in position.

    (v) Place the synchro cone by positioning the lug in the other slot in engaging gear.

    (vi) Turn the assembly up side down and place the other synchro cone to complete the assembly.

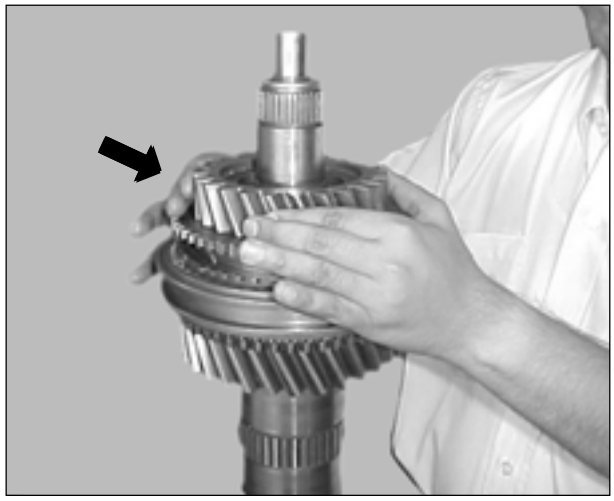


Fig. 4

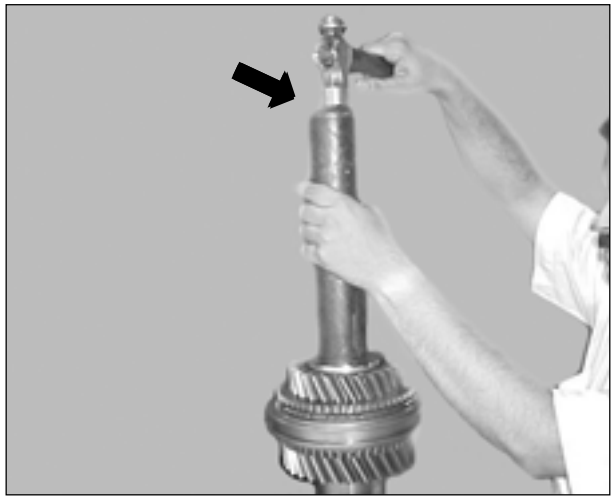


Fig. 5

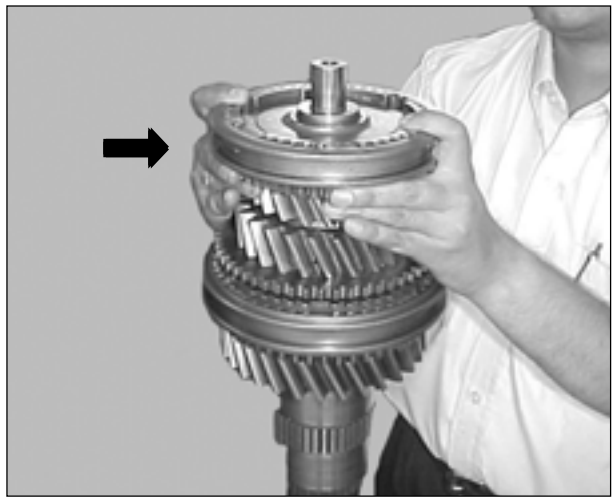
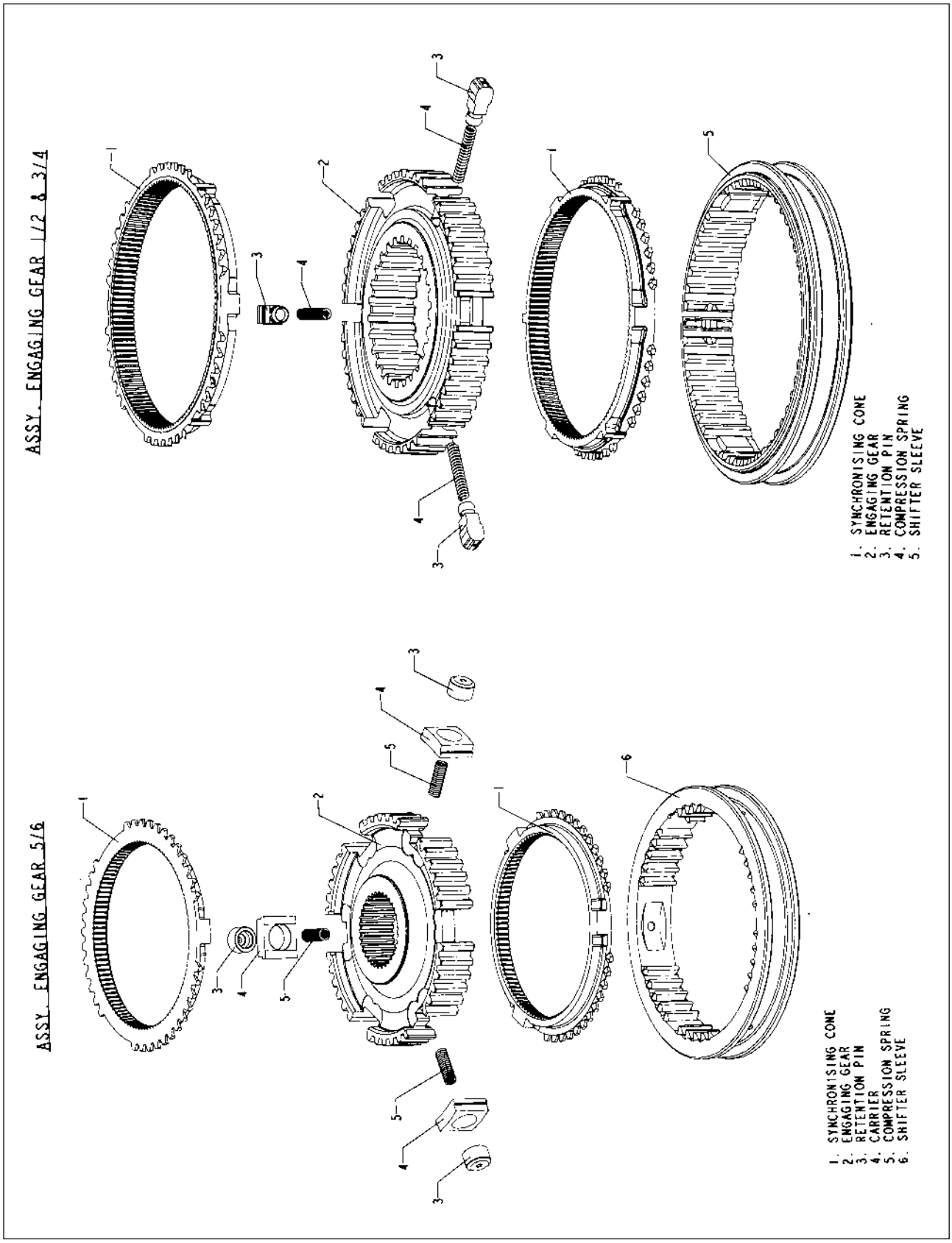


Fig. 6


ASSY. ENGAGING GEAR 1/2 & 3/4
1. SYNCHRONISING CONE
2. ENGAGING GEAR
3. RETENTION PIN
4. COMPRESSION SPRING
5. SHIFTER SLEEVE
ASSY. ENGAGING GEAR 5/6
1. SYNCHRONISING CONE
2. ENGAGING GEAR
3. RETENTION PIN
4. CARRIER
5. COMPRESSION SPRING
6. SHIFTER SLEEVE

## ASSEMBLY OF MAIN SHAFT

11. Install the 5th/6th engaging gear assembly with the bigger step facing the main shaft collar side (Fig. 6).
12. Select correct size circlip and insert in the groove to hold the 5th/6th engaging gear assembly. (2.60 to 2.80 mm ± 0.02 in steps of 0.05 mm)
13. Install the pilot bearing by using a suitable drift and hammer. Remember that there is no outer race for this taper roller bearing and the drive shaft conical bore forms the outer race for this bearing.
14. Remove the coupling flange and hold the assembly with flange end upwards in a vice with soft grips.
15. Install 2nd gear assembly along with needle cage and ensure free rotation of the gear. Lubricate the needle cage.
16. Install the 1st/2nd engaging gear assembly with the smaller step facing the main shaft collar (Fig. 7).
17. Lock the engaging gear assembly axially by inserting correct size circlip. (2.30 to 2.60 mm ± 0.02 in steps of 0.1 mm)
18. Install 1st gear assembly along with needle cage and ensure free rotation of the gear. Lubricate the needle cage.
19. Install the reverse engaging gear with the chamfered external teeth facing up. (i.e. towards reverse gear side)
20. Select circlip and insert in the groove to hold the engaging gear (Fig. 8). (1.80 to 2.40 mm ± 0.02 in steps of 0.1 mm)
21. Install reverse gear along with needle cage and ensure free rotation of the gear. Lubricate the needle cage.
22. Install the selection spacer with the smaller step collar facing up.
23. Press the taper roller bearing inner race using a drift and hammer to complete the main shaft assembly (Fig. 9).

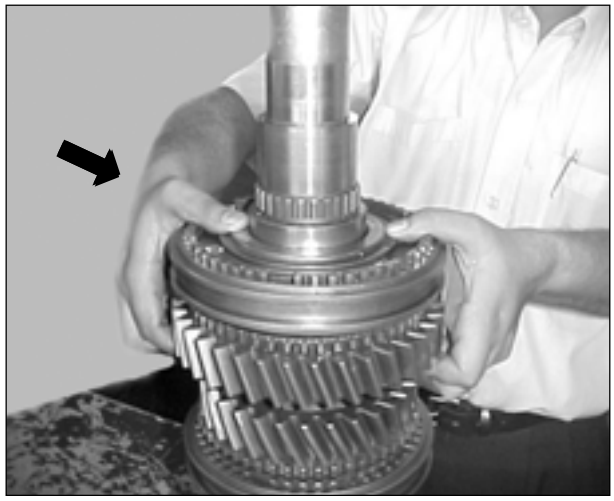


Fig. 7

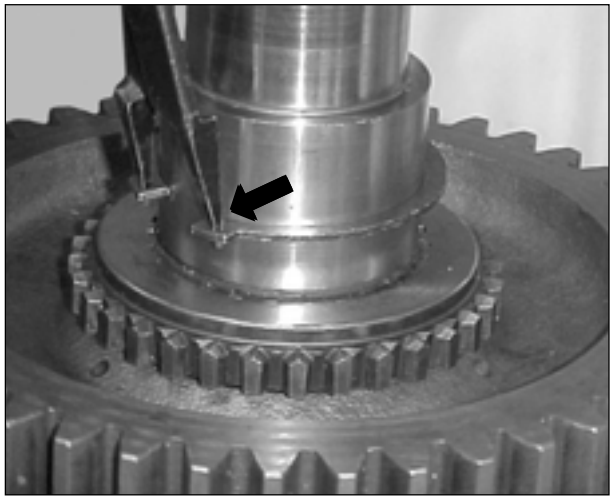


Fig. 8

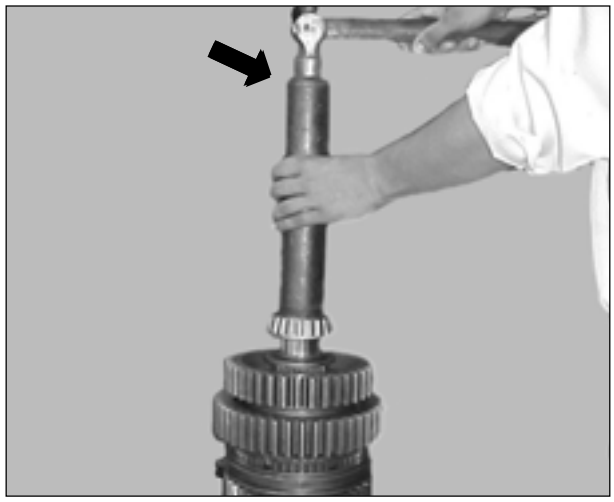
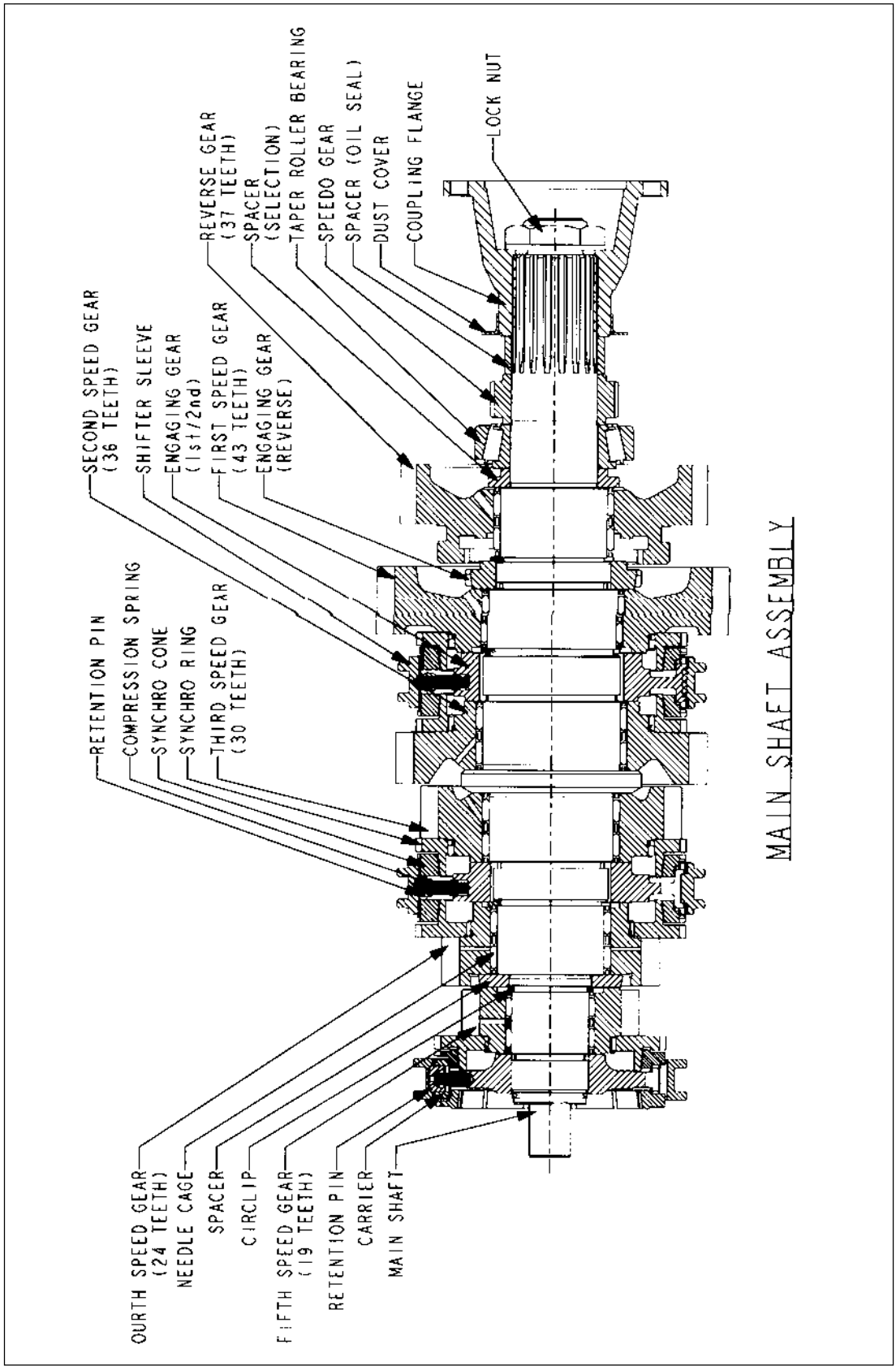


Fig. 9


MAIN SHAFT ASSEMBLY
LOCK NUT
COUPLING FLANGE
DUST COVER
SPACER (OIL SEAL)
SPEEDO GEAR
TAPER ROLLER BEARING
SPACER (SELECTION)
REVERSE GEAR (37 TEETH)
ENGAGING GEAR (REVERSE)
FIRST SPEED GEAR (43 TEETH)
ENGAGING GEAR (1st/2nd)
SHIFTER SLEEVE
SECOND SPEED GEAR (36 TEETH)
RETENTION PIN
COMPRESSION SPRING
SYNCHRO CONE
SYNCHRO RING
THIRD SPEED GEAR (30 TEETH)
OURTH SPEED GEAR (24 TEETH)
NEEDLE CAGE
SPACER
CIRCLIP
FIFTH SPEED GEAR (19 TEETH)
RETENTION PIN
CARRIER
MAIN SHAFT

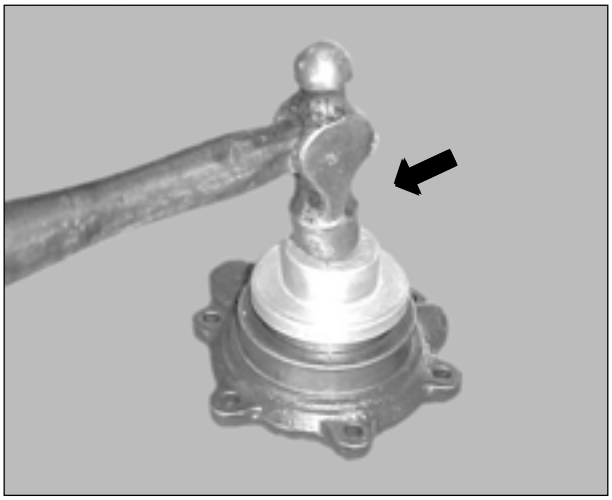
## DISASSEMBLY, INSPECTION AND ASSEMBLY OF FRONT COVER

**SPECIAL TOOLS**

| | |
|---|---|
| Drift for installing oil seal | 2751 5890 26 21 |

**DISASSEMBLY :**

1. Place the front cover assembly on a plain horizontal table.
2. Knock out the oil seal using a suitable rod and hammer.



**INSPECTION :**

1. Oil seal for hardness, bulging, lip cracking etc.
2. Cover for burrs, bearing rotation marks in the spigot.

**ASSEMBLY :**

1. Place the front cover on a plain horizontal table.
2. Press the oil seal using drift 2751 5890 26 21 & hammer.
3. Apply molycoat grease between the two lips.

## ASSEMBLY OF GEARBOX

| | |
|---|---|
| Axial play of main shaft, drive shaft and counter shaft | 0.1/0.2 mm |
| **TIGHTENING TORQUES in mkg.** | |
| Coupling flange nut | 36-40 |
| Housing Interface Bolts | 6 |
| Front Covers | 2.5 |
| Rear cover upper | 2.5 |
| Rear cover lower (inner) | 6 |
| Rear cover lower (outer) | 2.5 |
| Reverse idler cover | 1.5 |
| Top Cover | 2.5 |
| **SPECIAL TOOLS** | |
| Work stand | 2573 5890 37 01 |
| Torque wrench | |
| Coupling flange holder | 2576 5890 35 22 |
| Dummy rear cover upper | |
| Main shaft axial play checking fixture | |
| Outside micrometer (0-25 mm) | |
| Depth gauge (0-25 mm) | |

1. Clean gearbox and mount the rear half housing on work stand 2573 5890 37 01.
2. Install the main shaft taper roller bearing outer race in the dummy rear half housing (Fig. 3).
3. Install the dummy rear cover upper on the housing by tightening the screws (Fig. 1).
4. Install the counter shaft taper roller bearing outer race in the rear half housing (Fig. 4).

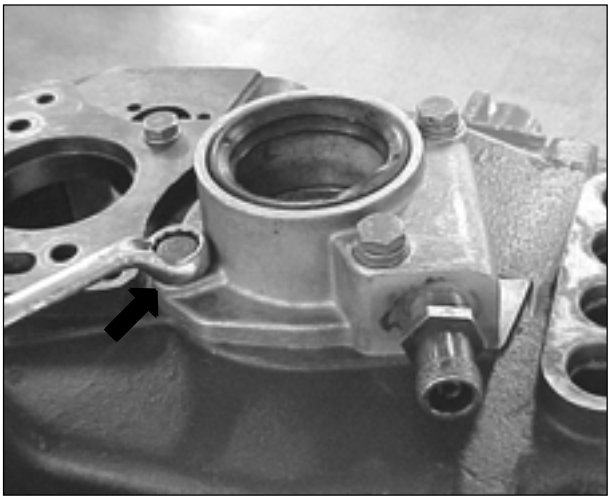


Fig. 1

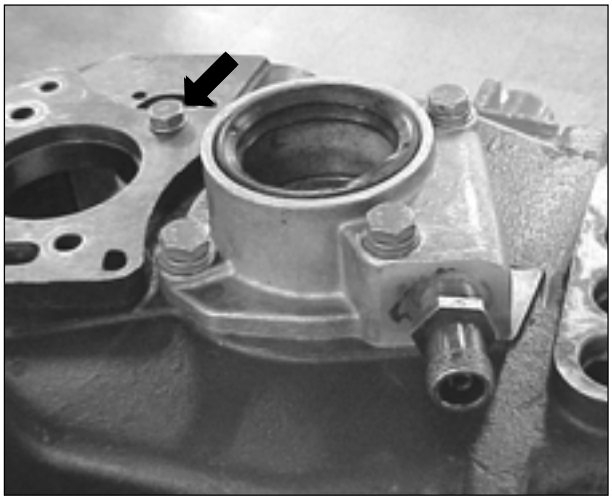


Fig. 2

## ASSEMBLY OF GEARBOX

5. Install the two lower rear covers on the counter shaft along with respective gaskets (Fig. 2).
6. Turn the housing up side down on the stand.
7. Mount the main shaft assembly on lifting tackle along with 1st/2nd shifter shaft assembly (with interlock pin), 5th/6th shifter shaft assembly and reverse & 3rd/4th forks (without shafts) positioned on respective shifter sleeves.
8. Carefully lower the tackle into the housing and align the main shaft in the main bore and also align the two shifter shafts in their respective bores.
9. From bottom side, place the interlock balls (3 nos.) in the housing recess between reverse & 1st/2nd shifter shaft, between 1st/2nd & 3rd/4th shifter shaft, between 3rd/4th & 5th/6th shaft.
10. Slide the reverse shifter shaft (with dog assembled) through the reverse gear fork and align the fork mounting holes.
11. From the breather mounting hole, drive the spiral pin connecting reverse fork with respective shaft.
12. Slide the 3rd/4th shifter shaft with interlock pin (with dog assembled) through the 3rd/4th fork and drive the spiral pin to secure the two. Place a wooden block between gears and shifter shaft while driving the spiral pin to prevent any damages to the shaft.
13. Place the drive shaft assembly over the main shaft assembly ensuring proper seating of the shaft in the pilot bearing & free rotation of drive shaft.
14. Lower the counter shaft assembly in the housing and align the bearing in the bore (Fig. 5).
15. Install the reverse idler thrust washer in the rear half housing and secure the tongue in the slot provided.
16. Assemble the reverse idler gear , spacer & roller cages by pressing the idler shaft with a suitable hammer. Place a wooden block on the shaft while hammering it to prevent any bulging of the shaft end. Note that the spacer is to fitted in the window towards the front side and the plain diameter of gear to be on spacer side (Fig. 7).
17. Install the housing interface gasket.

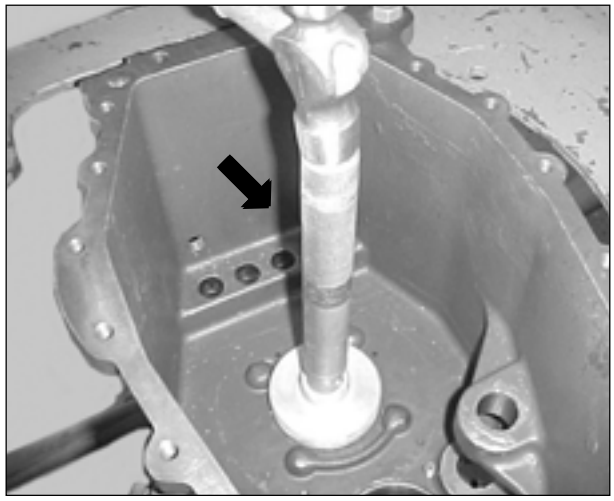


Fig. 3

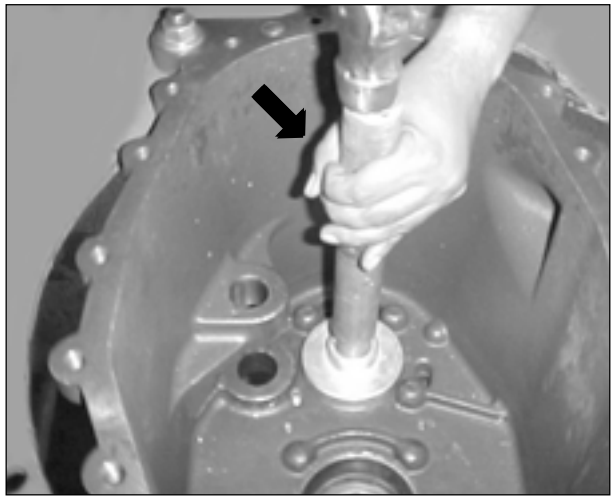


Fig. 4

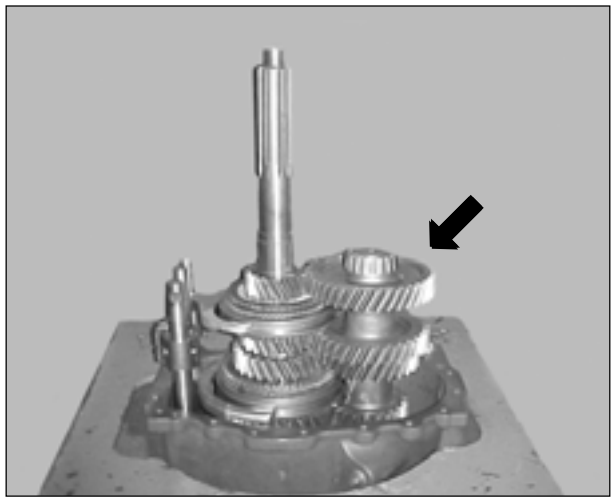


Fig. 5

## ASSEMBLY OF GEARBOX

18. Place the front half housing over the rear half by aligning the shifter shafts in their respective bores.
19. Secure the two housings by screwing all the fasteners. Apply torque 6 mkg.
20. Turn the gearbox horizontal on work stand.
21. Apply sealant and install all the shifter caps. (both rear & front half housings)
22. Install all the detent assemblies. Ensure that the slots on detents are all in one line and perpendicular to the axis of main shaft. Insert detent springs and plug them with a washer. Use thread locker. Ensure free rotation of roller before fitment.
23. Assemble the adaptor and breather .Use thread locker while assembling adaptor. Ensure correct positioning of shifter & selector finger.
24. Assemble the entire top cover assembly along with link rod mounting bracket. Tighten all the fasteners to specified torque.
25. Remove the dummy rear cover upper.
26. Install the speedo gear on the main shaft.
27. Install the rear cover upper assembly along with oil seal and gasket.
28. Tighten rear cover bolt to specified torque.
29. Slide the oil seal spacer on main shaft. Ensure that the oil seal lip is not damaged.
30. Install the coupling flange and secure it by tightening the lock nut (Fig. 6).
31. Tighten the nut to specified torque using torque wrench 36 - 40 mkg.
32. Stake the nut by punching the collar on nut into the main shaft slot using a chisel and hammer.
33. Assemble the reverse idler cover along with gasket by fastening all the screws.
34. Ensure that the reverse idler shaft is locked axially by installing the lock plate.
35. Tighten the two housing joint bolts which are screwed on to front housing from rear on rear housing (Fig. 8).
36. Screw the reverse indicator switch. Use thread locker.

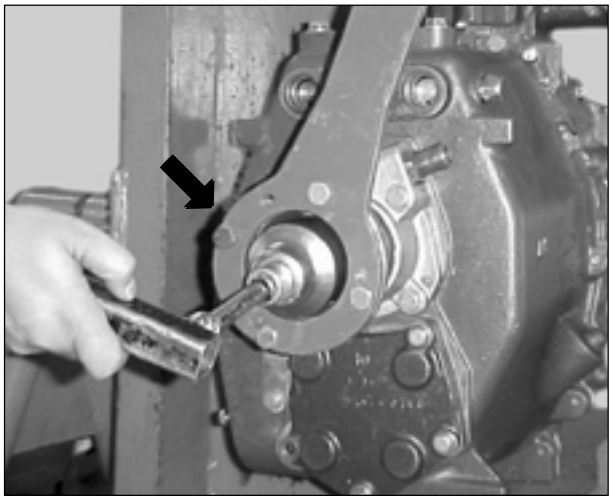


Fig. 6

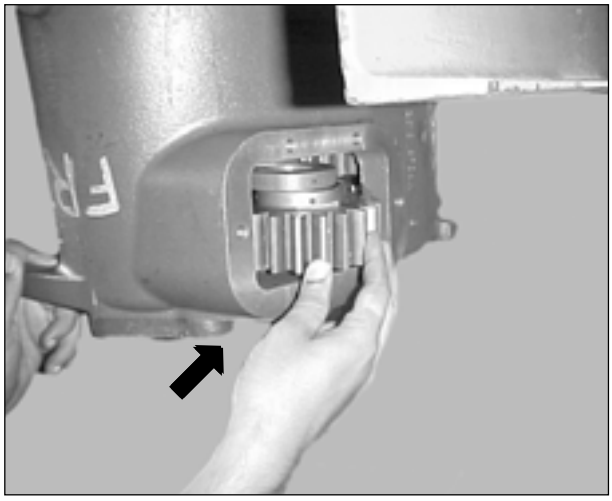


Fig. 7

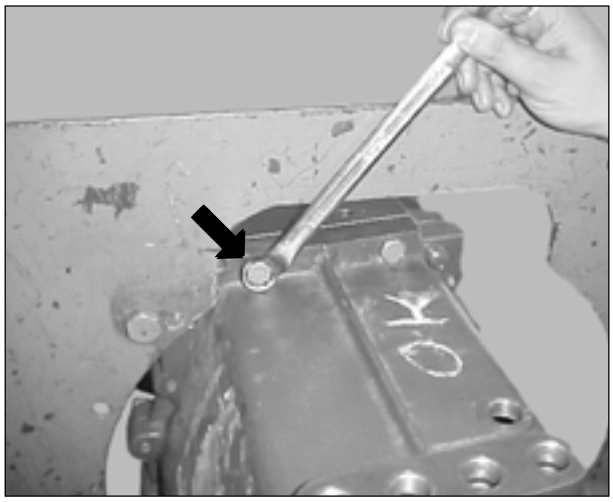


Fig. 8

## ASSEMBLY OF GEARBOX

37. Turn the gearbox assembly upside down on the work stand.
38. Selection of shims for counter shaft : (front cover bottom)
    (i) Measure the projection of counter shaft taper roller bearing from housing face (Fig. 12).
    (ii) Measure the depth of front cover lower along with gasket (Fig. 9).
    (iii) Select a shim such that the counter shaft will have an axial play of 0.1 to 0.2 mm.

**Note :** Shims are to be added in front cover only.

39. Selection of shims for main shaft : (front cover upper)
    (iv) Measure the projection of drive shaft taper roller bearing from housing face (Fig. 10).
    (v) Measure the depth of front cover upper along with gasket (Fig. 11).
    (vi) Select a shim such that the main shaft will have an axial play of 0.1 to 0.2 mm.

**Note :** Shims are to be added in front cover only.

40. Assemble front cover upper assembly along with gasket and shims. Care to be taken while sliding the cover over drive shaft to prevent any damages to oil seal lip.
41. Assemble the front cover lower along with gasket and shims.
42. Check the main shaft axial play by mounting the axial play checking fixture.

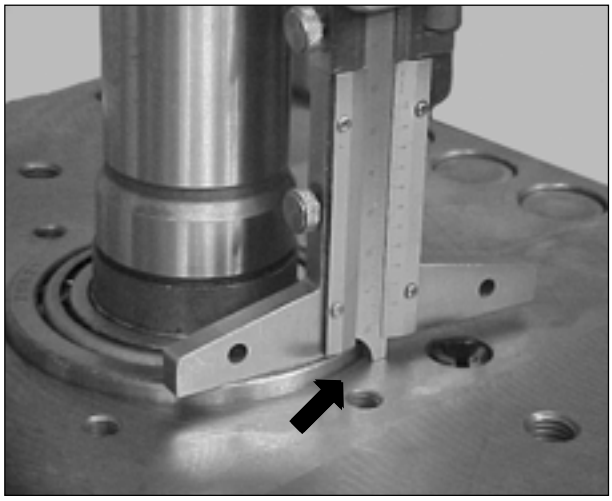


Fig. 10

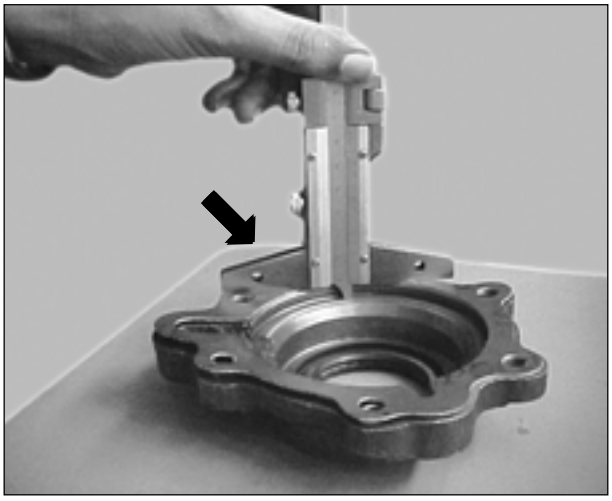


Fig. 11

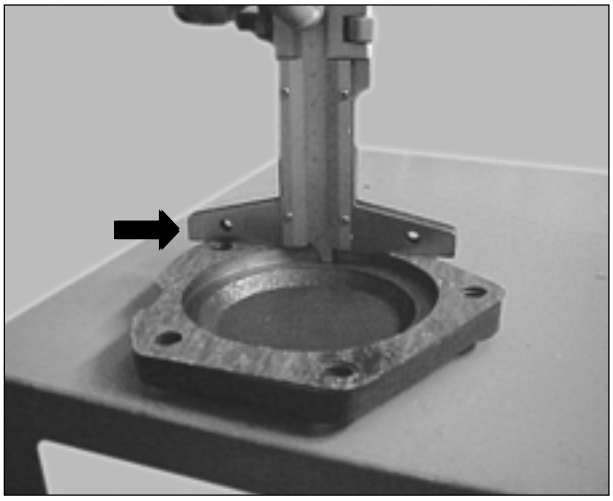


Fig. 9

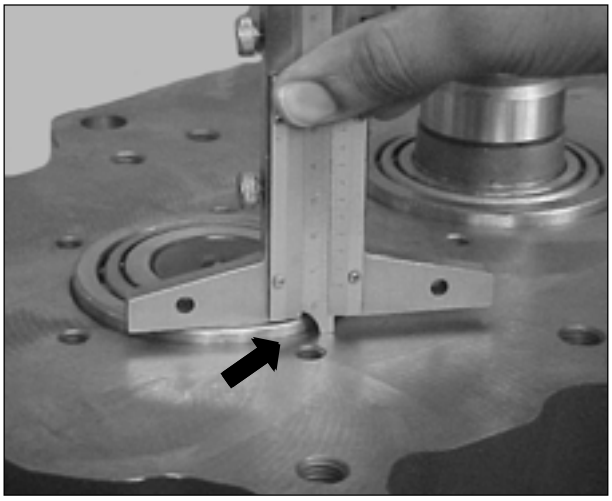


Fig. 12

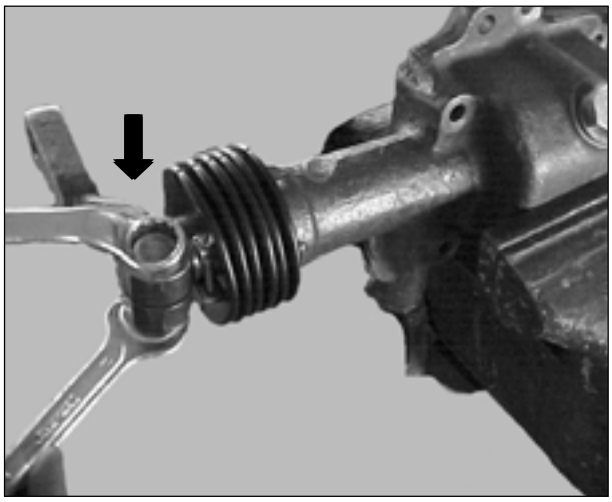
# DISASSEMBLY, INSPECTION AND ASSEMBLY OF TOP COVER

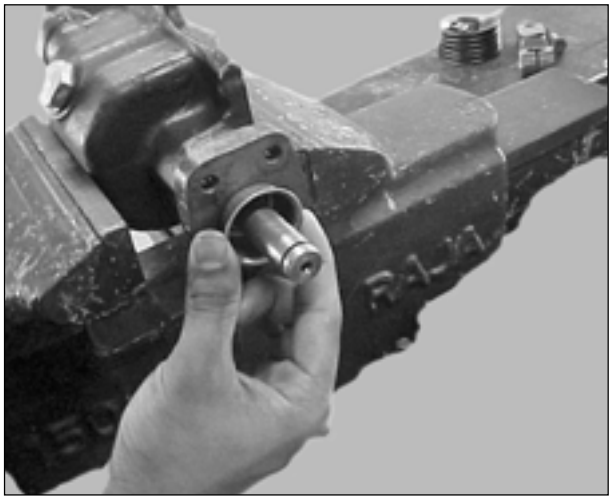
**SPECIAL TOOLS**

| | |
|---|---|
| Drift for installing needle bushes | 2641 5890 26 01 |

**DISASSEMBLY**

1. Hold the top cover assembly in a vice. Loosen & takeout the bolt and remove the shifter lever.
2. Remove the gear shift lever from unique position.
3. Remove the hose clip and rubber bellow.
4. Unscrew the side cover mounting fasteners and remove side cover.
5. Hold the spacer and carefully remove the circlip with a plier. Please note that spring force is acting on the spacer and hence the spacer needs to be held before easing out the spring tension slowly.
6. Pick the two compression springs and cup.
7. Unscrew the threaded plug of reverse gear plunger and remove plunger along with the spring.
8. Remove the sealing plug located on top of the top cover.
9. Knock out the shifting finger spiral pin with a suitable pin and hammer by aligning it with the sealing plug threaded hole.
10. Tap on the selector shifter shaft from the side cover end to remove it.
11. Pick the shifter finger.
12. Remove the scraper ring and oil seal by inserting a suitable pin inside the cover.
13. Press out the needle bushes using a rod.





## DISASSEMBLY, INSPECTION AND ASSEMBLY OF TOP COVER

**INSPECTION :**

1. Selector shifter shaft for burrs, damages on the spline portion.
2. Needle bearing and oil seal seating diameters on shaft for over heating, scoring marks.
3. Scraper ring and oil seal for lip hardening, cracking, bulging etc.
4. Springs for permanent set, bend, breakages etc.
5. Rubber bellow for cracks.
6. Shifter finger for burrs, excess wear.
7. Needle bushes for free rotation of rollers.
8. Top cover for damage & cracks etc.

**ASSEMBLY :**

1. Hold the top cover in a vice.
2. Install the two needle bushes in the cover using a drift 2641 5890 26 01.
3. Install the oil seal and scraper ring using suitable drift. Apply grease to the seals.
4. Hold the shifter finger in position and slide the shifter shaft through the finger. Ensure correct orientation of the shaft spline flat. Note that the spiral pin mounting hole on finger should be pointing nearer to the threaded hole on top of the cover.
5. Drive the spiral pin through the finger and shaft to secure the two. Always use a new pin while assembling (Fig. 1).
6. Ensure free rotation of the shaft.
7. Assemble the plunger and springs of reverse gear plunger & tighten the screw along with crinkled washer.

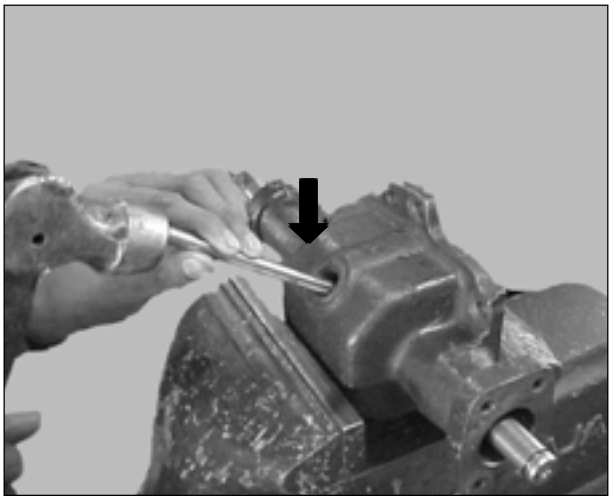


Fig. 1

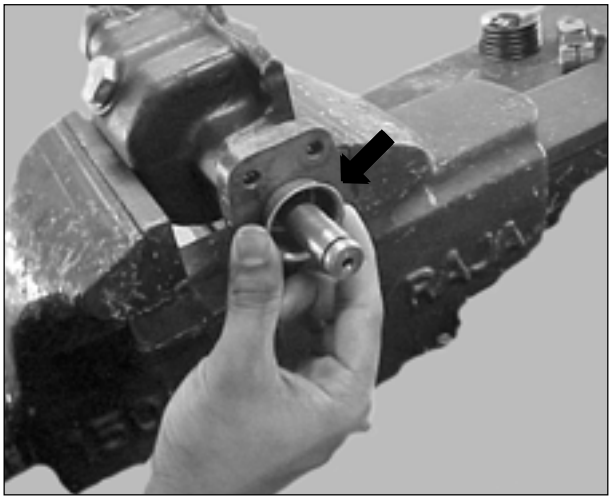


Fig. 2

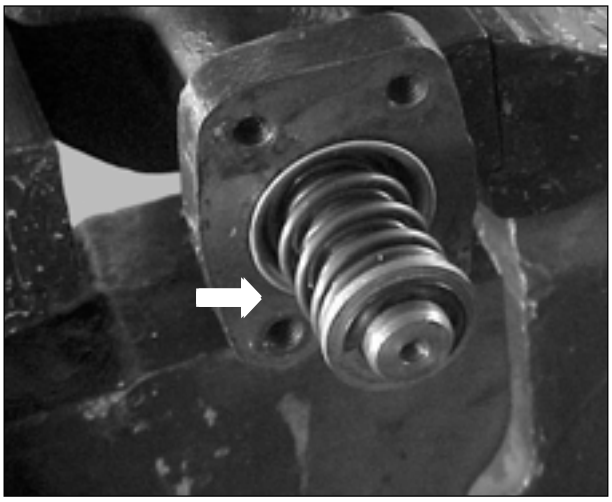


Fig. 3

## DISASSEMBLY, INSPECTION AND ASSEMBLY OF TOP COVER

8. Hold the cover in vice with the side cover end facing up.

9. Place the cup on the shaft with the flange touching the cover face (Fig. 2).

10. Place the two compression springs on the cup (Fig. 3).

11. Place the spacer on top of the springs & apply pressure by suitable means in order to insert the circlip in groove.

12. Assemble the side cover with gasket by screwing all the fasteners (Fig. 4).

13. Push the rubber bellow over the shaft until the inner end (major dia) is held on the boss provided in the cover.

14. Secure the bellow in position by tightening the hose clip screw by a screw driver (Fig. 5).

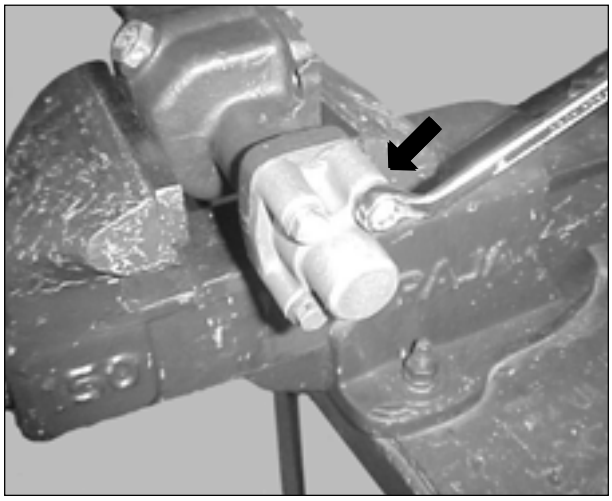


Fig. 4

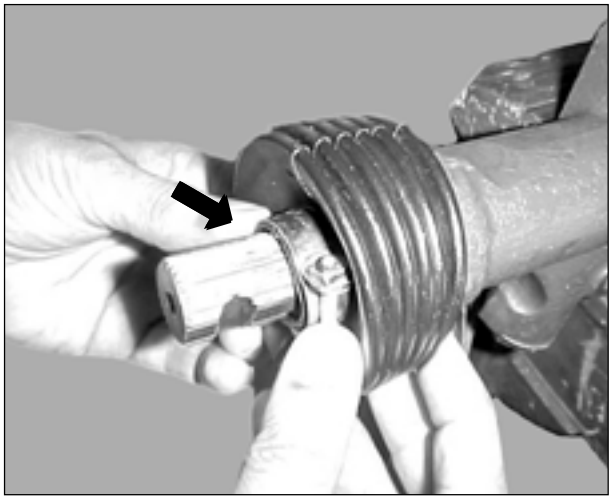


Fig. 5

## INSTALLATION OF GEARBOX AND SHIFTER LINKAGE ON VEHICLE

| **TIGHTENING TORQUES** in mkg. | |
|---|---|
| Coupling flange/propeller shaft nut/bolts | 7 |
| Centre bearing bracket mounting bolts | 5 |
| Gearshift lever bracket/connecting flange mounting bolts/nuts. | 3 |

| **SPECIAL TOOLS** | |
|---|---|
| Trolley, for aggregate handling | 2576 5890 02 19 |
| Adaptor trolley for gearbox | |
| Torque wrench | |

1. Assemble clutch housing on the gear box along with the clutch release fork assembly.
2. Mount adaptor trolley on aggregate handling trolley 2576 5890 02 19. Mount gearbox assembly on adaptor trolley. Clean and smear grease on clutch release bearing seating on drive shaft, drive shaft splines and pilot bearing locating diameter.
3. Raise the trolley and align the gearbox assembly (along with clutch housing) with the flywheel housing. Align the drive shaft splines with those of clutch disc and screw in clutch housing mounting screws with spring washers.
4. Feel correct location of the drive shaft in pilot bearing and fully tighten the clutch housing mounting screws.
5. Connect speedo cable to the gearbox (Fig. 1).
6. Connect the assembly link rod to assy. bracket which is mounted on gear box (Fig. 2)

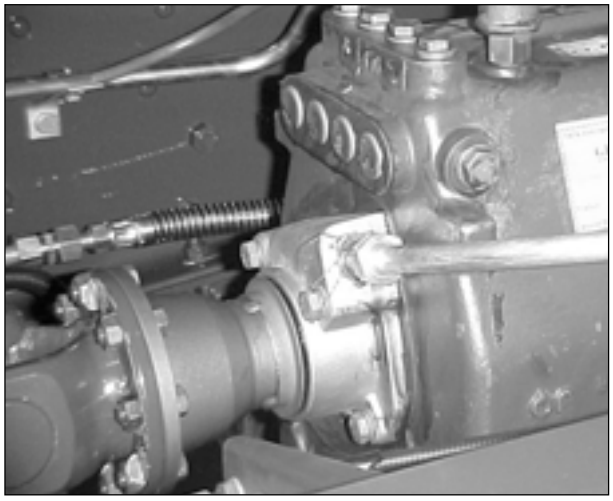


Fig. 1

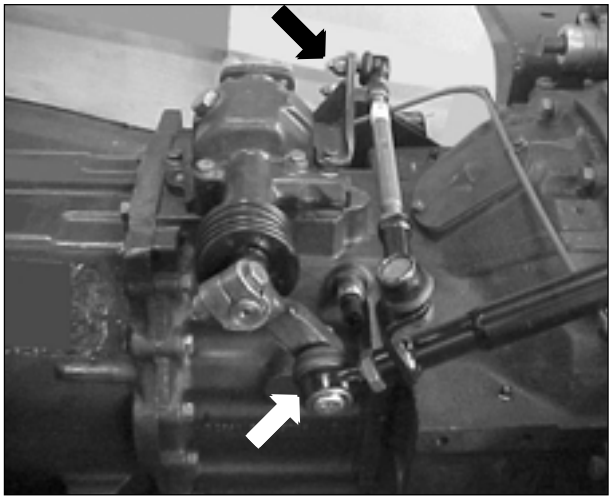


Fig. 2

## INSTALLATION OF GEARBOX AND SHIFTER LINKAGE ON VEHICLE

7. Position and fasten propeller shaft to the gearbox coupling flange with nuts, spring washers and bolts. Tighten fasteners to 7 mkg. torque (Fig. 3).

8. Mount centre bearing bracket on support cross member and tighten castle nuts to 5 mkg torque. Use new split pins for locking castle nuts.

9. Clean area around the filler plug and fill gearbox with recommended oil upto filler plug level (Fig. 4).

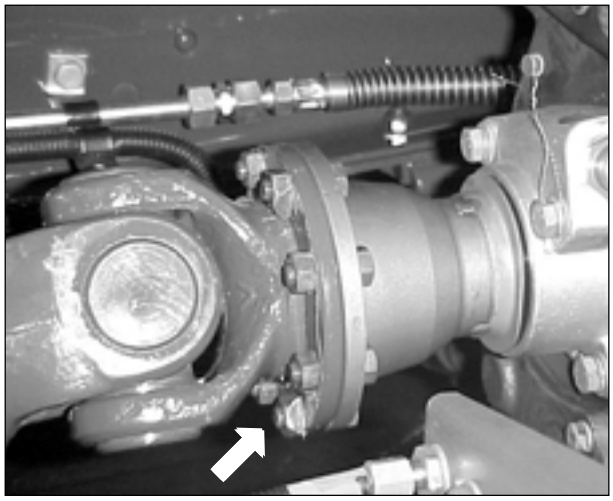


Fig. 3

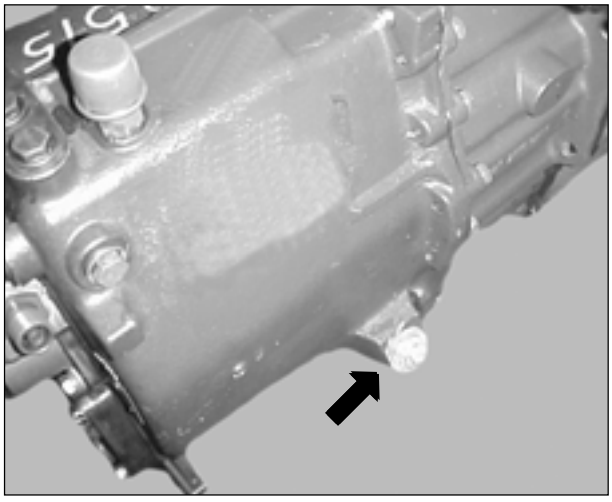
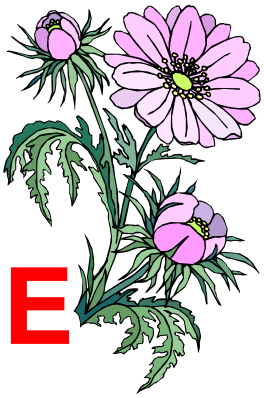


Fig. 4

# PTO (SIDE MOUNTED)
# FOR G-600 GEARBOX



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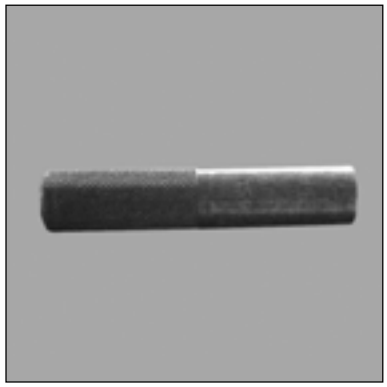
## SPECIAL TOOLS



1. 2654 5890 35 11
   Drift for Oil Seal (output shaft), ball bearing (input shaft) & inner race bigger taper roller bearing (output shaft)



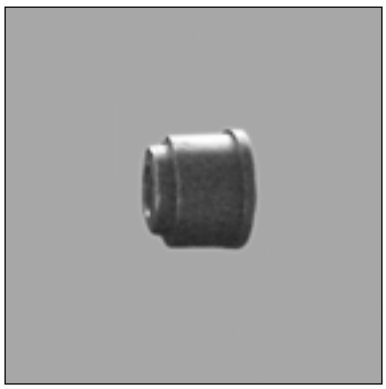
2. 2654 5890 26 05
   Drift for cylindrical roller bearing (input shaft) & inner race bigger taper roller bearing



3. 2651 5890 2001
   Drift for input shaft & inner race smaller taper roller bearing (output shaft)



4. 2657 5890 3303
   Drift for outer race of bigger taper roller bearing along with spacer (output shaft)



5. 2654 5890 3507
   Drift for ball bearing (input shaft), spacer (output shaft) & outer race of bigger taper roller bearing



6. 2654 5890 3508
   Puller for cylindrical roller bearing (input shaft)



7. 2654 5890 3201
   Puller for inner race of smaller taper roller bearing (output shaft)



8. 2640 5890 35 11
   Handle to be used with Drift 2654 5890 3507.

## DISASSEMBLY OF P.T.O.

| SPECIAL TOOLS | |
|---|---|
| Drift for Oil Seal (output shaft), ball bearing (input shaft) & inner race bigger taper roller bearing (output shaft) | 2654 5890 3511 |
| Drift for cylindrical roller bearing (input shaft) inner race bigger taper roller bearing | 2654 5890 2605 |
| Drift for outer race of bigger taper roller bearing along with spacer (output shaft) | 2657 5890 3303 |
| Drift for input shaft & inner race smaller taper roller bearing (output shaft) | 2651 5890 2001 |
| Drift for ball bearing (input shaft), spacer (output shaft) & outer race of bigger taper roller bearing | 2654 5890 3507 |
| Handle for drift | 2640 5890 3511 |
| Puller for cylindrical roller bearing (input shaft) | 2654 5890 3508 |
| Puller for inner race of smaller taper roller bearing (output shaft) | 2654 5890 3201 |
| Torque Wrenches | |
| Circlip pliers | |

**DISASSEMBLY OF P.T.O. :**

1. Dismantle the P.T.O. unit from Gearbox assembly by unscrewing the M10 fasteners (4 nos) and M10 Nuts (4 nos).

   (Refer fig. 1)

2. Remove the M10 studs (4 nos).

   (Refer fig. 2)

3. Cover the P.T.O. opening window on Gearbox to prevent damage to the R.I. Gear.

   (Refer fig. 3)

Note : If spare cover is not available, cover the opening suitably.

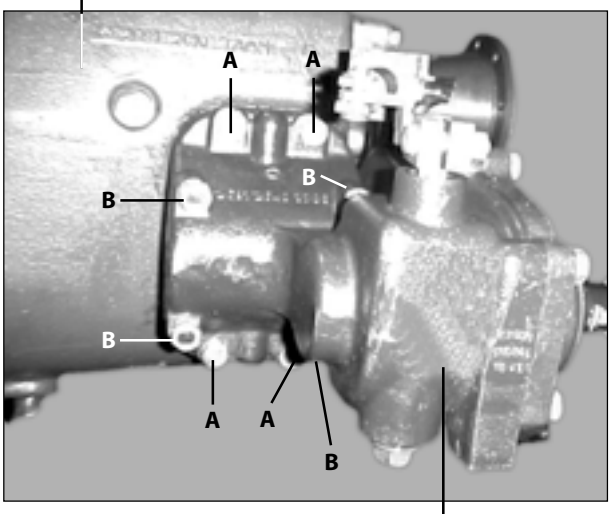



Fig. 1 A - M10 Bolts (4 Nos.)
B - M10 Nuts (4 Nos.)

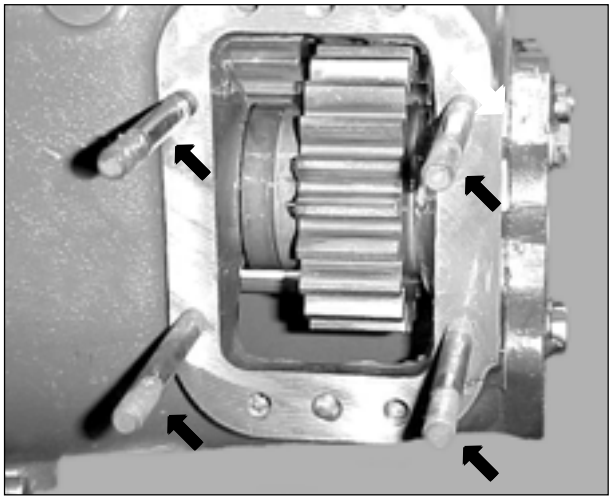


Fig. 2

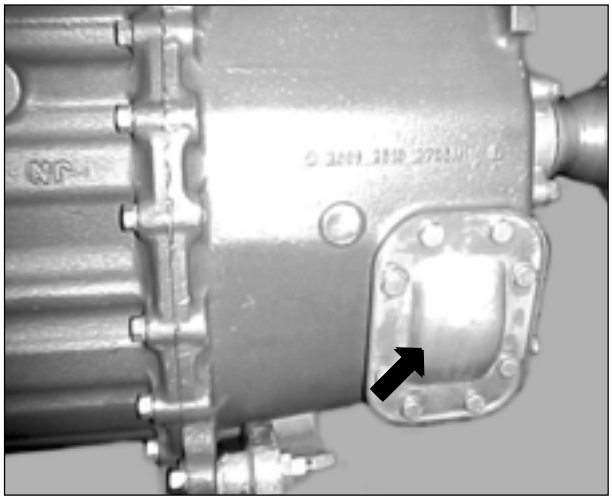
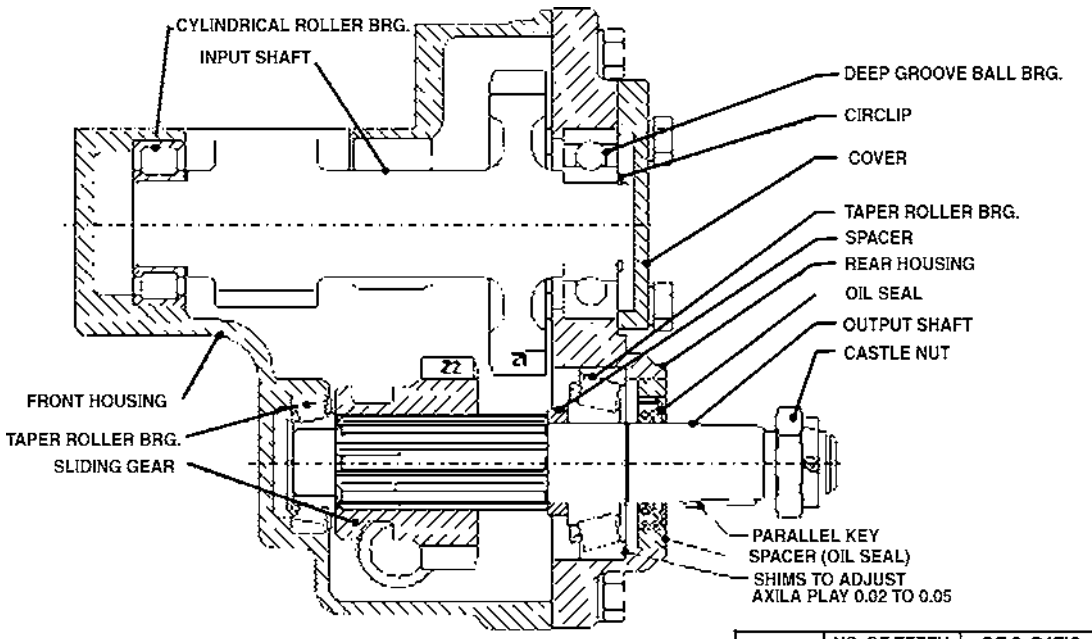


Fig. 3

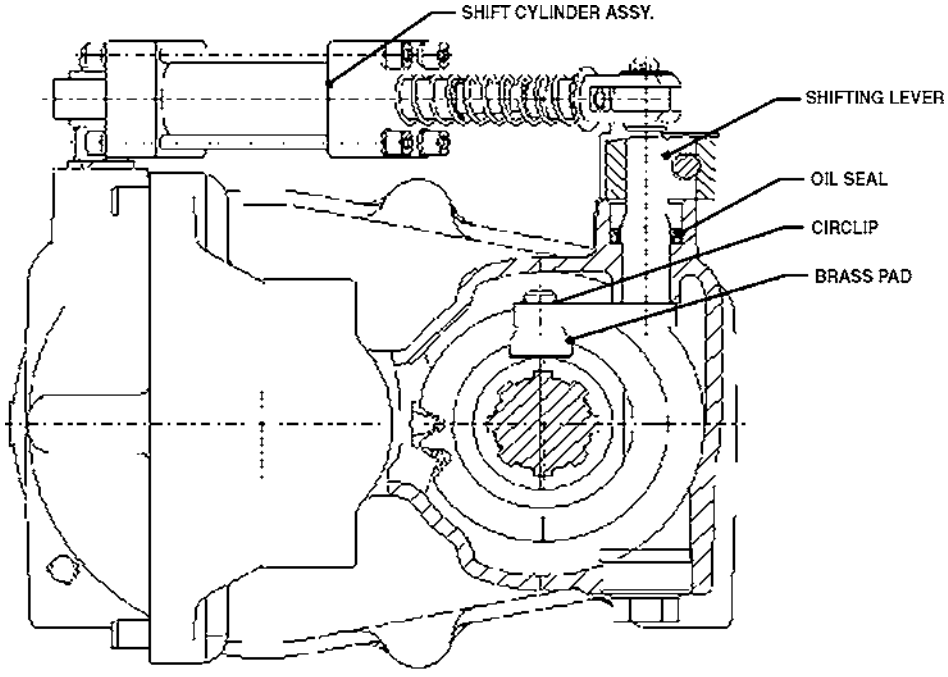
## DISASSEMBLY OF P.T.O.




ASSEMBLY POWER TAKE OFF UNIT

| | NO. OF TEETH | | P.T.O. RATIO | |
|---|---|---|---|---|
| | 21 | 22 | 8.41 RATIO GEARBOX | 9.19 RATIO GEARBOX |
| OPTION 1 | 27 | 18 | 0.692 | 0.637 |
| OPTION 2 | 31 | 14 | 1.02 | 0.94 |

Fig. 4




ASSY. P.T.O. WITH SHIFT CYLINDER ASSY.

Fig. 5

## DISASSEMBLY OF P.T.O.

4. Dismantle the Shift cylinder assembly.
(Refer Fig. 6)

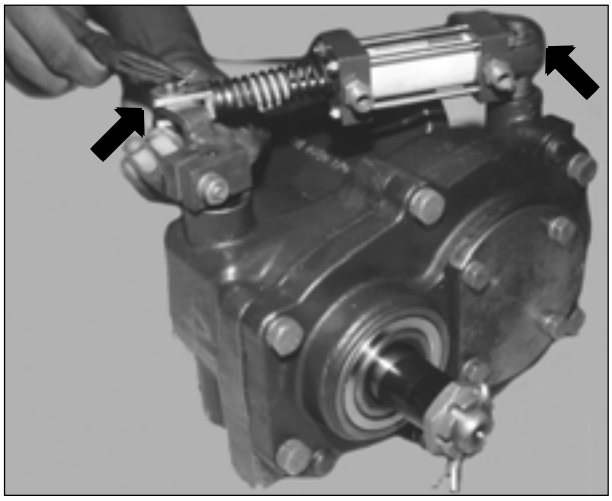


Fig. 6

5. Remove the split pin, castle nut and parallel key from Output shaft alongwith pulley / gear which are used to drive the external unit.
(Refer Fig. 7)

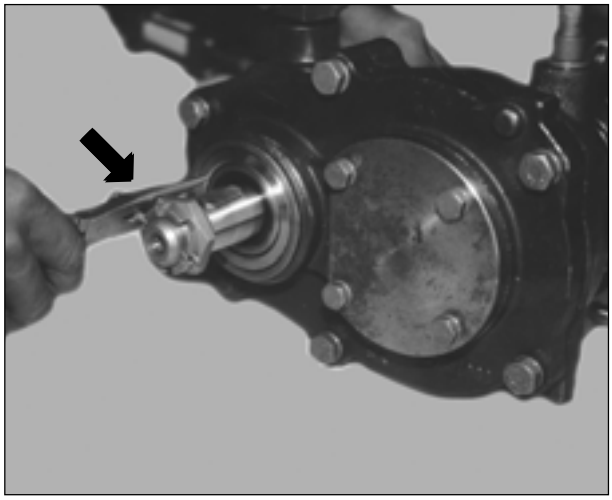


Fig. 7

6. Remove the Input shaft rear cover by unscrewing the 4 fasteners.
(Refer Fig. 8)

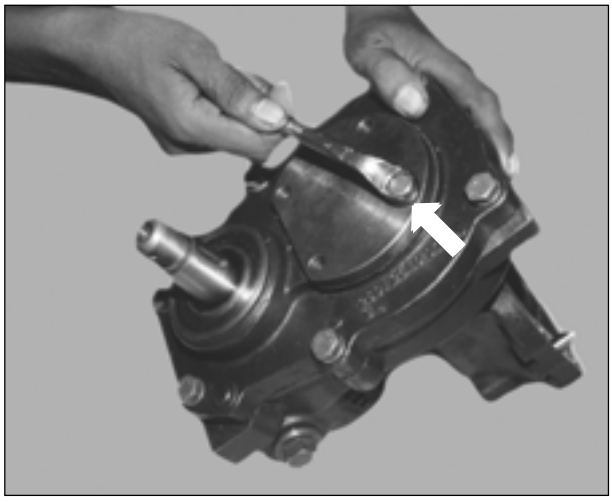


Fig. 8

## DISASSEMBLY OF P.T.O.

7. Dismantle the Rear half housing.
(Refer Fig. 9)

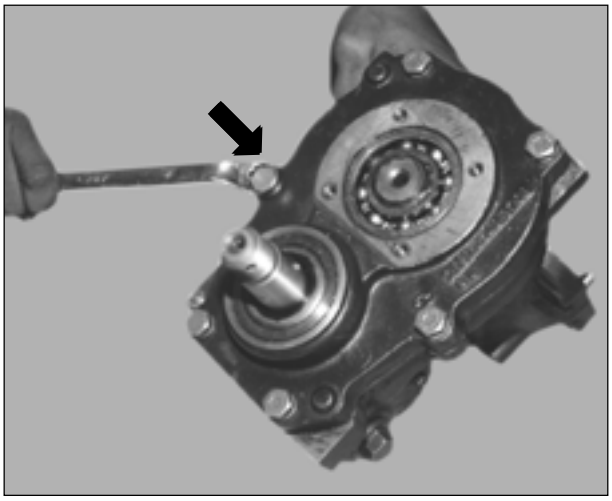


Fig. 9

8. Remove the circlip with plier of input shaft.
(Refer Fig. 10)

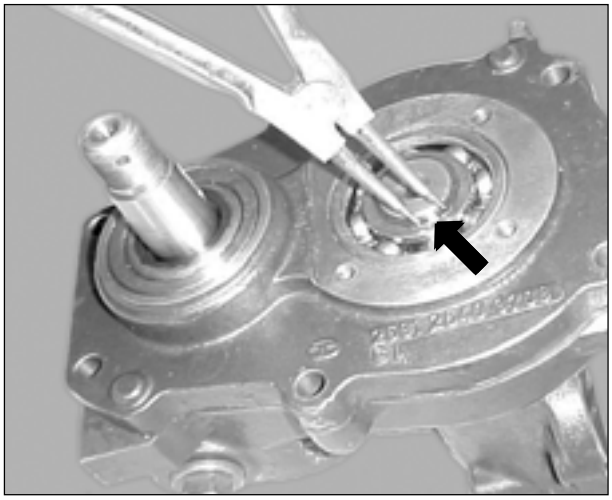


Fig. 10

9. Remove the rear housing.
(Refer Fig. 11)

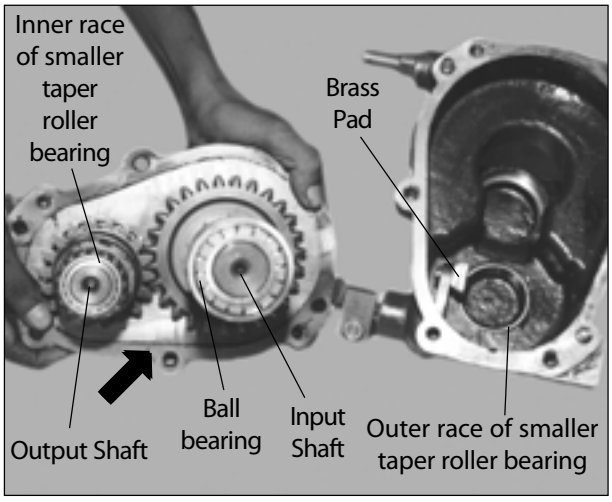
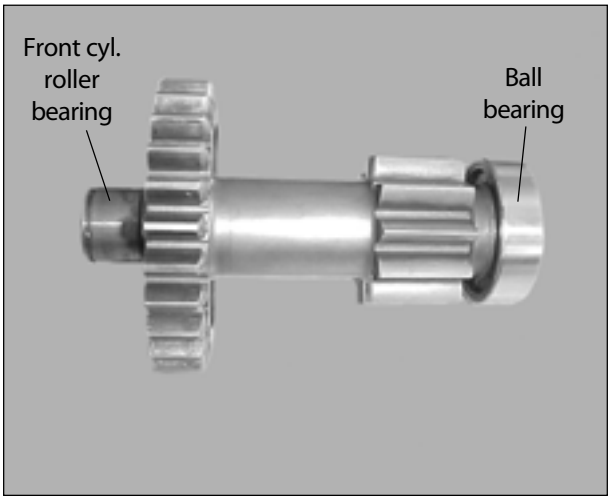
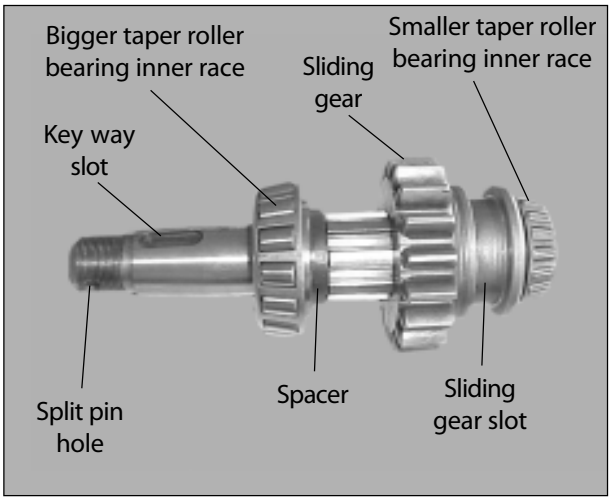



Fig. 11

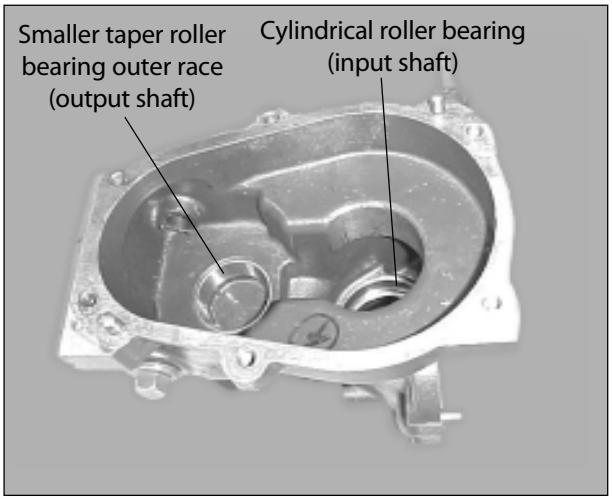
**ASSEMBLY INPUT SHAFT**



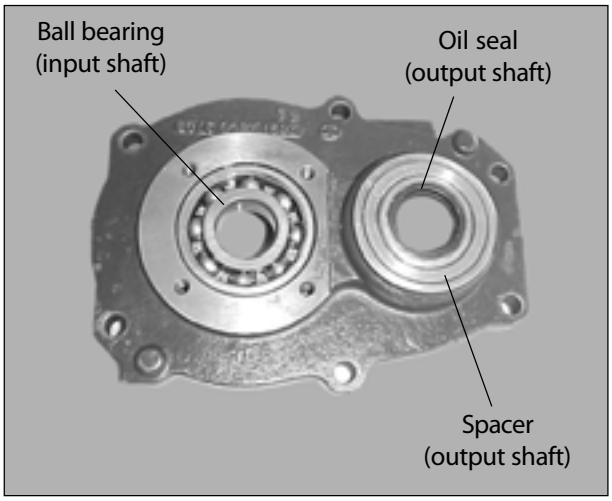

**ASSEMBLY OUTPUT SHAFT**




**ASSEMBLY FRONT HOUSING**




**ASSEMBLY REAR HOUSING**



## DISASSEMBLY OF INPUT/OUTPUT SHAFT & FRONT/REAR HOUSING

**DISASSEMBLY OF INPUT / OUTPUT SHAFT & FRONT/REAR HOUSING**

a) Remove Input shaft from rear housing, by using Drift, Pt. No. 2651 5890 20 01.

(Refer Fig. 12)



Fig. 12



Fig. 13

b) Remove cover Oil seal (Output shaft) by using Drift Pt. No. 2654 5890 35 11.

(Refer Fig. 13)

c) Remove Outer race of bigger taper roller bearing along with spacer (Output shaft) from the cover, by using Drift Pt. No. 2657 5890 33 03 & keep aside the shims

(Refer Fig. 14)



Fig. 14

d) Remove Ball bearing (Input shaft) from the cover, by using Drift Pt. No. 2654 5890 35 11.

(Refer Fig. 15)

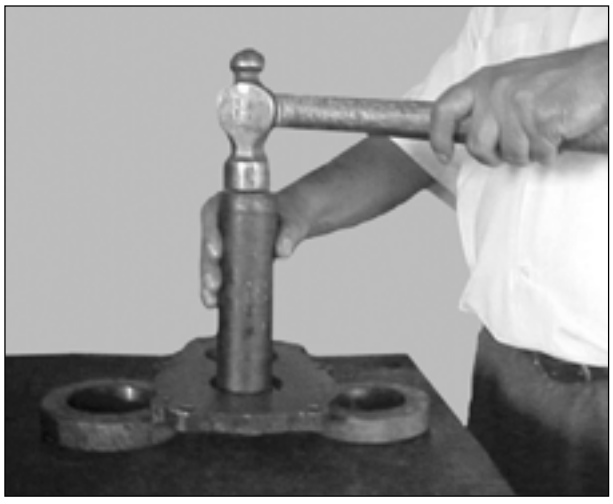


Fig. 15

## DISASSEMBLY OF INPUT/OUTPUT SHAFT & FRONT/REAR HOUSING

e) Remove Inner race of smaller taper roller bearing (Out put shaft) from the Housing side, by using Puller Pt. No. 2654 5890 32 01.

(Refer Fig. 16)



Fig. 16

f) Remove Inner race of bigger taper roller bearing (Out put shaft) from the cover side, by using Drift Pt. No. 2654 5890 35 11.

(Refer Fig. 17)



Fig. 17

g) To remove Cylindrical roller bearing (In put shaft) from the cover side, by using Puller Pt. No. 2654 5890 35 08 to be used. (Hold the Puller in the Bench-vice).

(Refer Fig. 18)

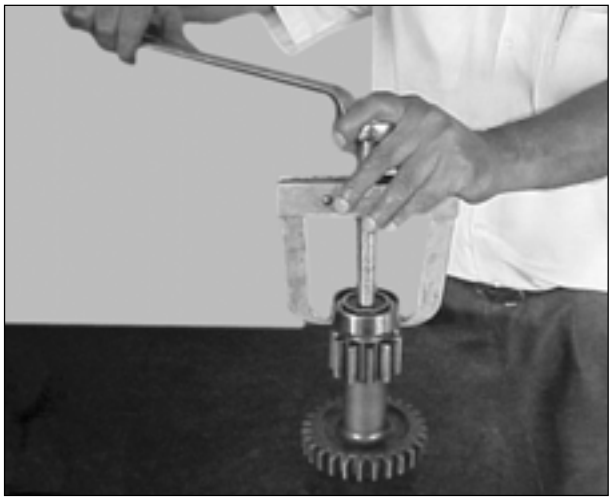


Fig. 18

## INSPECTION AND ASSEMBLY OF INPUT/OUTPUT SHAFT & FRONT/REAR HOUSING

**INSPECTION :**

1. Inspect Gear teeth for wear, breakage, pitting, scoring and over heating marks.
2. Bearing seats for rotation marks.
3. Splines for breakage, burrs and wear on sides.
4. Check the bearings for scoring, pitting.
5. Output shaft oil seal lip contact area for wear.
6. Inspect the Oil seal for hardness, bulge marks etc.
7. Inspect the Brass pad for wear.
8. Check the Shift Cylinder assembly for proper functioning.

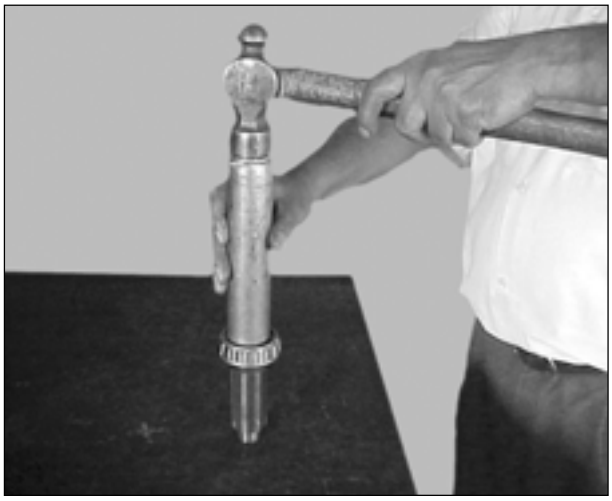


Fig. 19

**ASSEMBLY OF INPUT / OUTPUT SHAFT & FRONT/ REAR HOUSING :**

a. Assemble the spacer and press the inner race of bigger Taper Roller bearing output shaft (cover side) using drift Pt. No. 2654 5890 2605.

(Refer Fig. 19)

b. Assemble the Sliding gear on Output shaft with the slot towards the smaller bearing.

c. Using drift Pt No. 2651 5890 2001, press the smaller Taper Roller bearing inner race on the Output shaft (Housing side).

(Refer Fig. 20)

d. Press the cylindrical roller bearing on input shaft using drift Pt. No. 2654 5890 2605; with the snap ring holding the rollers facing inside.

(Refer Fig. 21)



Fig. 20



Fig. 21

## ASSEMBLY OF INPUT/OUTPUT SHAFT & FRONT/REAR HOUSING

e. Press the Ball bearing in rear housing (Input shaft) using drift Pt. No. 2654 5890 3507 with handle Pt. No. 2640 5890 3511.

(Refer Fig. 22)

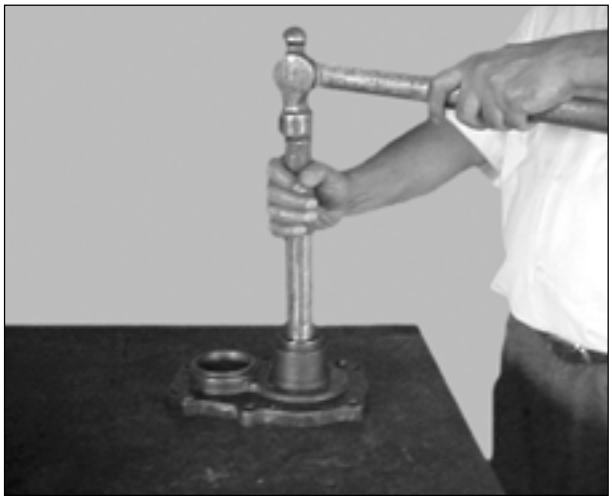


Fig. 22

f. **Shim Selection :**

- Measure the standout Dimension of bigger Taper Roller bearing outer race from Front housing face. Let the dimension be 'A'.
- Measure the depth of bigger Taper Roller bearing bore in Rear housing along with corresponding gasket. Let the dimension be 'B'.
- The required shim thickness will be B-A-axial float.
- Axial float is required in the range of 0.02 to 0.05 and preferably 0.03.

g. Assemble the shims and bigger taper roller bearing outer race in Rear housing.

(Refer Fig. 23)

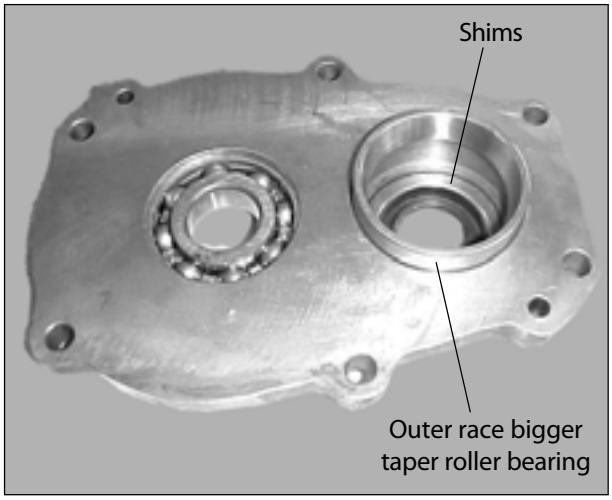



Fig. 23

h. Press the outer race of bigger taper roller bearing using drift 2654 5890 3507 with handle 2640 5890 3511

(Refer Fig. 24)



Fig. 24

## ASSEMBLY OF INPUT/OUTPUT SHAFT & FRONT/REAR HOUSING

i. Assemble the Spacer assembly in Rear housing using drift Pt. No. 2654 5890 3507 with handle Pt. No. 2640 5890 3511.

(Refer Fig. 25)



Fig. 25

j. Press the oil seal in rear housing using drift Pt. No. 2654 5890 3511.

(Refer Fig. 26)

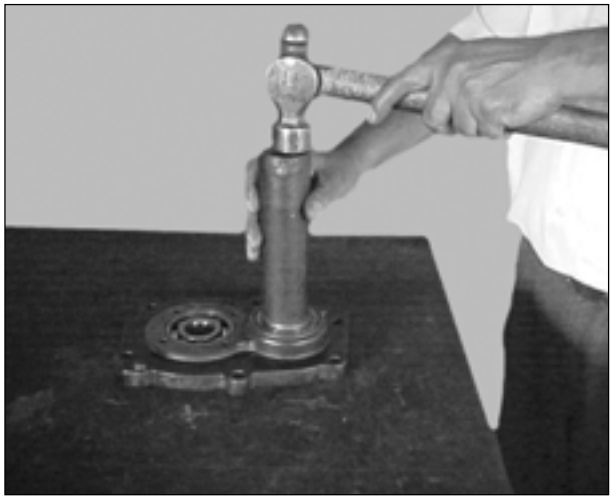


Fig. 26

## ASSEMBLY OF P.T.O.

**ASSEMBLY OF P.T.O. :**

1. Place the Front housing on a table.

   (Refer Fig. 27)

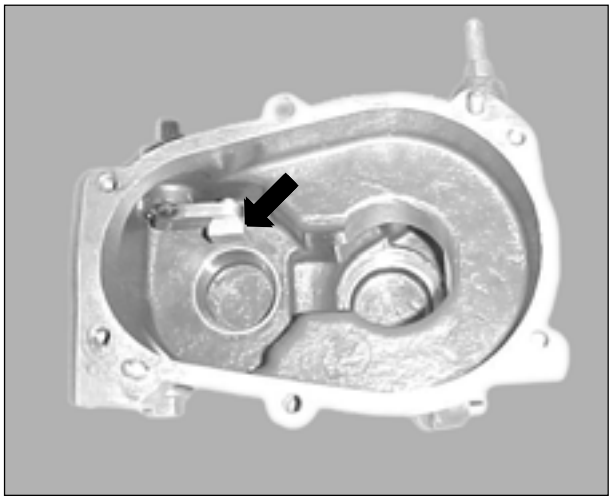


Fig. 28

2. Insert the Shift lever assembly in Front housing along with Brass pad and circlip.

   (Refer Fig. 28)

3. Insert output shaft assembly in front housing.

   (Refer Fig. 29)

4. Locate the brass pad in the sliding gear slot properly while the gear is butting against the inner race of smaller Taper roller bearing.

   (Refer Fig. 30)

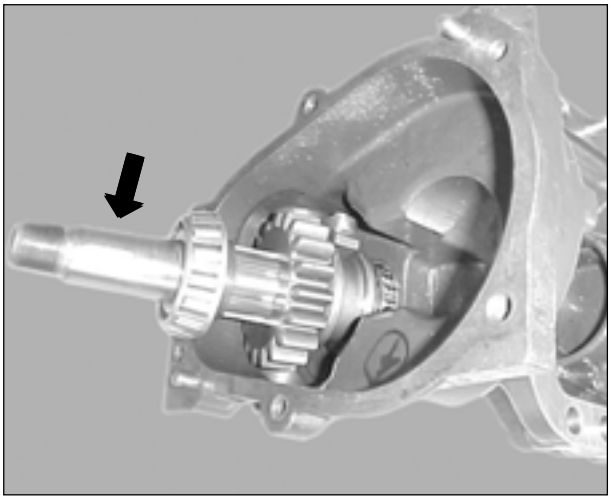


Fig. 29

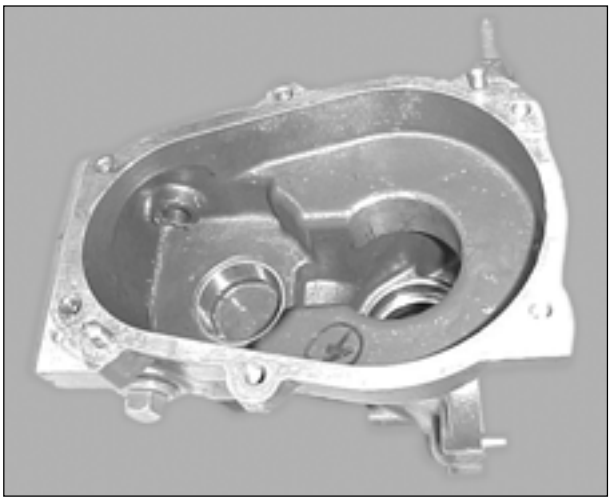


Fig. 27

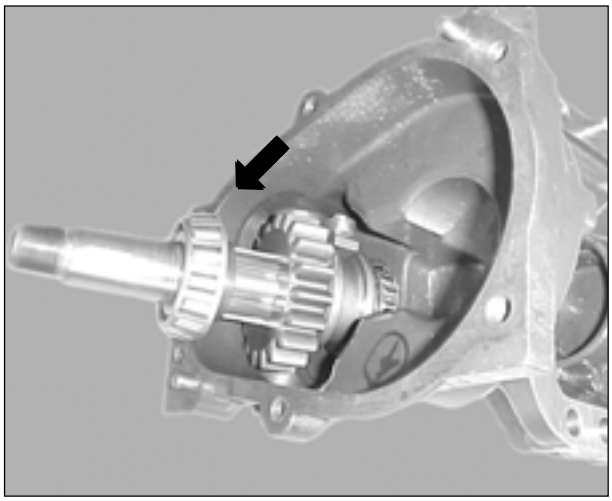


Fig. 30

## ASSEMBLY OF P.T.O.

5. Insert the input shaft assembly in front housing.

   (Refer Fig. 31)

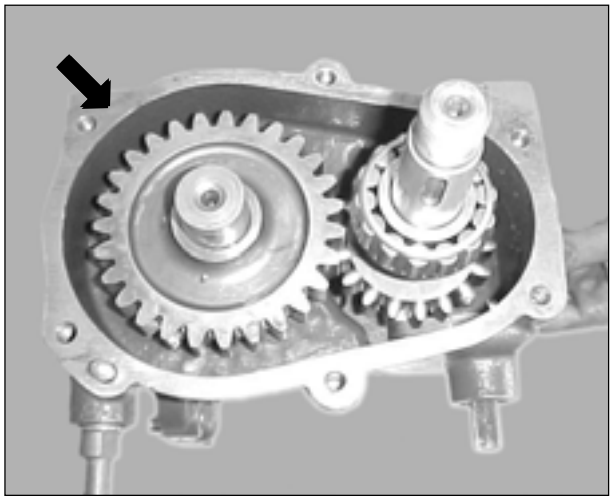


Fig. 32

6. Place the gasket on front housing.

   (Refer Fig. 32)

7. Put rear housing on front housing, press input shaft in rear housing ball bearing with drift 2654 5890 2605.

   (Refer Fig. 33)

8. Secure input shaft position with circlip by using plier.

   (Refer Fig. 34)

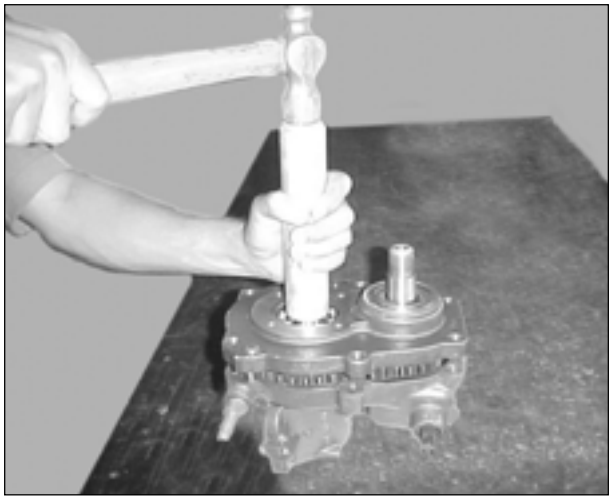


Fig. 33

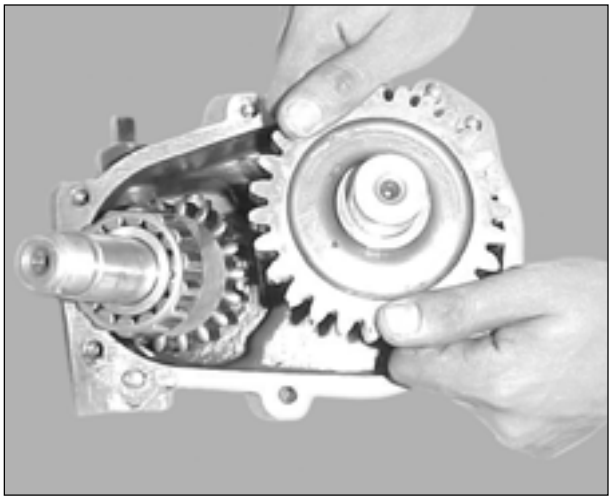


Fig. 31

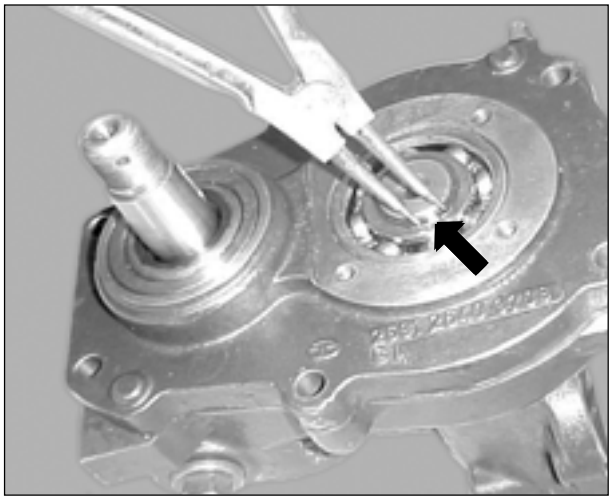


Fig. 34

## ASSEMBLY OF P.T.O.

9. Secure the two housings with bolts. Apply a tightening torque of 4.5mkg. using torque wrench.

   (Refer Fig. 35)

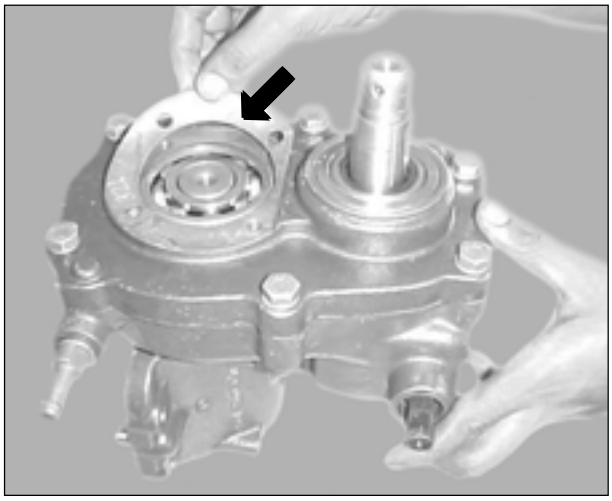


Fig. 36

10. Put the bearing cover gasket on rear housing.

    (Refer Fig. 36)

11. Put bearing cover and tighten the bolts to 2.3 mkg torque.

    (Refer Fig. 37)

12. Assembly the drain plug and tighten with 4.5mkg. Torque.

    (Refer Fig. 38)

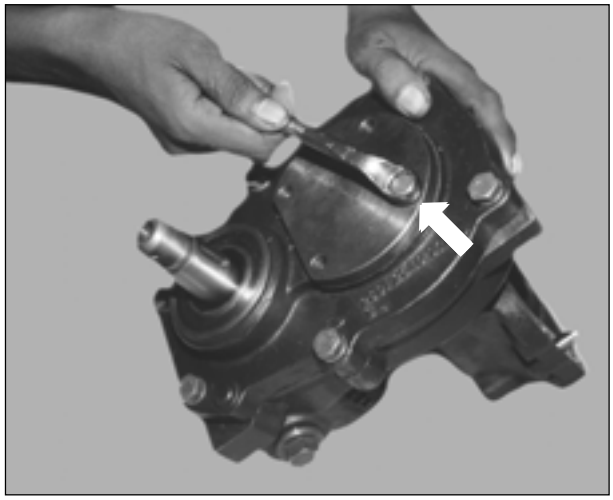


Fig. 37

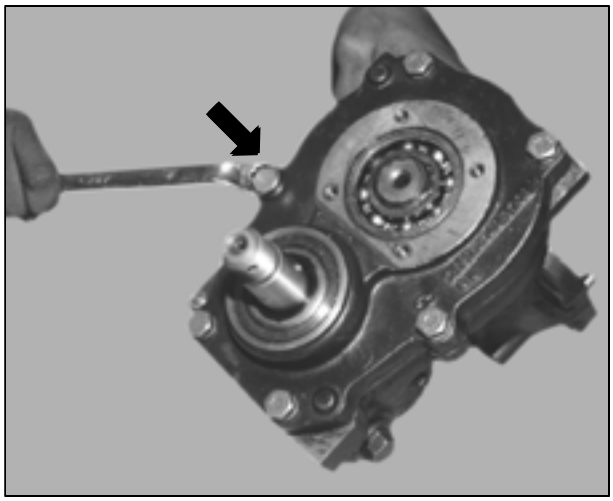


Fig. 35

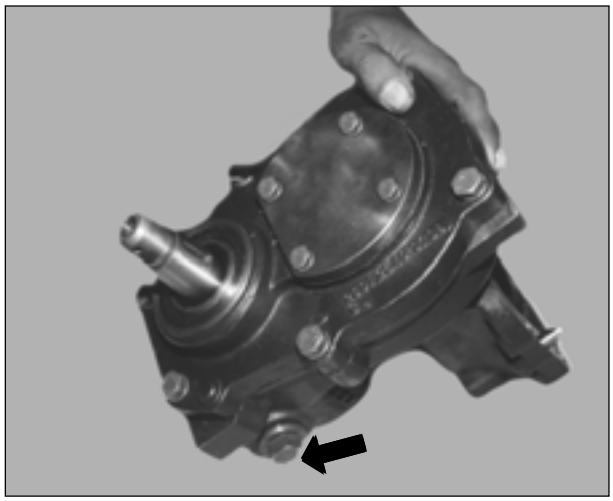


Fig. 38

## ASSEMBLY OF P.T.O.

13. Assemble the parallel key and secure it in position on Output shaft with a tape.

    (Refer Fig. 39)

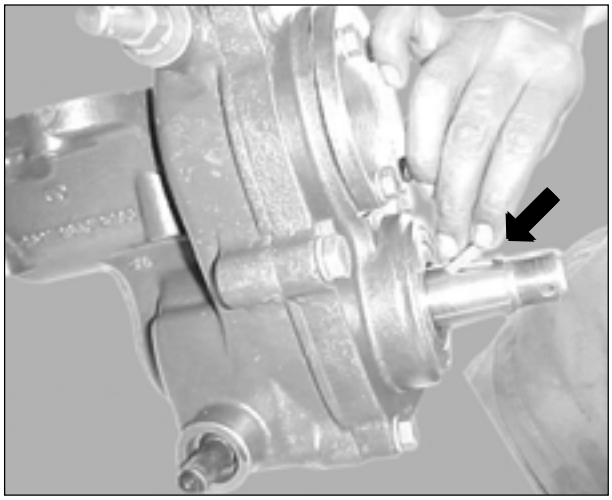


Fig. 39

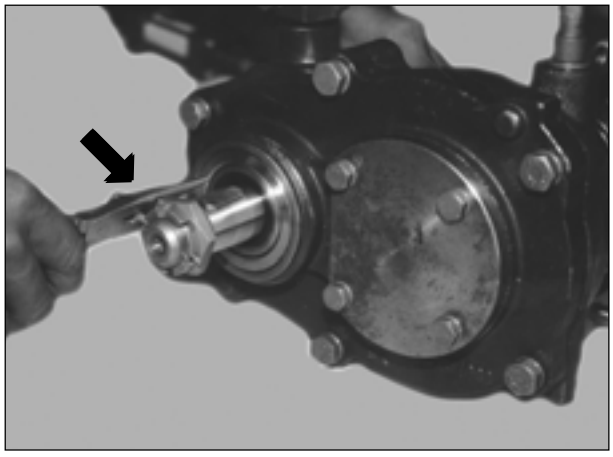


Fig. 40

14. Assemble the Castle nut and secure it with split pin.

    (Refer Fig. 40)

15. Assemble the Shift Cylinder assembly on P.T.O. unit and ensure that the sliding gear butts against inner race of Smaller Taper Roller bearing.

    (Refer Fig. 41)

16. Assemble the PTO unit on G-600 gearbox by screwing M10 fasteners (4 nos) & M10 studs & nuts (4 nos).

    (Refer Fig. 42)

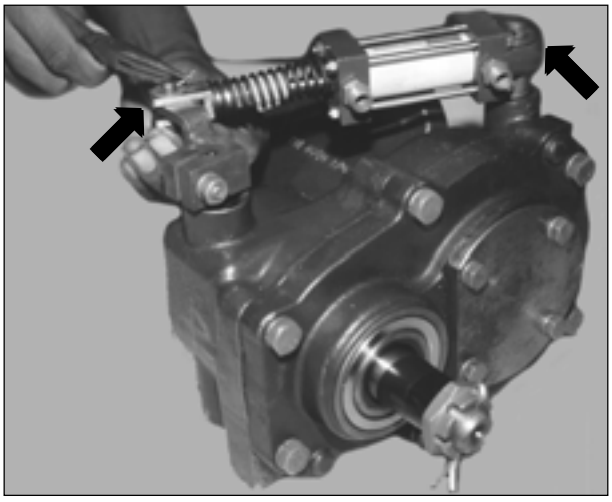


Fig. 41

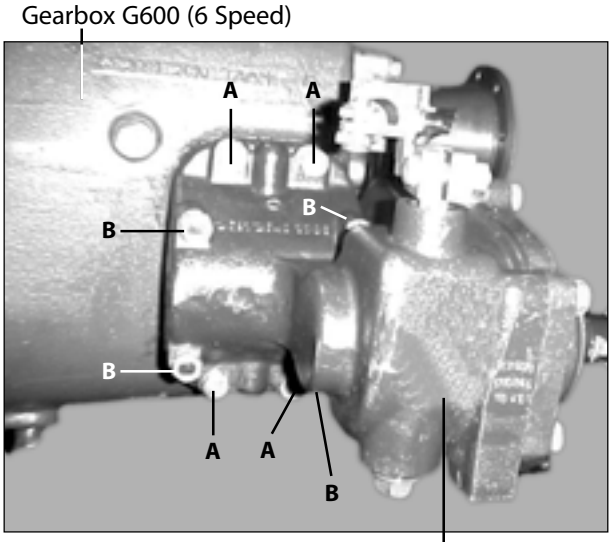



Fig. 42 A - M10 Bolts (4 Nos.)
B - M10 Nuts (4 Nos.)

# Transfer Case 28

## Contents


| | | Page No. |
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| 1 | a. Technical specifications | 3 |
| | b. Repair/adjustment data | 3 |
| 2. | List of special tools | 4 |
| 3. | Constructional details | 6 |
| 4. | Removal and installation of transfer case assembly | 9 |
| 5. | Dismantling, inspection and assembly of transfer case | 9 |

**a. Technical specifications**

Type : Constantmesh helical gear supported on taper roller bearings housed in ribbed cast housing suspended from chassis frame cross members with rubber bushes.

No. of speeds : 2

Gear ratios : 1.05: 1 High gear (For highway operation)
1.60: 1 Low gear (For cross country operation)

**b. Repair/adjustment data**

| | | |
|---|---|---|
| Blacklash between all mating gear | : | 0.2 ± 0.05 mm |
| Axial play of input shaft and idler shaft | : | 0.04 to 0.07 mm |
| Axial play of output shaft rear | : | 0.05 to 0.10 mm |
| Dimension between input shaft gear (small) face and front face of housing | : | 27.0 ± 01 mm |
| Dimension between idler gear front face and front face of housing | : | 28.0 ± 0.1 mm |

## SPECIAL TOOLS

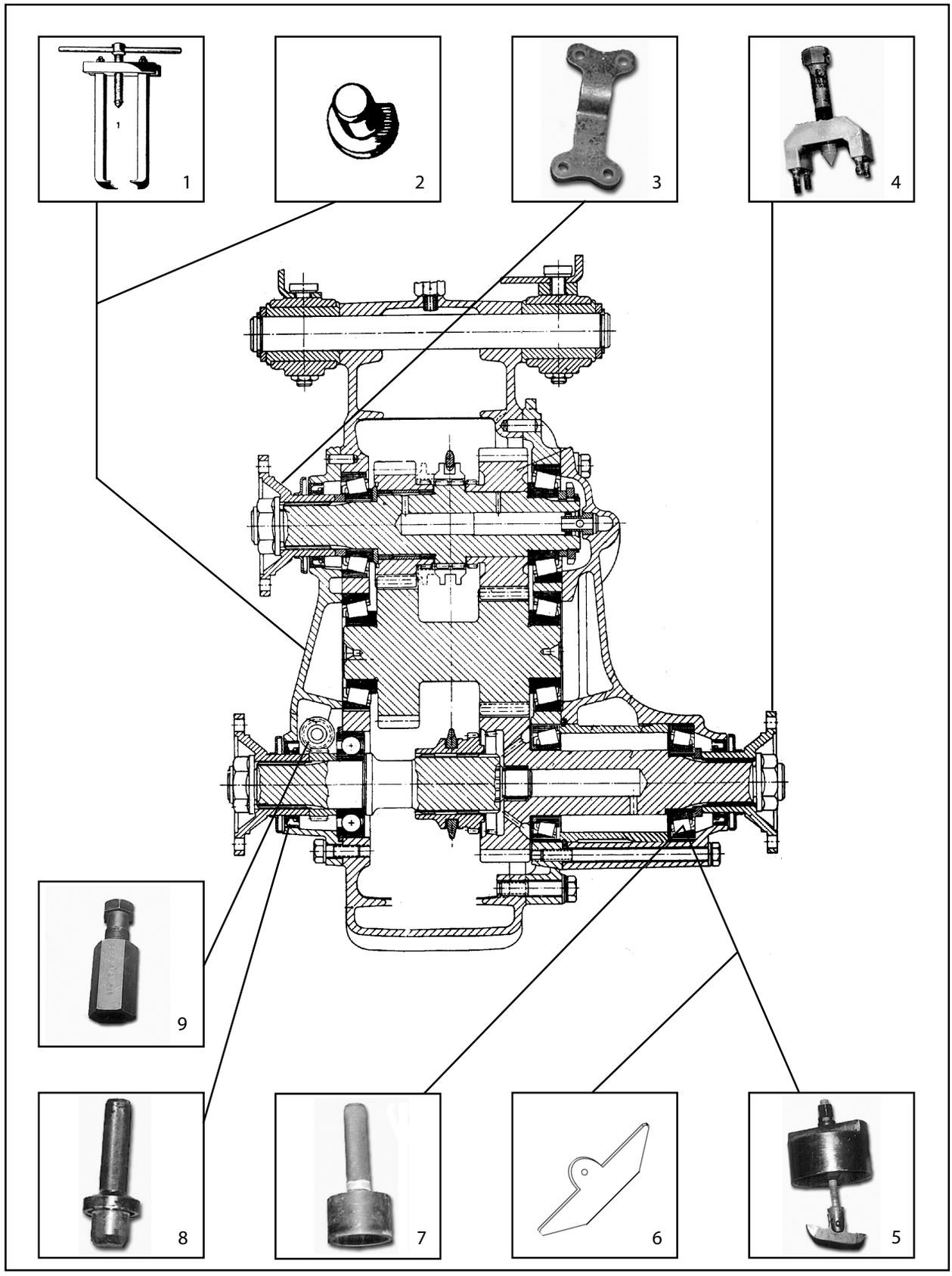



*Fig. 1*

**LIST OF SPECIAL TOOLS**

| Sr. No. | Description | Part Number |
|---|---|---|
| 1 | Puller for transfer case cover | 2505 5890 01 02<br>Or<br>(312 589 14 33) |
| 2 | Support piece (To be used with above tool) | 312 589 01 33 |
| 3 | Holder for coupling flange | 312 589 07 07 |
| 4 | Puller for coupling flange | 2574 5890 35 07<br>Or<br>(312 589 10 33) |
| 5 | Puller for removal of bearing with spacer tube from rear cover of transfer case | 312 589 23 33 |
| 6 | Rocker (For use with puller 312 589 23 33) | 012 589 00 33 J |
| 7 | Drift for installation of taper roller bearing in transfer case rear cover | 2505 5890 99 02<br>Or<br>(312 589 32 39) |
| 8 | Drift for removal and installing of transfer case cover oil seal | 312 589 16 39 |
| 9 | Puller for speedometer threaded bushing | 312 689 37 33 |

**Constructional details**

1. The transfer case suspended from the chassis cross-members behind the transmission, is designed for fitment on four-wheel drive vehicles (SA/SD). See fig. 2.
2. The transfer case has three coupling flanges- two in the front and one in the rear. See fig. 4.
3. The transmission coupling flange is connected to the front top coupling flange of the transfer case through a propeller shaft. See fig. 4. The sliding yoke of this propeller shaft is fitted at the transmission end.
4. The front bottom flange of the transfer case is connected to the tail pinion coupling flange of the live front axle through a second propeller shaft, having its sliding yoke at the transfer case end. See fig. 2.
5. The rear coupling flange of the transfer case is connected to the tail pinion coupling flange of the rear axle through a third propeller shaft having its sliding yoke at the transfer case end. See fig. 2.
6. One oil filler-cum-level check plug and one drain plug are provided in the transfer case housing. For recommended lubricants; please see group 00
7. The transfer case is flexibly mounted on the chassis cross members by means of rubber bushes.
8. The transfer case gears are operated by a gear shift lever located in the driver's cab to the left of the transmission gear lever and connected through linkage. The position of the transfer case gear lever for normal operation on high- ways and for cross country operation, are marked on its knob. See fig. 3.

   The transfer case gears are engaged through a sliding mesh mechanism similar to the one in the transmission.

***Note***

*The cross country gear of the transfer case is mainly intended for cross country driving and for operation on slippery roads.*

**Important**

The cross country gear should as far as possible be used only with the main transmission gears engaged in 1st or 2nd speed.

When engaging transfer case gears bring the vehicle to complete stop.

9. The internal constructional details of the transfer case are shown in fig. 4.

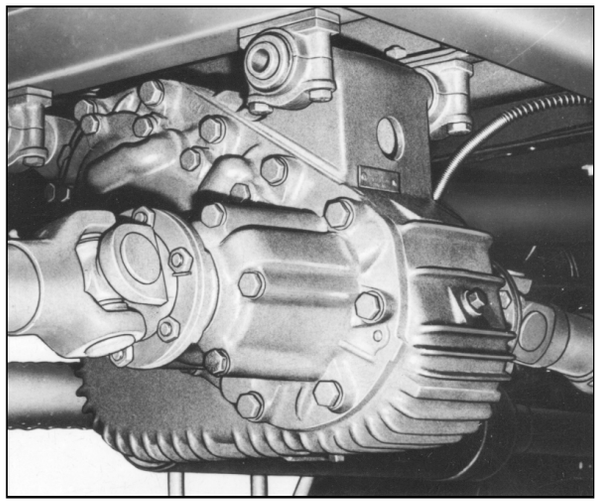


*Fig. 2*

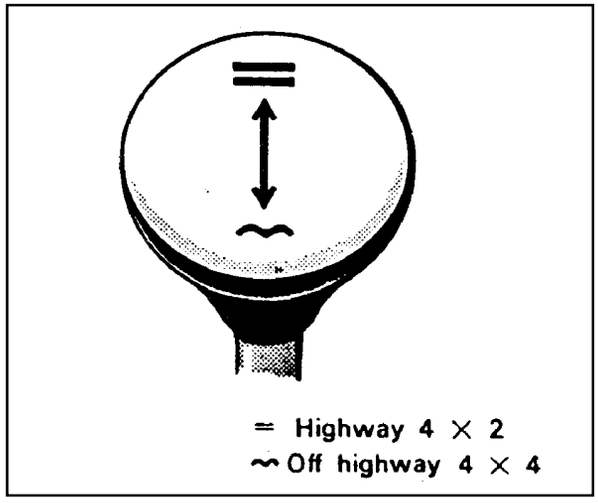
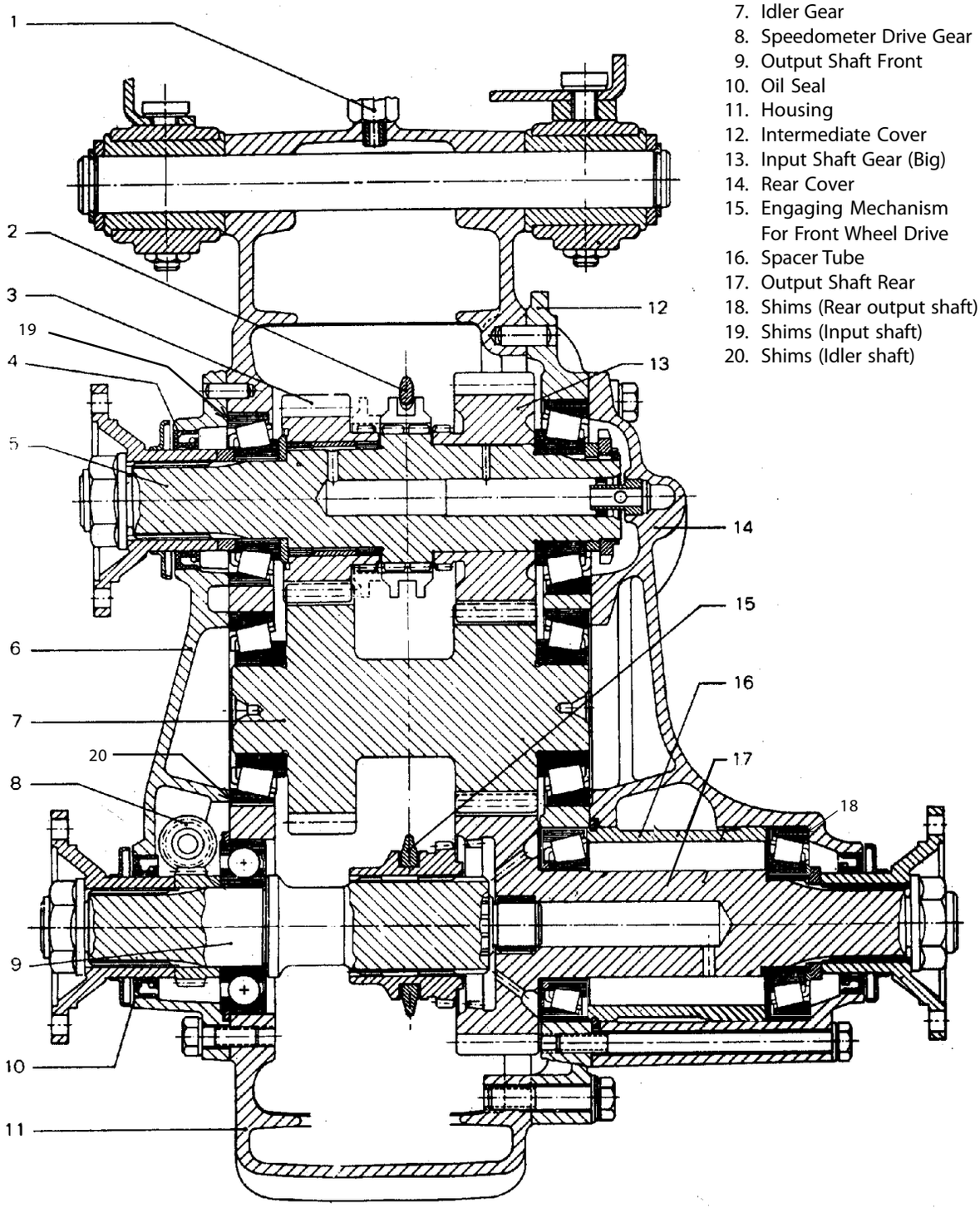



*Fig. 3*

***Note***

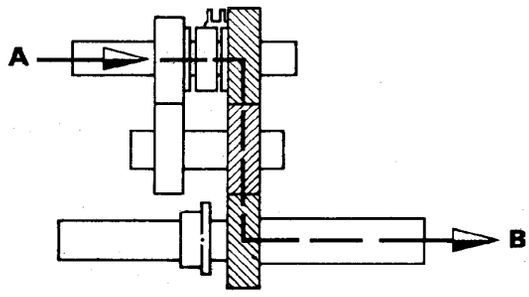
*The knob has to be fitted on the lever with the parallel lines running horizontally and facing front as shown in fig. 3.*

10. For details of the engaging mechanism and power flow, see fig. 5, 6 and 7.




1. Breather
2. Engaging Mechanism
3. Input Shaft Gear (small)
4. Oil Seal
5. Input Shaft
6. Front Cover
7. Idler Gear
8. Speedometer Drive Gear
9. Output Shaft Front
10. Oil Seal
11. Housing
12. Intermediate Cover
13. Input Shaft Gear (Big)
14. Rear Cover
15. Engaging Mechanism For Front Wheel Drive
16. Spacer Tube
17. Output Shaft Rear
18. Shims (Rear output shaft)
19. Shims (Input shaft)
20. Shims (Idler shaft)

*Fig. 4*



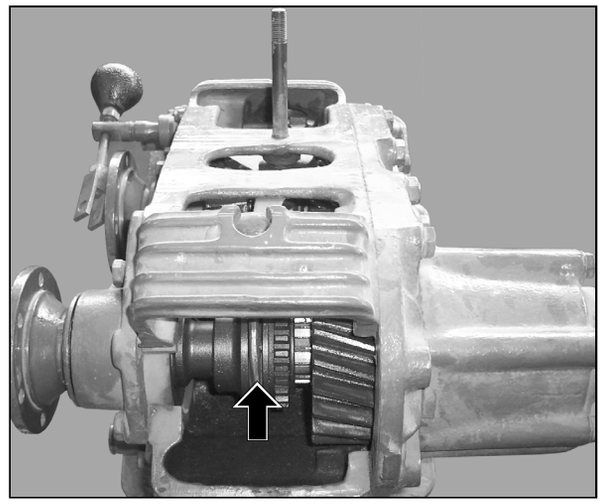
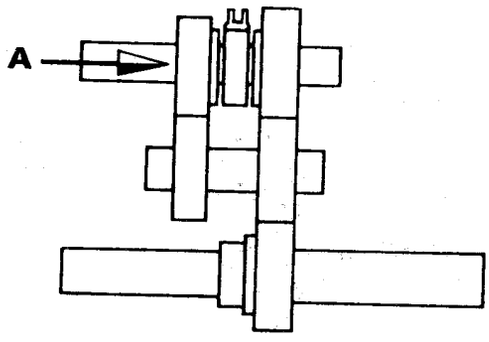



*Fig . 5 : Rear wheel drive for normal operation on highways*



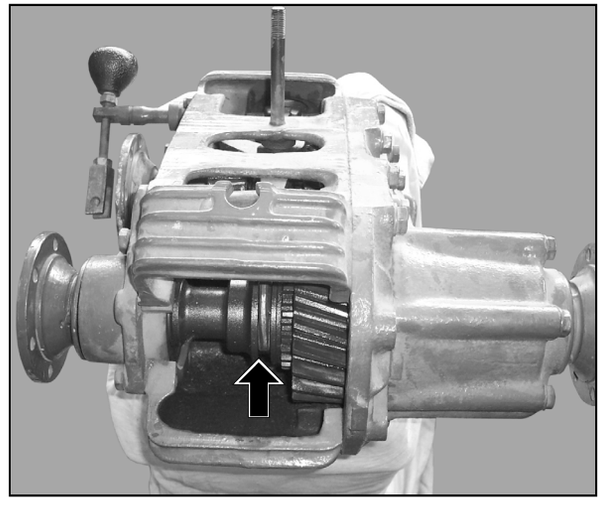
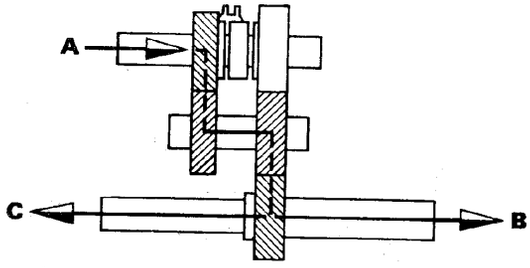



*Fig. 6 : Transfer case in neutral position*




A — Drive from gear box
B — Drive to rear axle
C — Drive to front axle

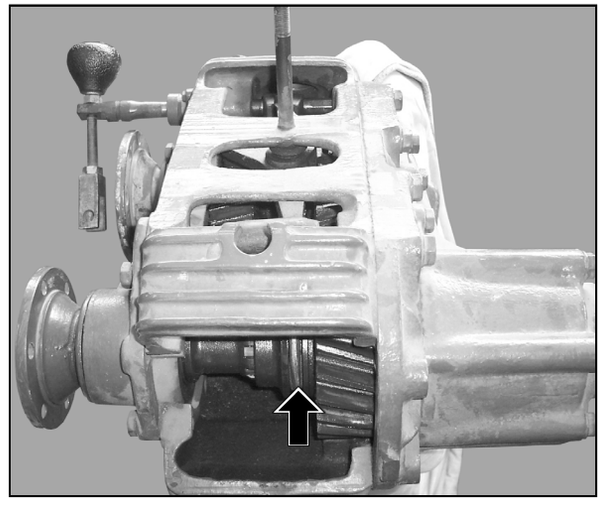


*Fig. 7 : Four wheel drive for cross country operation*

**Removal & installation of transfer case assembly**

**A. Removal**

1. Drain oil in a clean container while still hot and check for foreign matter.
2. Keep transfer case gear shift lever in neutral position.
3. Disconnect gear shift rod at the transfer case end.
4. Disconnect speedometer drive cable from transfer case.
5. Disconnect propeller shafts (3 nos.) from coupling flanges and lay them on one side.
6. Support the transfer case assembly suitably and loosen the mounting bolts. Remove transfer case from below the chassis.

**B. Installation**

1. Check condition of the rubber bushes of the mounting bars and replace, if necessary.
2. Carefully lift transfer case and mount it on the chassis by tightening the mounting bolts firmly.
3. Fit speedometer cable, propeller shafts and the gear shift rod.
4. Fill in recommended oil.
5. For recommended oils, please see group 00,
6. Road test the vehicle for smooth operation of transfer case in both the gears.

**Dismantling, inspection and assembly of transfer case**

(Transfer case removed from chassis)

**A. Dismantling**

1. Mount transfer case on work-stand
2. Remove split pins from the coupling flange nuts.
3. Mount special tool, part No. 312 589 07 07 see fig. 8. Engage in any gear. Unscrew the castle nuts and remove washers. Remove special tool, part- No: 312 589 07 07.
4. Mount puller, part No. 2574 5890 35 07 (or 312 589 10 33) on the coupling flanges and extract them from their shafts. See fig. 9. Mark the coupling flanges for refitment on the respective shaft.
5. Unscrew transfer case rear over, loosen cover slightly by tapping on the output shaft, rear, with a plastic mallet. See fig. 10.
6. Mount special tool, part No. 2505 5890 01 02 (or 312 589 14 3) and 312 589 01 33 and extract rear cover with spacer tube and taper roller bearing from output shaft rear. See fig. 11.

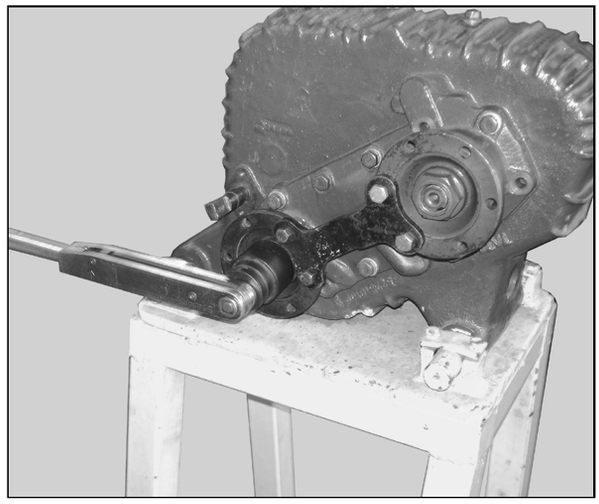


*Fig. 8*

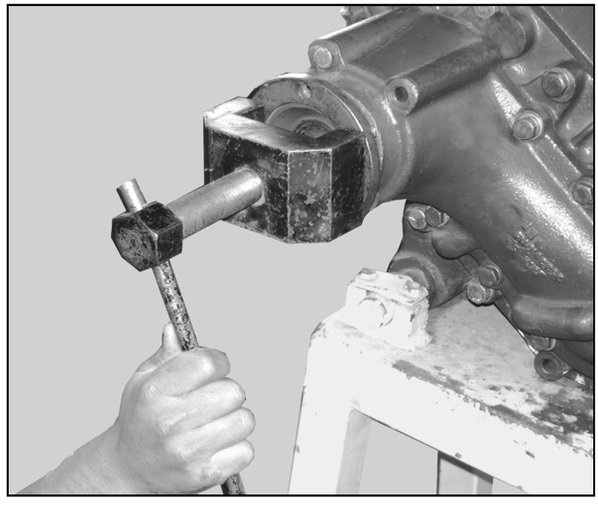


*Fig. 9*

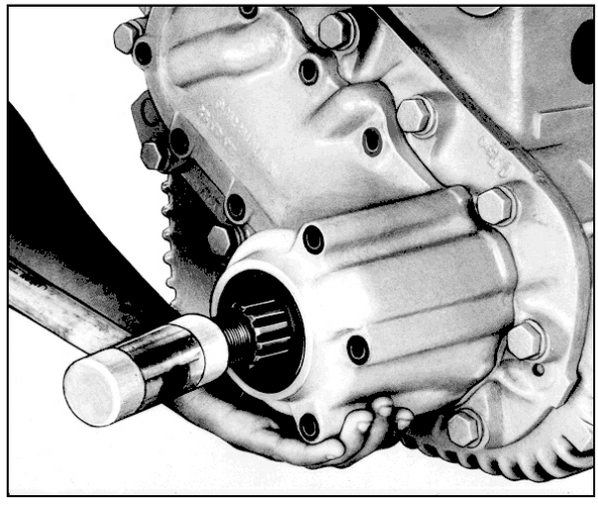


*Fig. 10*

7. Remove the shims from the outer races of the rear bearings.
8. Using special tool, part No. 312 589 23 33 and special tool. part No. 012 589 00 33 J remove taper roller bearing with spacer tube from rear cover. Remove thrust washer from rear cover.
9. With special tool, part No. 312 589 16 39, remove oil seal from rear cover.
10. Unscrew intermediate cover bolts and, with the help of two screwdrivers applied on lugs release the cover from dowel pins as shown in fig. 12.
11. Remove intermediate cover with outer races of (a) idler gear rear bearing (b) input shaft rear bearing and (c) the rear output shaft bearing.
12. Remove snap ring from the spacer tube.
13. Unscrew front cover bolts from housing and with the help of two screwdrivers. Release the cover from the dowel pins.
14. Remove thrust washers from input shaft.
15. Remove speedometer drive gear from output shaft.
16. With special tool, part No. 312 589 16 39, press out the two oil seals from the front cover. See fig. 13.
17. With special tool, part No. 312 589 37 33, remove the speedometer drive shaft threaded bushing from the front cover. Remove end plug from the bore of the speedometer drive shaft and press out speedometer drive shaft and remove the speedo drive gear.
18. Remove front output shaft, from housing by tapping with a plastic mallet. See fig. 14.
19. Pick out engaging mechanism for front wheel drive from the housing.
20. Press out ball bearing from output shaft front.

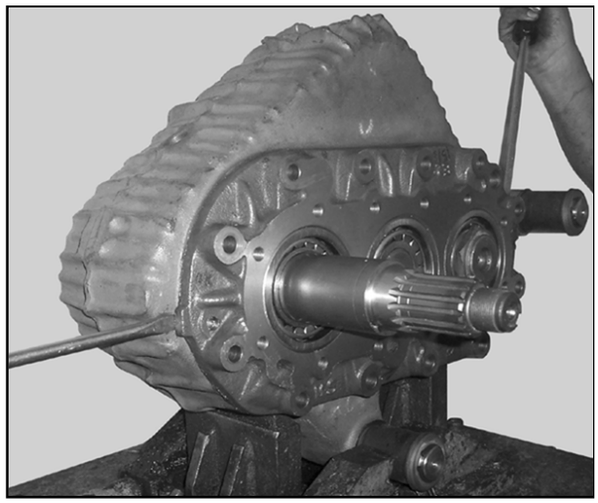


*Fig. 12*

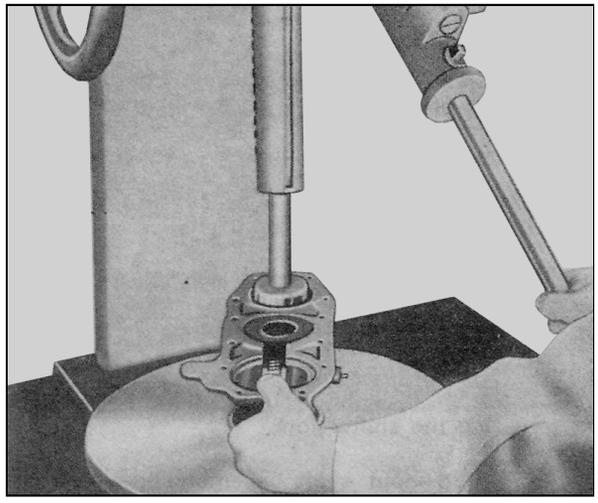


*Fig. 13*

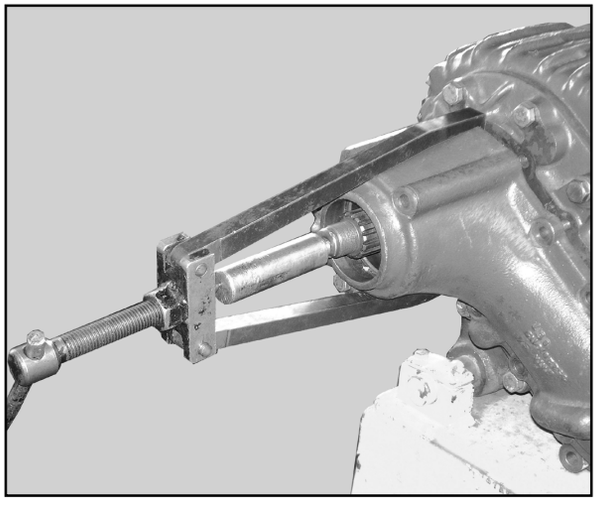


*Fig. 11*

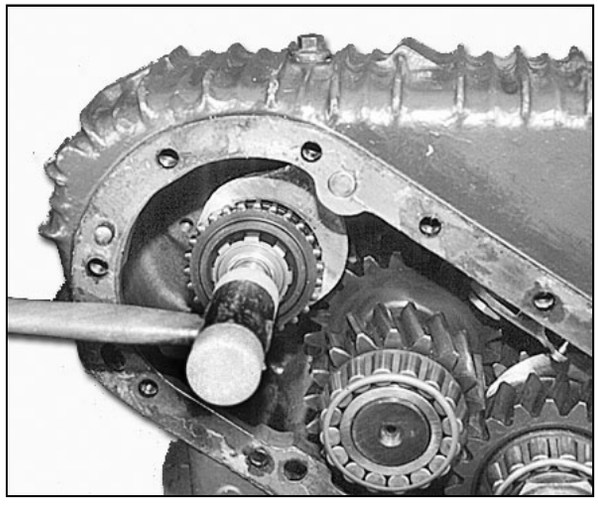


*Fig. 14*

21. Screw out plug with washer from the housing. See fig. 15.
22. Cut locking wire and unscrew the setscrew holding shifter fork on the input shaft.
23. Remove screw plug and pick out pressure spring and steel ball from the shifter mechanism (see fig. 16) and pull out shifter shaft from front end.
24. Unscrew flange bolts holding the shifter rod and remove dust boot, snap rings, felt washers and spacer. See fig. 17.
25. Hold shifter fork and tap out the input shaft assembly from front without damaging the shifter fork.
26. Hold input shaft assembly between soft jaws in a vice. Unstake and unscrew hex. nut on the rear end of the shaft and remove tongued thrust washer.
27. Support input shaft gear (big) and press shaft out of the rear bearing. See fig. 18. Remove thrust washer and input shaft gear (big).
28. Support input shaft gear (small) and press shaft out of the front bearing. See fig. 19. Remove thrust washer, input shaft gear (small) and the needle rollers with spacer bush. Remove sliding sleeve from input shaft. See fig. 20 for input shaft assembly components.
29. Knock out shifter shaft lever and remove shifter fork.
30. Remove split pin and unscrew castle nut holding shifting lever assembly in the housing. Remove shifting lever from the housing. See fig. 21. For shifting lever assembly components See fig 22.

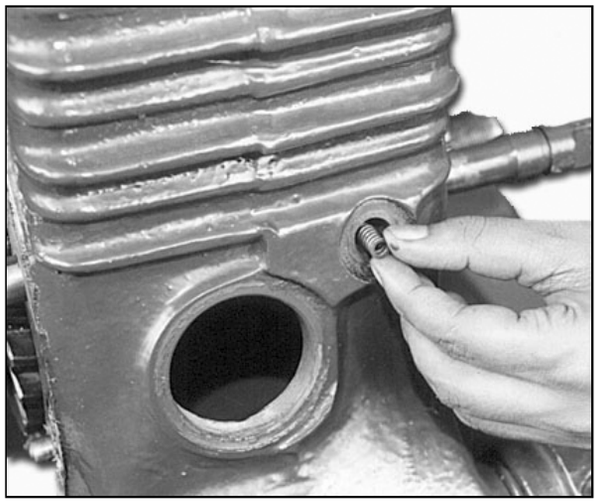


*Fig. 16*

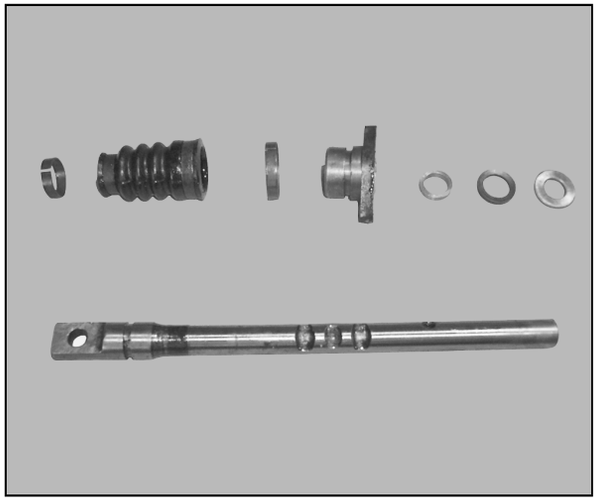


*Fig. 17*

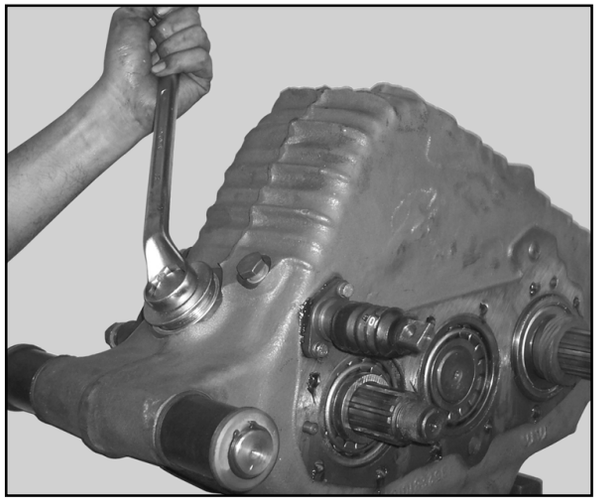


*Fig. 15*

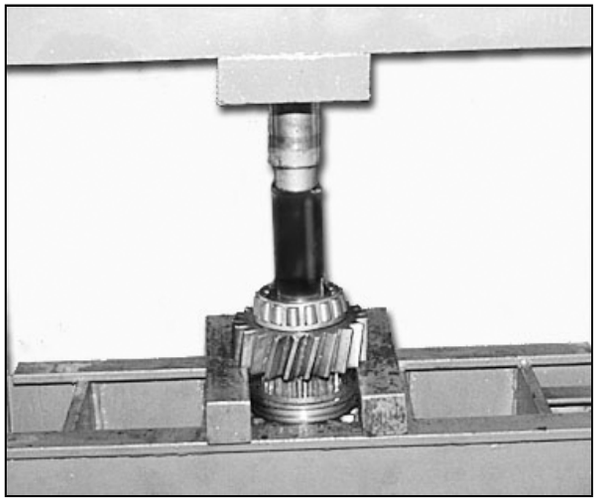


*Fig. 18*

31. Remove idler gear assembly from the rear end of housing and press out its bearing from housing. Press out bearing inner races from the idler gear.

**B. Inspection**

1. Clean all parts thoroughly and check bearings, bushes, gears, shafts, shifter mechanism and seals for wear and tear. Check bores of bearing in housing and covers. Replace all worn/damaged parts.
2. Check backlash between all mating gears and engaging sleeves and gears.

**C. Assembly**

**I. Sub-assembly of front, intermediate and rear covers:**

**a Front cover**

1. Press oil seals in the bores of the front cover with the help of special tool part No. 312 589 16 39. See fig. 23.
2. Insert speedo drive gear (lightly oiled) in front cover and press in speedo drive shaft and mount threaded bushing with special tool part No. 312 589 37 33.
3. Check for free movement of speedo drive gear on its shaft. Refit end plug in cover after coating with sealing compound.
4. Paste gasket on the cover, aligning the holes.

**b. Intermediate cover**

Fit outer races of (a) rear bearing on input shaft, (b) bearing of the output shaft, rear, and (c) rear bearing of idler gear in the appropriate bores in the intermediate cover. See fig. 4 for correct fitment of outer races.

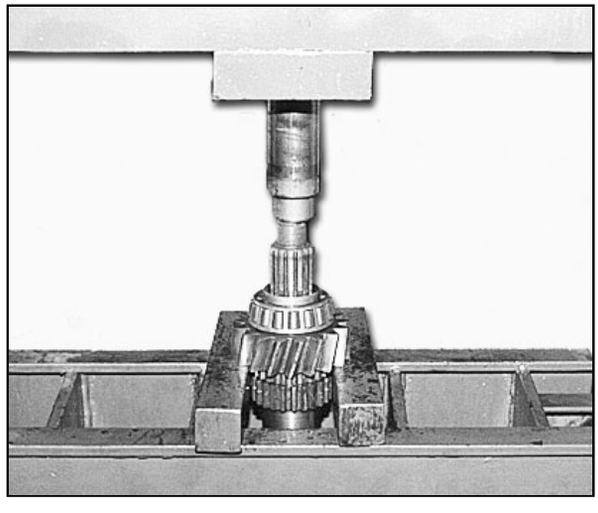


*Fig. 19*

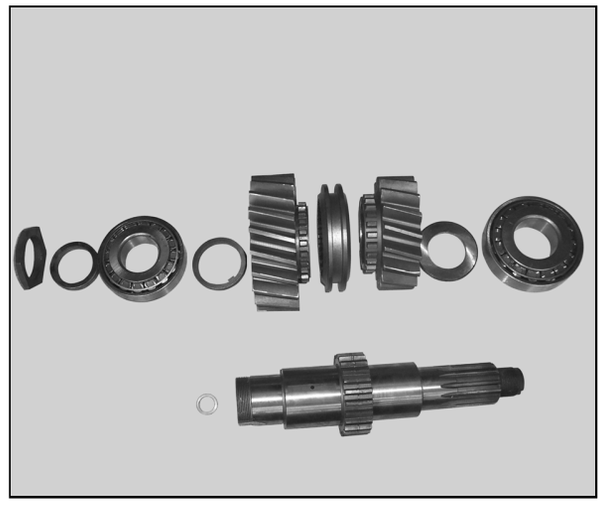


*Fig. 20*

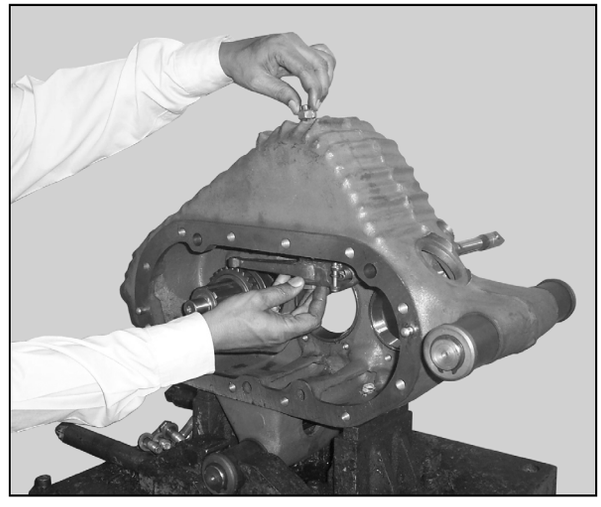


*Fig. 21*

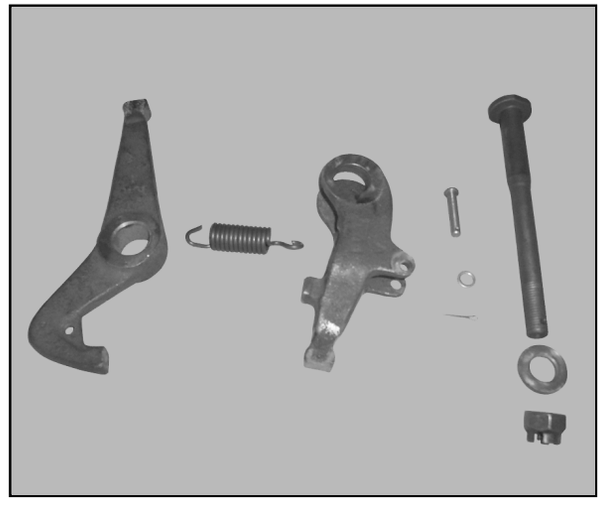


*Fig. 22*

**c. Rear cover**

1. Press oil seal in the cover with special tool, part No. 312 589 16 39.
2. Position thrust washer in the cover and press in taper roller bearing with special tool, part No. 2505 5890 99 02 (312 689 32 39).
3. Fit snap ring on spacer tube.
4. Select shims as follows to give an axial play of 0.03 to 0.05 mm
   a) measure the depth of bearing outer race from mating face of the cover with gasket plated over the cover. Let it be 'X'.
   b) measure the height of rear face of the spacer tube from the front face of the snap ring. Let it be 'Y'.
   c) Now select shims of total thickness within 0.03 to 0.05 mm less than the difference between X & Y. Shims are available in thicknesses of 0.05, 0.10, 0.20 & 0.40 mm.
5. Place the selected shims on ball bearing.
6. Press in spacer tube in the cover.
7. Paste gasket on the cover, aligning the holes.

**II. Sub assembly of input shaft**

1. Check that the oil passages in the input shaft are clear.
2. Lightly oil the bore of the input gear bigger diameter and slide it on the rear end of the input shaft with the engaging dogs towards the centre of the shaft.
3. Oil and press the inner race of the rear taper roller bearing on the input shaft with its thrust collar facing the gear.
4. Slide the tongued washer in the slot provided on the input shaft.
5. Fit a new collared hex nut. Tighten fully and stake the collar in the slot of the input shaft.
6. Slide engaging sleeve on input shaft.
7. Install spacer bush and 86 needle rollers on input shaft.
8. Oil and slide small gear on the needle rollers on the input shaft with the engaging dogs towards the sliding sleeve.
9. Oil and slide the thrust washer with the bigger diameter ground face towards the gear.

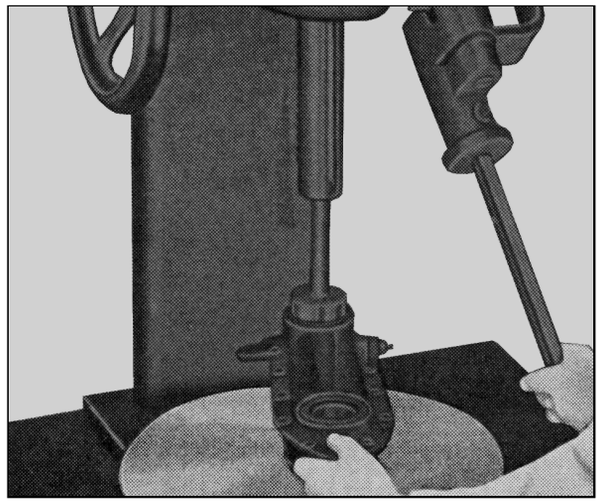


*Fig. 23*

10. Oil and press the inner race of the front taper roller bearing on the input shaft with its thrust collar facing the gear.

**III. Idler gear sub-assembly**

Oil and press the inner race of the front & rear taper roller bearings on the idler gear with their thrust collar facing the idler gear.

**IV. Output shafts, rear and front**

1. Check that the oil passages in the output shaft, rear are clear.
2. A cylindrical roller bearing is fitted in the inner bore of the output shaft rear. Oil and slide the bearing in the output shaft rear.
3. Check fit of spigot end of output shaft, front, in the bearing.
4. The radial clearance between spigot bearing and the spigot should be 0.1 mm to 0.3 mm.
5. Press ball bearing on output shaft, front with the sealed end of the bearing towards spigot end of the shaft.
6. Fit circlip in the groove provided on the bearing.

**V. Sub-assembly shifter shaft, upper**

1. Replace seals in mounting flange of shaft, upper.
2. Fit new dust boot and locate in position with snap rings.

**VI. Sub-assembly of shifting lever assembly**

Lightly oil the bores and the pin and assemble.

**VII. Assembly of transfer case**

1. Install the front taper roller bearing outer race of the idler gear in the front bore of the housing.
2. Position idler gear assembly in the housing with bigger gear towards the front.
3. Assemble shifting lever assembly in the transfer case housing and secure it with its castle nut.
4. Assemble input shaft in the housing from rear end till the front bearing is positioned in the housing bore.
5. Fit shifter shaft upper, with its fork, in the transfer case housing. Locate top end of the shifter lever in the slot provided in the fork, secure fork on shaft with set screw and lock with wire.
6. Mount flange of shifter shaft, upper, on transfer case.
7. Insert steel ball and pressure spring and screw on plug with washer.
8. Fit shifter shaft lower, with its fork in the housing and locate engaging mechanism for front wheel drive in the fork. See fig. 24. Connect fork with the lower end of the shifter lever.
9. Slide output shaft, front, from the front end of the housing aligning the splined end with the engaging sleeve and locate ball bearing in the housing bore till circlip flushes with the housing face.
10. Slide speedometer drive gear (big) on the output shaft front.
11. Mount thrust washer on input shaft.
12. Slide output shaft, rear, on its bearing in the intermediate cover. Oil the roller cage in the output shaft, rear, and align it on the spigot of the output shaft, front. Locate intermediate cover on its dowel pins. Tighten the mounting bolts evenly and equally, after coating the threads with sealing compound.
13. Tap input shaft with its bearing suitably to get a dimension of 27.0 $\pm$ 0.1 mm between input shaft gear front face to housing front face. Measure the depth of the bearing outer race from housing front face. The shims required for the front bearing is arrived by the adding the front gasket thickness to the measured depth. Shims for input shaft bearing are available in thicknesses of 0.05, 0.1, 0.2, 0.4 and 0.8 mm.

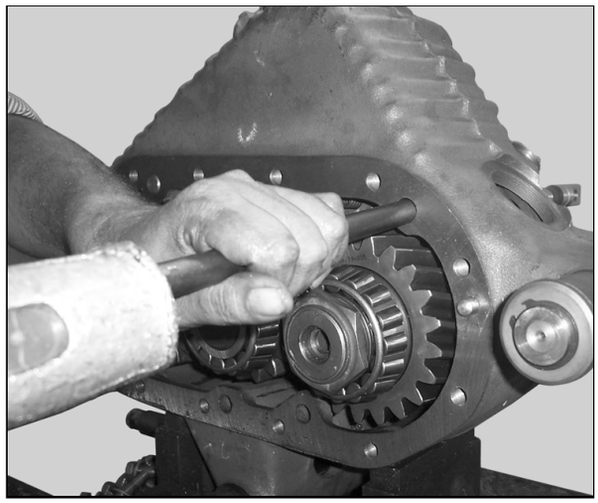


*Fig. 24*

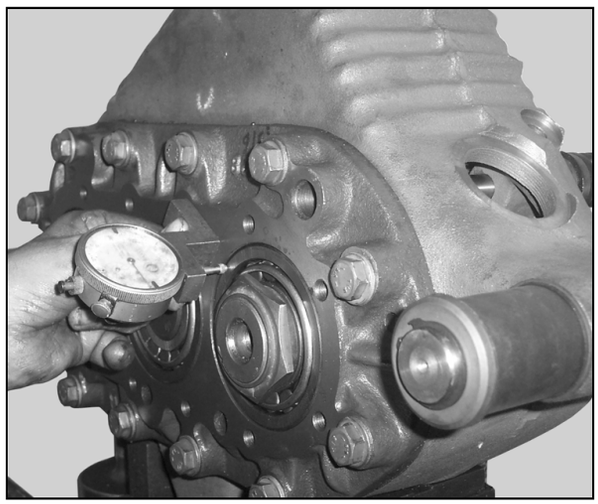


*Fig. 25*

14 Tap idler gear with its bearings suitably and select shims for the front bearing similar to input shaft bearing to get a dimension of 28.0 $\pm$ 0.1 mm between Idler gear to housing front face. Shims for idler gear bearings are available in thicknesses of 0.05, 0.1, 0.2, and 0.4 mm.

15. Fit front cover with gasket, taking care to align the speedometer drive gears and locate cover on dowel pin. Tighten the cover mounting bolts evenly and equally after coating their threads with, sealing compound.

16. For checking the axial play of the input shaft and idler gear, proceed as follows

    a. With a plastic mallet tap the rear faces of the input shaft and the idler gear, till they butt against the front cover.

    b. Similarly tap the rear outer bearing races of these shafts till they are seated.

    c. Using a dial depth gauge as shown in fig. 25, measure the depth of the outer races from the machined surface of the intermediate cover.

***Note***

*The axial play of these shafts should be adjusted to 0.04 to 0.07 mm, preferably 0.05 mm.*

**Example**

Measured depth: 0.3 mm; add shims of total thickness 0.25 mm to give an axial play of 0.05 mm.

17. Place the selected shims on the rear outer races of the input, idler and rear output bearings. Fit the rear cover, aligning the outer bearings of the output shaft, rear, with its spacer tube on the output shaft. Locate the oil nipple in the rear cover with the oil passage of the input shaft. Tighten cover bolts uniformly after coating their threads with sealing compound.

18. Check transfer case for smooth operation in all gears.

19. Fit appropriate coupling flanges on their shafts and fit washer on the couplings. Screw on castle nuts and tighten to correct torque as specified below and fit new split pins.

Castle nuts
on front coupling flanges : 30-36 mkg.
on rear coupling flange : 24-28 mkg.

## NOTES

# Suspension 32

# SUSPENSION 32

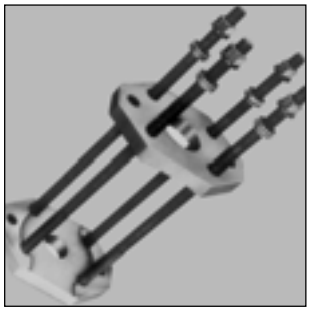
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**SPECIAL TOOLS**



*Spring pin puller*
*Part No.*
*2576 5890 32 02*
(For 1510/1612)



*Spring fixture*
*Part No.*
*2574 5890 42 01*

For lowered engine vehicles - 2573 5890 32 01

**REMOVAL AND INSTALLATION OF SUSPENSION**

**REMOVAL**

**Front Suspension**

1. Place wheel chocks in front of and behind rear wheels.
2. Place jacks under spring supports of front axle, Fig. 2.

   DO NOT PLACE SINGLE JACK UNDER CENTRE OF FRONT AXLE BEAM TO SUPPORT IT.
3. Jack up vehicle until front wheels are off the ground. Support frame by placing truck horses under frame long members behind front springs.
4. Loosen & remove shock absorber mtg. Bolt & nut from the mtg. Bracket on front axle.
5. Remove split pin, unscrew castle nut. Hold the shock absorber and remove shock absorber mounting bolt at top from mounting bracket on frame.
6. Remove shock absorber from its mountings along with spacers at the top.
7. Unscrew 'U' bolt lock nuts and nuts. Knock out 'U' bolts.

**Note:** Before removing 'U' bolt nuts ensure that front axle assembly is firmly and properly supported by jacks. Otherwise complete front axle assembly will come down suddenly.

8. Remove 'U' bolt bracket and rubber buffer.
9. Carefully lower front axle assembly using jacks.
10. Remove spring pin (front end) wedge screw and grease nipple.

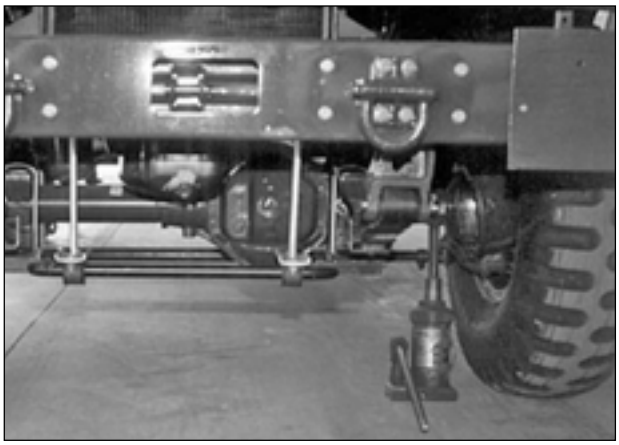


Fig. 2

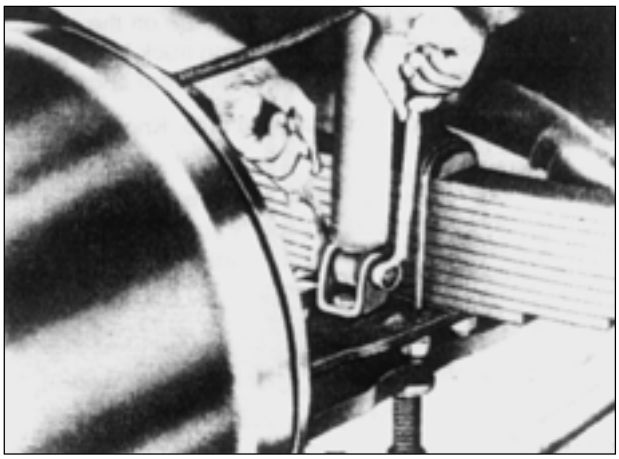


Fig. 3

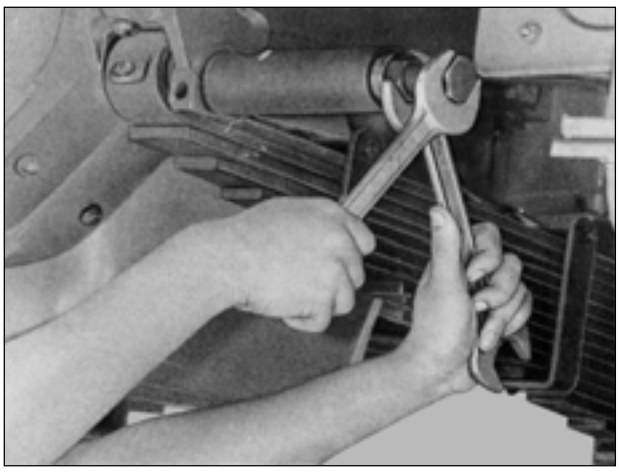


Fig. 4

11. Pull out spring pin (front end) with puller, 2576 5890 32 02. Fig. 4
12. Remove spacers and sealing rings.
13. Remove spring pin (rear end) wedge screw and grease nipple.
14. Take out Spring pin (rear end) by tapping it with a hammer.
15. Remove spacers and sealing rings.
16. Remove front spring assembly from the vehicle.
17. Remove caster plate (if fitted).
18. Remove hanger bracket pin wedge screw and grease nipple.
19. Hanger bracket pin can be taken out by tapping it with a hammer.
20. Remove shackle, spacers and sealing rings.

**REAR SUSPENSION**

1. Place wheel chocks in front of and behind front wheels.
2. Place jacks under spring supports of rear axle.

   DO NOT PLACE SINGE JACK UNDER REAR AXLE CENTRE HOUSING TO SUPPORT IT.
3. Jack up vehicle until rear wheels are off the ground. Support frame by placing truck horses under frame long members behind rear springs.
4. Unscrew 'U' bolt lock nuts and nuts. Knock out 'U' bolts.

   **Note:** Before removing 'U' bolt nuts ensure that rear axle assembly is firmly and properly supported by jacks. Otherwise complete rear axle assembly will come down suddenly.
5. Remove 'U' bolt bracket.
6. Carefully lower rear axle assembly using jacks.
7. Remove spring pin wedge screws and grease nipples of both front and rear end. Spring pins can be removed by tapping them with a hammer.
8. Remove spacers and sealing rings.
9. Remove rear spring assembly from the vehicle.
10. Remove spring hanger bracket pin wedge screw and grease nipple.
11. Hanger bracket pin can be removed by tapping it with a hammer.
12. Remove shackle, spacers and sealing rings.

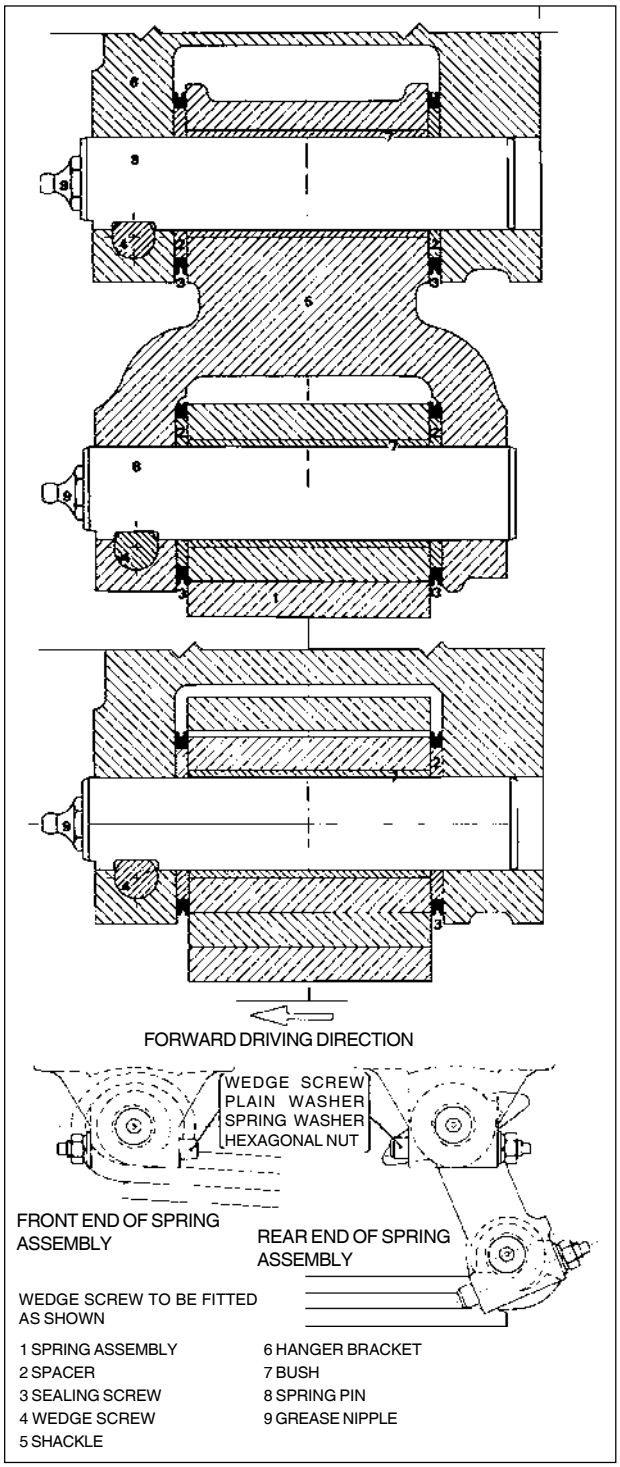



Fig. 5

e. Bushes.
f. Front spring rubber buffer.
g. 'U' bolt bracket.
h. 'U' bolt / 'U' bolt threads.
i. Shock absorber rubber bush.
j. Shock absorbers.

**INSTALLATION**

1. Check condition of following components. If found worn/damaged, replace them.

a. Spacers and sealing rings.

b. Shackle and hanger bracket pin support surfaces.

c. Hanger bracket pins.

d. Spring pins.

2. For installation proceed in reverse order of removal.

3. Following additional care is needed:

a. Direction of wedge screw and its locking nut should be as shown in Fig 5.

b. Caster plate (if fitted) should be fitted in such a way that thicker end is facing towards front. Fig. 6.

c. Install various bushes, spacers and sealing rings. Fig. 5.

d. Tighten 'U' bolt nuts/lock nuts to 35 mkg torque and the shock absorber mounting bolts to 10 mkg torque.

e. Install front springs in correct position.

f. Use new split pins to lock the castle nuts on shock absorber mounting bolts.

**DISASSEMBLY, INSPECTION AND ASSEMBLY PROCEDURE FOR FRONT AND REAR SPRINGS**

**Disassembly**

1. Clamp spring assembly in fixture 2574 5890 42 01. Fig. 6.
2. Remove spring clamp bolts, nuts, spacers and clamp.
3. Unscrew and remove spring centre bolt nut.
4. Release spring assembly by unscrewing fixture nuts slowly, alternately and crosswise.
5. Remove spring leaves.

**Inspection**

1 Check condition of spring leaves. Replace cracked/worn/broken leaves with new ones.

2. Check condition of bush in spring main leaf. Replace worn out bushes with new ones.

**Assembly**

1. Coat upper surface of spring leaves with recommended grease.
2. Assemble spring leaves in fixture, 2574 5890 42 01 on centre bolt. Fig. 6.
3. Clamp spring leaves together by screwing in fixture nuts slowly, alternately and crosswise.
4. Tighten centre bolt nut.
5. Assemble spring clamps, bolts spacers and nuts. Fig. 5.

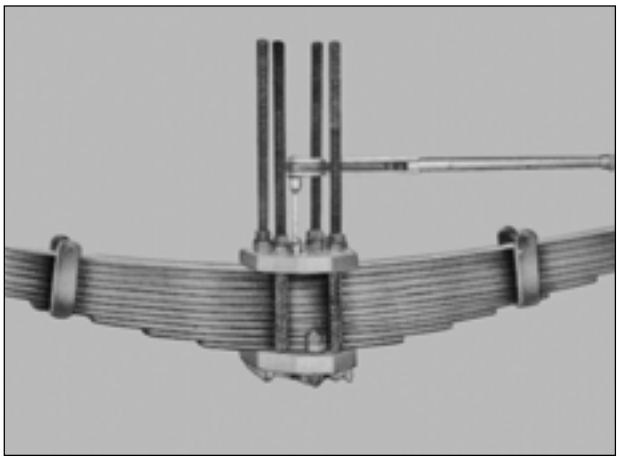


Fig. 6

## NOTES

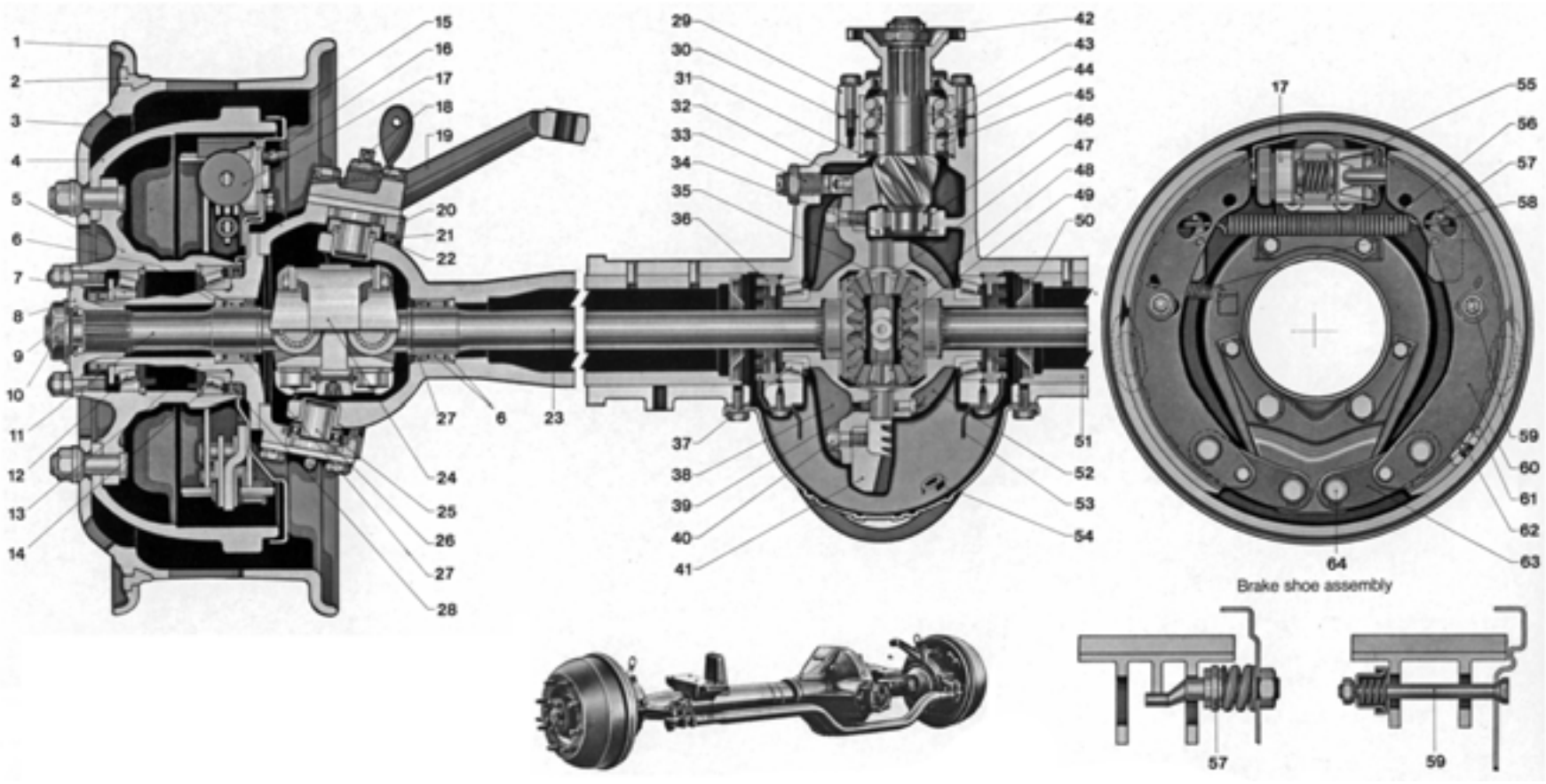
# Front Live Axle 33A

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Fig. 1

## Front Live Axle FA-104




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Side ring | 14 | Inner taper roller bearing | 27 | Sealing ring | 40 | Hex. bolt tack welded | 53 | Lock plate |
| 2 | Lock ring | 15 | Anchor plate | 28 | Sealing ring | 41 | Crown wheel | 54 | Oil filler cum level plug |
| 3 | Wheel rim | 16 | Bleeding screw | 29 | Bearing retainer flange | 42 | Coupling flange | 55 | Shield wheel cylinder |
| 4 | Drum | 17 | Brake wheel cylinder | 30 | Shims (for adjusting pinion bearing pre-load) | 43 | Angular contact ball bearing | 56 | Brake shoe return spring |
| 5 | Hub | 18 | Grease nipple | 31 | Shims (for adjusting pinion depth) | 44 | Tail pinion | 57 | Adjusting cam assy. |
| 6 | Spacer ring and Needle bearing | 19 | Steering arm | 32 | Thrust pad | 45 | Cylindrical roller bearing | 58 | Brake shoe return spring |
| 7 | Tongued spacer | 20 | Seal holder inner | 33 | Thrust screw | 46 | Cylindrical roller bearing | 59 | Brake shoe holding screw assy. |
| 8 | Coupling flange | 21 | Rubber Seal | 34 | Snap ring | 47 | Differential spider gear | 60 | Brake shoe |
| 9 | Spacer | 22 | Seal holder outer | 35 | Spherical washer | 48 | Thrust washer | 61 | Brake lining |
| 10 | Collar nut | 23 | Axle shaft inner | 36 | Threaded adjusting ring | 49 | Axle shaft gear | 62 | Rivet |
| 11 | Axle shaft outer | 24 | Universal joint assembly | 37 | Differential side bearing | 50 | Oil deflector | 63 | Link |
| 12 | Outer roller bearing | 25 | Thrust roller bearing | 38 | Differential cage | 51 | Axle tube | 64 | Anchor pin |
| 13 | Carrier sleeve | 26 | King pin | 39 | Differential spider | 52 | Differential cage cover | | |

**a. Technical specifications**

Type : FA-104 (Live axle), fully floating type.

Drive : Palloid (Gleason design)

| Gear ratio | 6.83:1 | 5.29:1 | 5.86:1 |
|---|---|---|---|
| Number of teeth on crown wheel | 41 | 37 | 41 |
| Tail pinion | 6 | 7 | 7 |

Rated capacity : 3,500 kg. (for 1210SD)
4,060 kg. (for 1210SA)

**b. Repair/adjustment data**

i. Maximum run out of wheel bearing seats on support sleeve : 0.05 mm

ii. Radial clearance between king pin and bush : 0.03 to 0.07 mm

iii. End play of swivelling joint on axle tube : No Play

iv. Axial play of front hub bearings : 0.02 to 0.04 mm

v. Front wheel alignment data :

| | | 1210 SA | 1210SD |
|---|---|---|---|
| Toe-in | : | 0 to 3 mm | 0 to 3 mm |
| Caster | : | $1^0 \pm 30'$ + ve | $1^0 \pm 30'$ + ve |
| Camber | : | $1^0$ + ve | $1^0$ + ve |
| King pin inclination | : | $9^0$ - 30′ | $9^0$ - 30′ |
| Wheel lock angel | : | $36^0$ | $36^0$ |

vi. Preload on tail pinion bearings : 0.05 mm

vii. Backlash between differential spider gears and axle shaft gears : 0.2 to 0.3 mm

viii. Maximum permissible lateral run out of crown wheel : 0.06 mm

ix. Backlash between crown wheel and tail pinion : 0.14 to 0.25 mm

x. Thrust pad adjustment clearance (screw in thrust pad till it touches crown wheel and screw out by 1/6th of a turn and tighten check nut) : 0.25 mm

**2. Special tools**

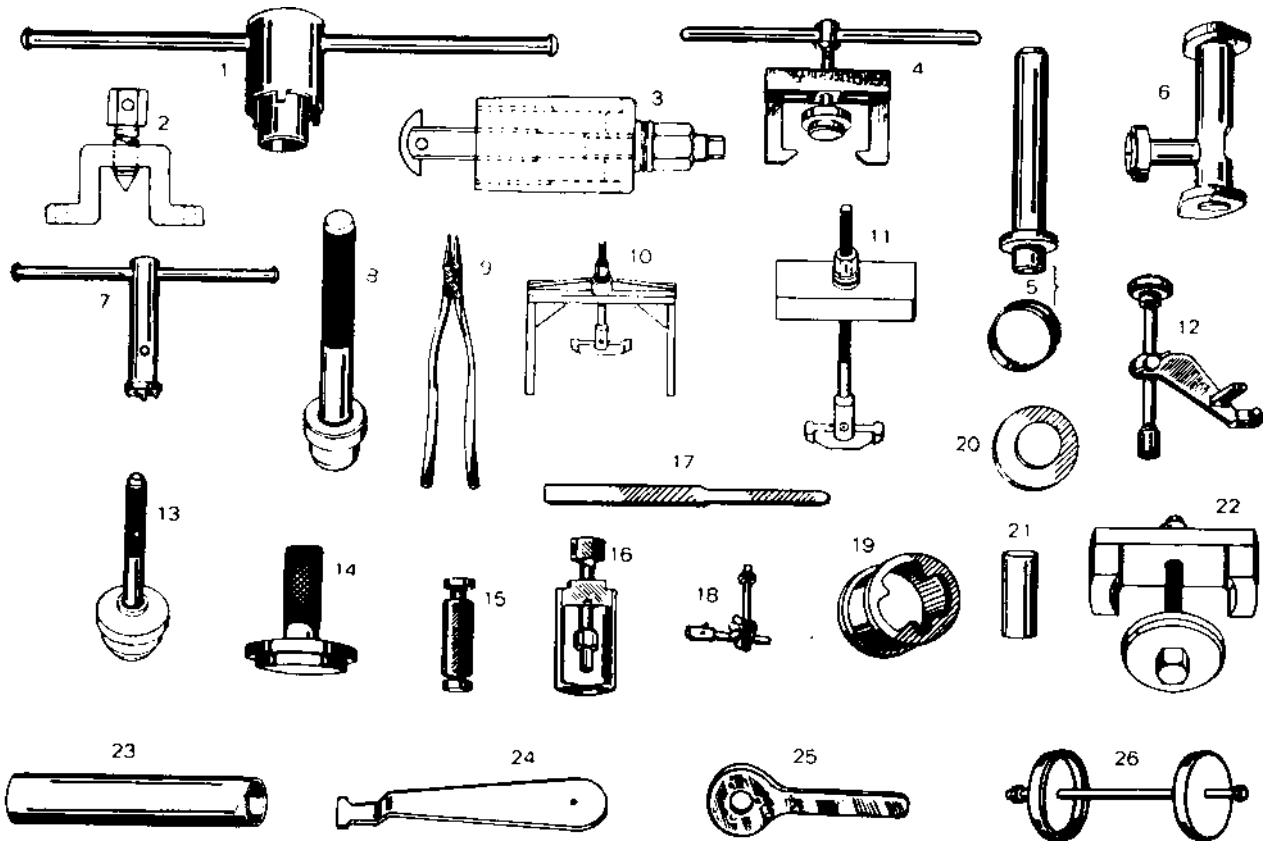



*Fig. 2 Special tools*

**List of special tools (See fig. 3)**

| Sr. No. | Description | Part No. |
|---|---|---|
| 1. | Wrench for slotted nut | 312 589 06 07 |
| 2. | Puller for hub | 2574 5890 33 02 |
| 3. | Puller for needle roller bearings, oil seal and spacer | 2574 5890 33 01 |
| 4. | Puller for differential side bearing | 312 589 20 33 |
| 5. | Drift for removal and installation of tail pinion spigot bearing outer race | 312 589 35 39 |
| 6. | Fixture for checking tail pinion depth | 312 589 00 21 |
| 7. | Wrench for front axle collar screw | 312 589 05 07 |
| 8. | Drift for installing roller bearing, seal and spacer in ball head support sleeve | 2574 5890 33 03 |
| 9. | Special plier for removal and installation of snap rings inner and outer, front hub | 312 589 00 31 |
| 10. | Puller for hub inner bearing with grease retainer | 2574 5890 33 05 |
| 11. | Puller for outer taper roller bearing in hub | 2574 5890 33 04 |
| 12. | Dial gauge holder for wheel bearing adjustment | 321 589 00 21 |
| 13. | Drift for installing outer race of outer taper roller bearing in hub | 2574 5890 35 03 |
| 14. | Drift for installing outer race of inner taper roller bearing in hub | 2574 5890 35 02<br>or<br>312 589 30 39 |
| 15. | Extractor for king pin bushings | 312 589 03 35 |
| 16. | Puller for drag link and tie rod ball joints | 312 589 06 33 |
| 17. | Wrench for threaded rings on differential side bearings | 312 589 04 07 |
| 18. | Dial gauge holder for checking backlash of crown wheel | 312 589 04 63<br>(2573 5890 3501) |
| 19. | Support for extraction of tail pinion bearings | 312 589 02 35 |
| 20. | Drift for installation of oil seal in tail pinion flange cover | 312 589 12 39 |
| 21. | Drift for tail pinion spigot bearing inner race | 2574 5890 99 04<br>or<br>312 589 01 35 |
| 22. | Puller for tail pinion cylindrical roller bearing outer race | 012 583 00 99J |
| 23. | Drift for installation of tail pinion bearings<br>(Inner race of cylinder roller bearing and double row ball bearing) | 312 583 14 39 |
| 24. | Adjusting gauge for wheel lock angle $36^0$ | 2574 5890 33 06 |
| 25. | Tail pinion flange holding device | 321 589 01 31 |
| 26. | Clamping device for differential taper roller bearing outer race | 042 583 00 82J<br>or<br>012 583 00 82J |

**3. I. Constructional details**

i. The front axles (FA-104) fitted on 1210 SA and 1210 SD vehicles are live axles capable of transmitting power to front wheels whenever required. See fig. 1.

ii. The differential assembly of FA-104 type front axle is of 312 designs and therefore, not inter-changeable with the differential assembly of 1210 type.

iii. The differential assembly along with the crown wheel and tail pinion is housed in the malleable cast iron centre housing. The crown wheel and tail pinion are Palloid gears of Gleason design. The crown wheel has 41 teeth and tail pinion has 6 teeth to give a final ratio of 6.83:1.

***Caution :*** *Crown wheel and tail pinion are lapped in sets and set numbers are etched on them for proper identification. Do not interchange individual crown wheel and tail pinion. Always use the crown wheel and tail pinion of same set nos.*

iv. The differential assembly comprises a two piece differential carrier, a differential spider with four bevel gears, 2 axle shaft gears, 2 brass thrust washers, and 4 spherical washers. The two mated halves of the differential carrier are bolted together and secured by locking with wire.

v. The crown wheel is bolted to differential carrier and the bolt heads are secured by tack welding by arc welding.

vi. The differential side bearing bores in the centre housing as well as the threading in these bores for crown wheel and tail pinion backlash adjustment are line bored and threaded after bearing caps are located in the housing. This construction ensures,

   a. An accurate alignment of the side bearing bores.

   b. Accuracy of machining of the parent bore diameter and

   c. Correct fit of the screw threads of cap and bore.

   Because of this construction the side bearing caps are not serviced separately nor should they be interchanged from left to right or replaced by side bearing caps from another centre housing.

vii. The differential carrier assembly is supported on two taper roller bearings with the inner races pressed on the seats machined on the differential carrier and outer races gripped between the differential side bearing caps and bearing bore halves machined in the centre housing.

viii. The tail pinion is straddle mounted with a cylindrical roller bearing at the spigot end and a double row ball bearing together with a cylindrical roller bearing on the shaft of the pinion. The tail pinion coupling flange is splined to the tail pinion and fastened with a castle nut and spilt pin. An oil seal is fitted on the tail pinion.

ix. The centre housing is provided with a drain plug at the bottom. An oil filler and level check plug is located in the front cover. A breather is also provided in the centre housing at the top. The front cover and the protective guard are bolted to the centre housing.

***Note :*** *Always mount the front cover with the axis of the oil filler and level check plug below the horizontal axis of the centre housing.*

x. The axle tubes are pressed and rivetted to the centre housing. The dome type ends of axle tubes have provision for mounting the king pin bushings and swivelling joint housing. This is to enable swivelling of the front wheels in order to steer the vehicle.

xi. The axle shafts are having universal joints at their outer ends.

xii. For smooth swivelling of universal joint the pivot pins are supported on needle roller bearings and grease nipples have been provided on universal joints for lubrication of needle roller bearings.

xiii. To transmit the drive from differential to front wheels the inner and outer ends of axle shafts are splined to fit with axle shaft gear in differential assembly and coupling flange on front hub, respectively. See fig. 1.

xiv. The hub assembly is mounted on support sleeve. See fig. 1.

xv. The mounting of tie rod, wheel arm and steering arm are shown in fig. 1.

xvi. The axle is mounted on the vehicle in the conventional way.

**II. Adjustments on the differential assembly**

The following three major adjustments are to be carried out on the differential assembly.

1. Tail pinion depth adjustment. This is achieved with the help of adjusting shims of different thickness.

2. Crown wheel tail pinion backlash adjustment. This is achieved with the help of threaded adjusting rings located behind the differential side bearings.

3. Crown wheel thrust pad adjustment. This is achieved by screwing in/out the thrust pad adjusting screw to the correct level.

**4. I. Removal and installation of front axle from vehicle**

**Removal**

1. Position the vehicle on level ground and place wheel chokes.
2. Drain oil in a clean container while still hot and check for foreign matter.
3. Disconnect front propeller shaft, from the tail pinion coupling. Flange and lay it on the side. Disconnect brake hoses.
4. Jack up the front axle and remove wheels.

***Caution :*** *Jack should b applied directly on axle tube beneath the spring pads. Under, no circumstances should the jack be applied on the centre housing.*

5. Support chassis frame just behind front spring rear hanger brackets.
6. Disconnect drag link from steering arm with the special tool part no. 312 589 06 33.
7. Support centre housing on trolley jack.
8. Unscrew 'U' bolt check nuts and nuts and tap 'U' bolts out.
9. Lower the trolley jack and roll out the axle assembly.

**Installation**

1. Position the axle assembly on trolley jack beneath the front springs and fit 'U' bolts and nuts. Tighten 'U' bolt nuts to a torque of 22 mkg and 'U' bolt check nuts to 15 mkg.
2. Fit propeller shaft front on the tail pinion coupling flange. Tighten coupling flange bolts to 8 mkg torque.
3. Connect drag link and steering arm.
4. Fit front brake hoses and bleed brake system.
5. Fit front wheels, lower axle on ground and tighten wheel nuts.
6. Fill up oil. For recommended oils and lubricants please refer to group 00.
7. Road test the vehicle.

**II. Disassembly, inspection and assembly of front axle**

**Disassembly**

1. Mount axle assembly on workstand.
2. Remove tie rod ends from wheel arms with special tool part no. 312 589 06 33.
3. Screw in two bolts size M12 X 1.5 X 25 mm in the extraction holes provided in the brake drum and remove brake drum. See fig. 3.
4. Unlock the hexagonal nut and remove it. See fig. 4.

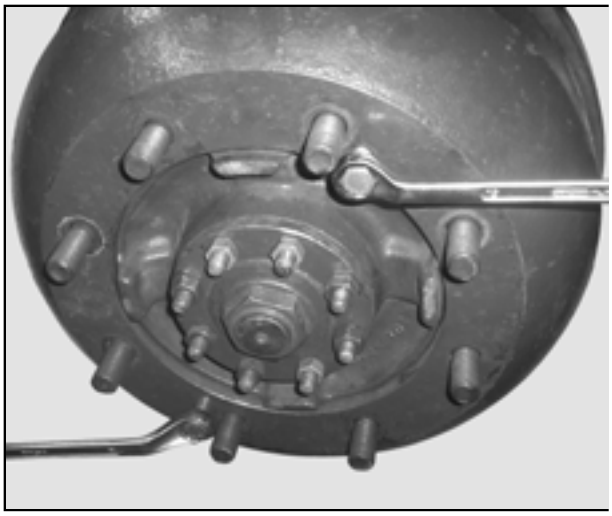


*Fig. 3*

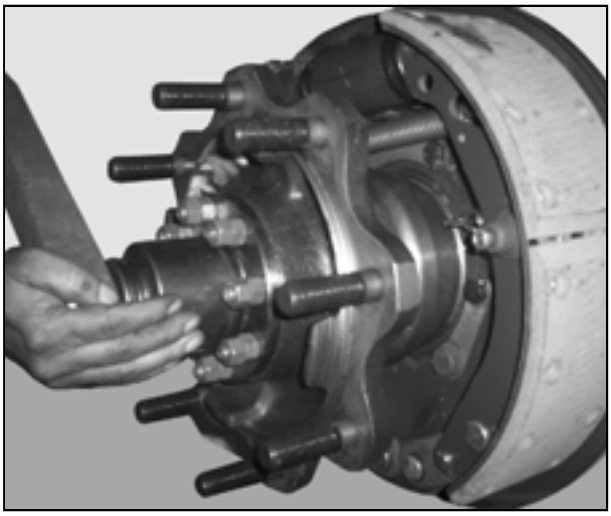


*Fig. 4*

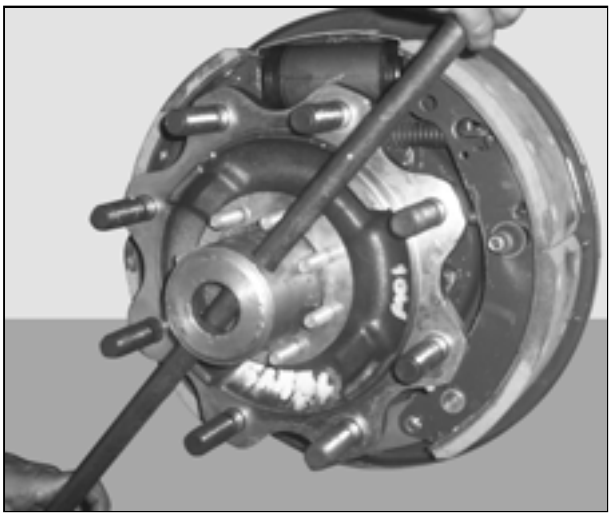


*Fig. 5*

5. Unscrew nuts holding axle shaft coupling flange and remove it. Remove coupling flange.
6. Unstake lip of lock washer from the slot in the check nut and unscrew check nut with special tool, part no. 312 589 06 07. See fig. 5.
7. Remove lock washer and unscrew main nut with special tool part no. 312 589 06 07.
8. Pull out the hub with the help of special tool part no. 2574 5890 33 02. See Fig. 6.
9. Remove brake shoe assembly and then remove anchor plate assembly.
10. Tap out support sleeve.
11. Remove spacer with needle bearing and oil seal from the carrier sleeve using special tool, part no. 2574 5890 33 01. See fig. 7.
12. Pull out axle shafts with universal joints from the axle tube.
13. With special tool part no. 2574 5890 33 01 remove spacer with needle bearing and oil seal from axle shaft tube. See Fig. 8.
14. Unscrew dust covers from swivelling joint housing and remove with rubber ring.
15. Unscrew bolts holding king pins to the swivelling joint housing and remove king pin assembly. See fig. 9.
16. Remove swivelling joint housing and remove thrust washers upper, thrust bearing lower, and king pin grease seal.
17. With special tool part no. 312 589 03 35 extract king pin bushing from the front axle tube. See fig. 10.

**Inspection**

1. Clean all parts thoroughly and inspect for wear and damage. Replace all worn and damaged parts.
2. Inspect all bearings for wear and signs of over heating.

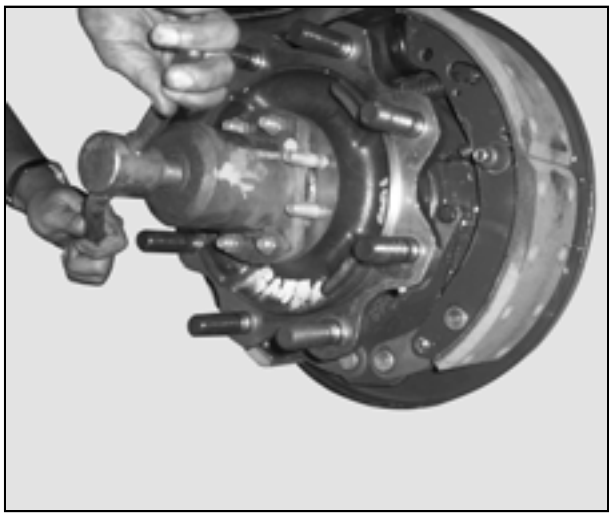


*Fig. 6*

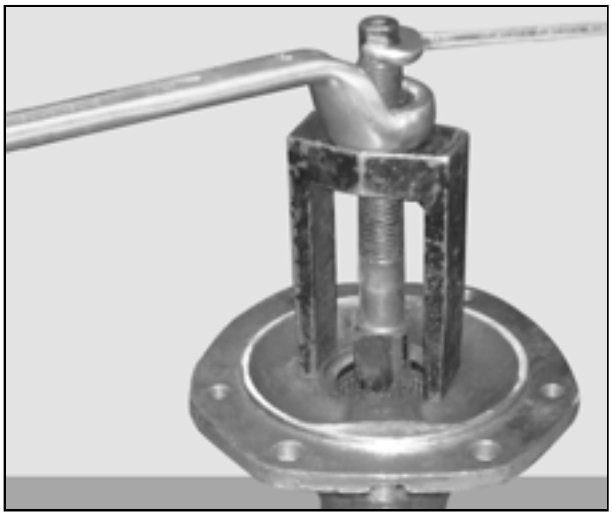


*Fig. 7*

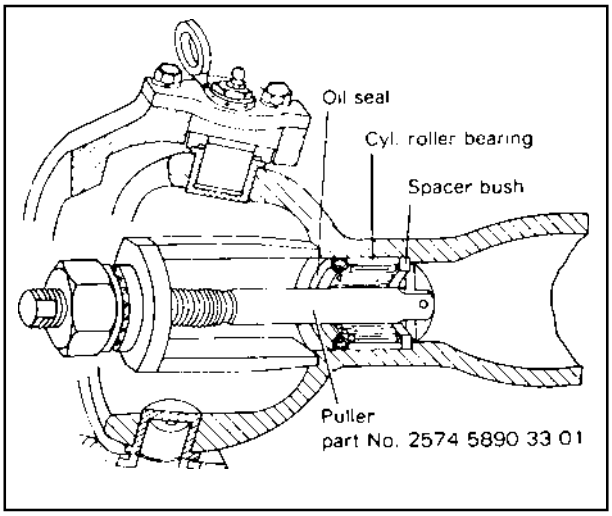



*Fig. 8*

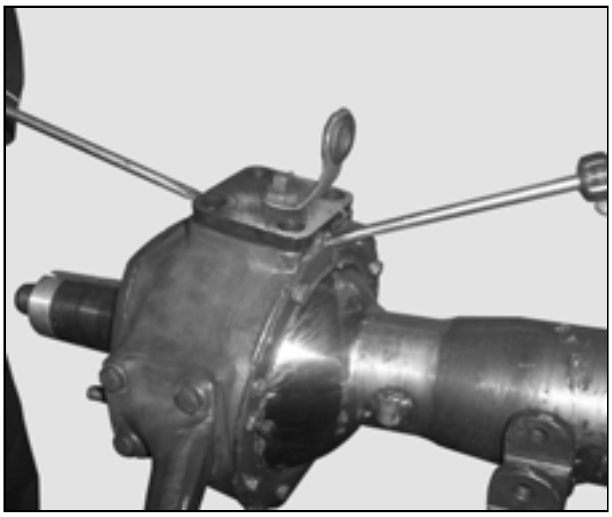


*Fig. 9*

3. Check splines on axle shaft ends, coupling flanges and differential side gears.
4. Check wear in king pin bushings. Replace worn bushings.
5. Check condition of swivelling joint housing and ball head on front axle tubes.
6. Replace seals.

**Assembly**

1. Mount oil seal, needle bearing and spacer on special tool, part no. 2574 5890 33 03 and fit it in the bore of axle tube. See fig. 11.
2. Lightly oil the bearings.
3. Fit king pin bushings till the collar is flush with the ball head surface.
4. Insert rubber seal and cylindrical roller thrust bearing into the lower end of swivelling joint housing.
5. Position swivelling joint housing on the ball head.
6. Fit steel thrust washers on the collar of upper king pin bush.
7. Oil lower king pin and screw it into the swivelling joint housing.
8. Mount bronze thrust washer with the grooved end facing steel thrust washer.
9. With a vernier depth gauge measure depth from upper face of swivelling joint housing to the upper king pin to its flange. See fig. 12.
10. Similarly measure the depth from the collar of the upper king pin to its flange. See fig. 13.

***Note :*** *The difference between these two readings indicates the thickness of steel thrust washer required for the proper adjustment of the swivelling joint housing. These thrust washers are available in 14 different thickness ranging from 3.7 to 5 mm rising in steps of 0.1 mm. The swivelling joint housing has to be assembled on the ball head without any clearance.*

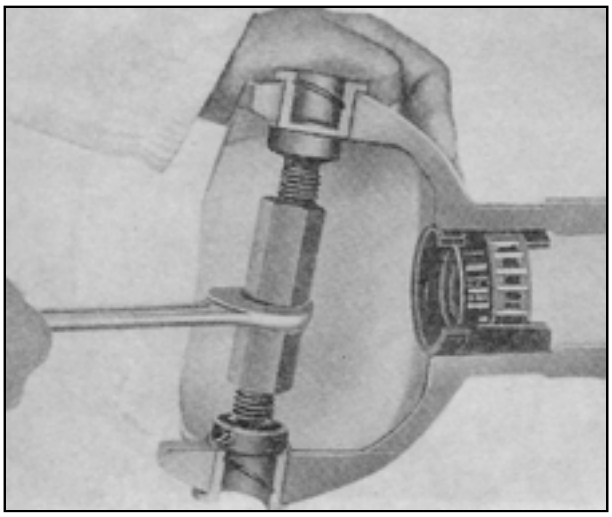


*Fig. 10*

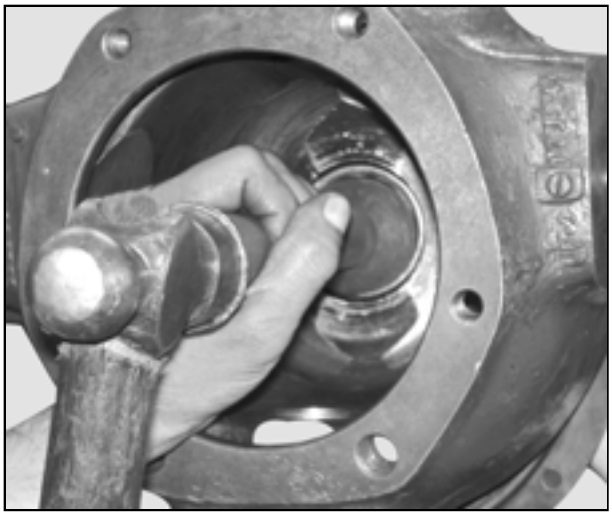


*Fig. 11*

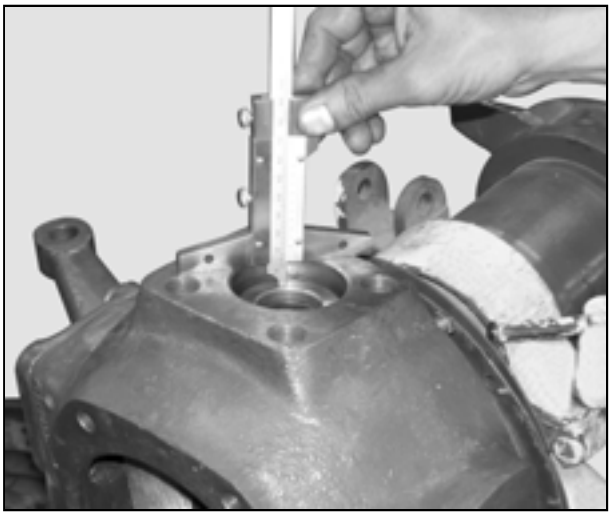


*Fig. 12*

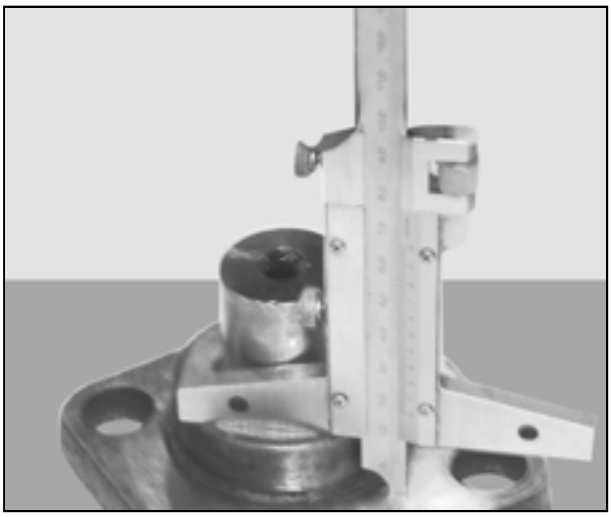


*Fig. 13*

11. Oil and fit upper king pin and screw it onto the swivelling joint housing.

***Note :*** *Mount the steering arm on the king pin bushing upper (right hand).*

***Important :*** *After the above assembly operations are completed the swivelling joint housing should be checked for swivelling smoothly and freely on the ball head without any play. Should there be any play or preload, dismantle and select proper thickness of steel thrust washer for fitment.*

12. Mount the inner and outer flanges with rubber seal on the swivelling joint housing. See fig. 14.

***Note :*** *The split ends of the inner and outer flanges should be diametrically opposite to each other. The rubber seal has to be fitted with its curved face facing the ball joint and with its split end on the top.*

13. Mount wheel arms on the swivelling joint housing.

***Note :*** *Do not mix left and right wheel arms.*

1. Mount support sleeve on the swivelling joint housing and fit anchor plate with brake shoe assembly.

***Note :*** *Support sleeve should be mounted with grease overflow slot at the bottom. The four longer bolts for mounting the anchor plate should be fitted at the bottom. Lock the bolts with lock plates.*

**III. Disassembly, inspection and assembly of universal joint on axle shaft**

**Disassembly**

Before disassembly of the universal joint on axle shafts mark position of all mating parts to ensure correct reassembly later.

1. Remove split pins and unscrew castle nuts from the bolts holding universal joint assembly and remove the bolts.
2. Detach bearing housing from centre ring.
3. Remove end caps with needle rollers from bearing housings.
4. Unscrew hex head screw and remove cover plate, thrust washer and sealing ring covering the pivot pins.
5. On a press, press out pivot pins from the assy. joint cross.

**Inspection**

1. Clean all parts thoroughly and inspect for wear and damage. Replace damaged/worn parts and sealing rings.

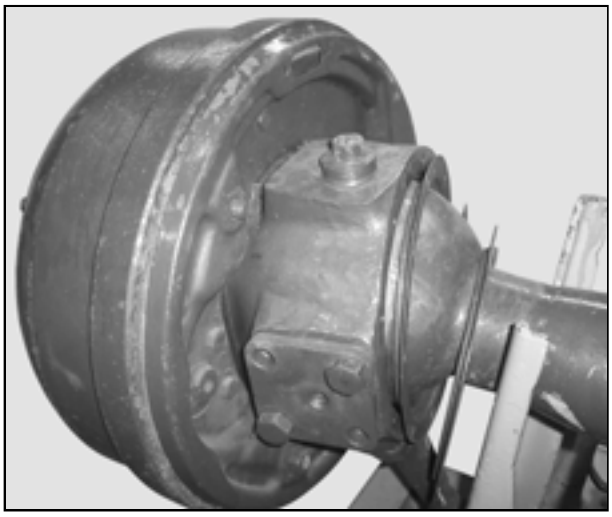


*Fig. 14*

2. Clean and check lubrication passages in U. J. assy. joint cross
3. Check condition of the needle rollers, pivot pins and bearing housing. Replace damaged/worn parts.
4. Check condition of splines on axle shafts.

**Assembly**

1. Assemble universal joint in reverse order of disassembly taking care that all mating parts are correctly fitted.
2. Replace all damaged/worn out parts,
3. Tighten mounting bolts of universal joint assembly to specified torque and lock the castle nuts with new split pins.
4 Pressure grease both grease nipples in each universal joint and see that grease has penetrated well.

**IV. Disassembly, Inspection and assembly of hub**

**Disassembly**

1. Using special tool, 2574 5890 3305, pull out inner hub bearing outer race with grease retainer. See fig. 15.
2. With special tool, 312 589 00 37 remove circlip from hub. See fig. 16.

   Similarly remove circlip locating outer race of outer bearing in hub. See fig. 17.
3. With special tool, 2574 5890 33 04 remove outer bearing with thrust washer. See fig. 18.

**Inspection**

1. Clean all parts thoroughly and inspect for wear and damage.

   Replace all worn/damaged parts.

2. Inspect bearings for wear and signs of over heating.
3. Check bearing seats in hub for wear etc. Check machined collar on hub for brake drum mounting.
5. Check wheel mounting pins and replace if' necessary.
6. Replace seals.

**Assembly**

1. Clean the hub thoroughly and oil the bearing seat surfaces in the hub.
2. Insert thrust washer in the hub.
3. Pack roller cage of wheel hub bearing outer, with recommended grease and fit in the hub with its thrust face towards the tongued washer.
4. With special tool part no. 2574 5890 35 03, press outer race of outer bearing in the hub till it just clears the groove for circlip in the hub. See fig. 19.
5. U sing special tool part no. 312 589 00 37, fit the circlip in its groove in the hub.

***Note :*** *Check to ensure that the outer race of the outer bearing is flush against the circlip. If not, press the bearing from the front end till it flushes against the circlip.*

6 Pack recommended grease in the hub. For specification, see group 00.

7. Insert the second circlip in its groove in the hub,
8. Press outer race of inner hub bearings, till it rests on the circlip, by using special tool part no. 2574 5890 35 02. See fig. 20.
9. Pack roller cage of inner hub bearing with the recommended grease and fit it in the outer race.
10. Insert spacer on the outer race with its recessed end facing the bearing.
11. Press grease retainer in hub with special tool part no. 2574 5890 35 02 till it rests on the spacer. See fig. 21.

***Note :*** *Fit grease retainer with its lip facing the bearing*.

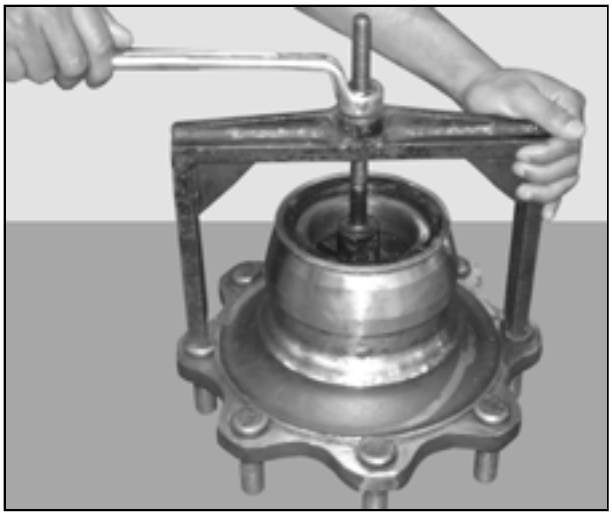


*Fig. 15*



*Fig. 16*



*Fig. 17*

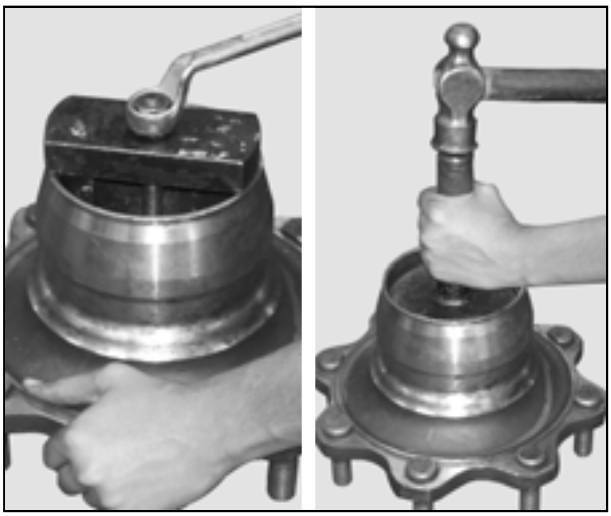


*Fig. 18*



*Fig. 19*

**V. Mounting of hub assembly and adjustment of wheel bearings.**

1. Thoroughly clean bearing seats on the support sleeve and the oil seal land. Oil threads on the carrier sleeve.
2. Carefully mount the hub assembly on the support sleeve. Taking care that grease retainer is not damaged at the time of assembly.
3. Mount tongued washer on the support sleeve. Screw on the inner slotted nut with the help of special tool part no. 312 589 06 07 and tighten the nut fully.

***Note :*** *At the time of tightening this nut revolve the hub and tap hub with a mallet to properly seat the bearing assemblies.*

4 Loosen the nut by approximately two turns and pull the hub carefully with special tool part no. 2574 5890 33 02 till there is an axial play in the hub.

5. Mount special tool part no. 321 589 00 21 with dial gauge on any one of the wheel mounting pins.

***Note :*** *The dial gauge spindle must rest on the outer face of the support sleeve.*

6. With special tool, part no. 312 589 06 07 go on tightening the inner slotted nut till the axial play on the hub is reduced to approximately 0.10 to 0.15 mm.
7. Remove special tool, part no. 312 589 00 21. Fit a new lock plate and screw the slotted check nut on the support sleeve with special tool, part no. 312 589 06 07, Tighten the check nut fully. Till any one of the slots in the nut lines up with a lip of the lock plate. Refit dial gauge on support sleeve face and check play of the hub. The axial play of the hub should be 0.02 to 0.04 mm,
8. Remove dial gauge holder.
9. Lock lip of lock plate in the check nut slot.
10. Recheck the axial play of hub.

**VI. Mounting brake drum and adjustment of the front wheel brakes**

1. Check brake drum for cracks, deep scoring on the braking surface, ovality of drum etc. Machine brake drum surface or replace brake drum if necessary.
2. Thoroughly clean the brake drum, specially the area in contact with the brake shoes.
3. Contract brake shoes fully.
4. Mount brake drum on the hub by tightening two opposite wheel nuts with their conical washers.
5. Adjust brake shoes by fully expanding any one shoe till it firmly grips the drum.



*Fig. 20*



*Fig. 21*

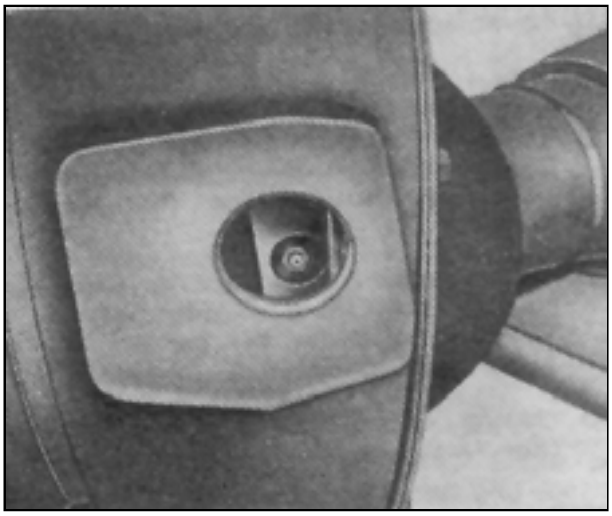


*Fig. 22*

6. Contract shoe till the brake drum revolves freely. Similarly adjust the second shoe and test drums for free rotation.

**VII. Connecting steering linkages and toe-in adjustment**

1. Fit tie rod to the wheel arms and lock with split pin.
2. Fit wheel lock adjusting gauge part no, 2574 58 0 33 06 on the spring pad and adjust wheel lock angle to $36^0$.

**Toe-in**

For adjustments of toe-in, the left tie rod end has to be disconnected from the wheel arm. After loosening the two clamping bolts on the tie rod, the left tie rod end should be screwed in or out for correct adjustment of toe-in.

**VIII. Lubrication of universal joint**

For periodic Lubrication of the universal joint, remove threaded plug from the front end of the universal joint housing, jack up the wheel and proceed as follows

i. For lubricating the left universal joint, turn the left wheel fully towards left. At the same time, revolve the wheel till one of the grease nipples lines up with the opening in the universal joint housing. Grease with grease gun. Revolve wheel through 180 till the second grease nipple is visible. Grease the same. See figs. 22 and 23.

ii. For greasing the right universal joint, proceed as described in (i) after turning the right wheel fully to right.

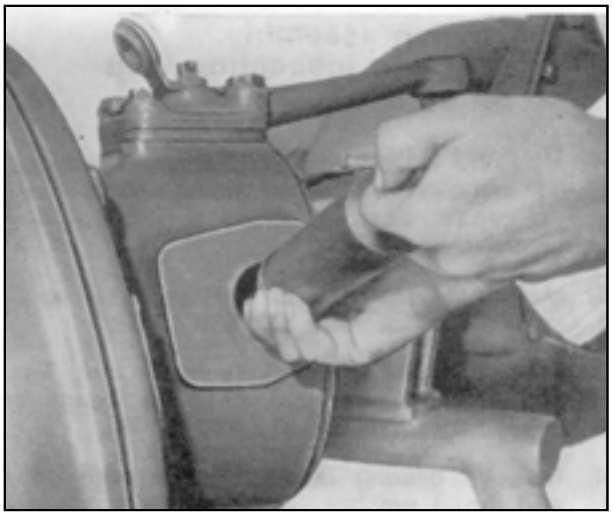


*Fig. 23*

**5. I. Removal of crown wheel and tail pinion assembly**

1. Unscrew bolts and remove the front covers from the front axle centre housing.
2. Unlock the plate washers and remove the bolts and lock plates from the differential bearing caps.
3. Loosen nut holding thrust pad, in differential housing and remove thrust bolt with pad. See fig. 24.
4. The side bearing caps are marked 'L' and 'R' for left and right respectively.
5. Remove bearing caps.
6. Pull out threaded adjusting rings on the left and right of the differential taper roller side bearing.
7. Remove carefully the outer races of the differential taper roller bearings and store them carefully.

***Caution :*** *These should not be interchanged.*

8. Remove crown wheel with differential assembly from the centre housing by tilting the assembly to clear the tail pinion spigot bearing support.
9. Unscrew tail pinion bearing retainer flange bolts (8 nos.) and remove tail pinion with bearing assemblies complete with coupling flange and bearing retainer flange from the centre housing. Remove tail pinion bearing pre-loading shims from the bearing retainer flange.
10. Remove the outer race of the cylindrical roller bearing together with 1 mm spacer and adjusting shims from the rear axle housing by means of special tool part no. 01 2 583 00 99 J. See fig. 25.

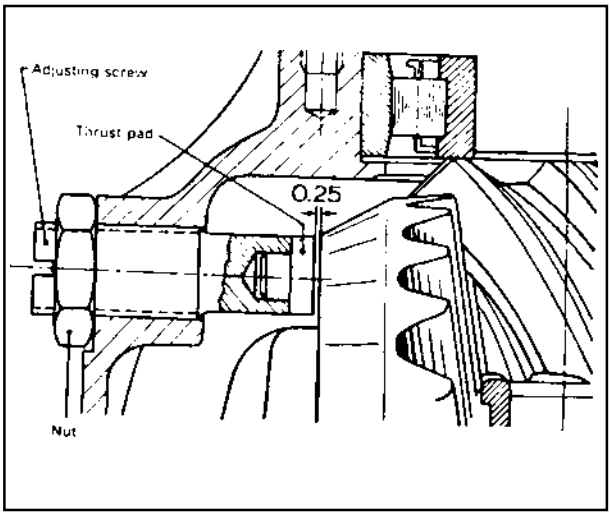



*Fig. 24*

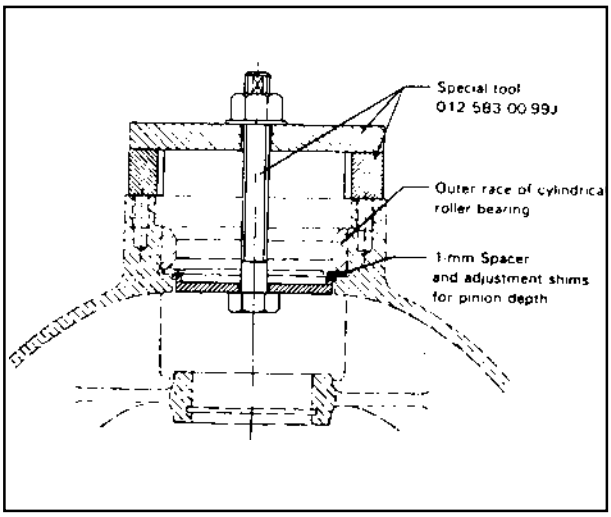



*Fig. 25*

**II. Tail pinion assembly, dismantling, inspection, and assembly**

**A. Dismantling**

1. For removal of the tail pinion assembly from the centre housing please follow the procedure given on page 13.
2. Mount tail pinion with bearing assemblies on special tool part no. 312 589 10 33.
3. Remove split pin and unscrew nut on tail pinion shaft. Remove coupling flange with special tool part no. 312 589 02 35.
4. Remove bearing retainer flange with oil seal and thrust washer.
5. Remove cylindrical roller bearing and double row ball bearing from tail pinion using special tool part no. 312 589 02 35. See fig. 26.
6. Remove/contract the circlip retaining the inner race of cylindrical roller spigot bearing, on tail pinion. By means of a drift, remove inner race.
7. Two types of cylindrical roller bearings are used for the tail pinion of the FA 104 Model.

i. For spigot bearing part no. 000 981 07 01 remove circlip with circlip pliers, then extract bearing by using the drift of special tool, part no. 312 589 35 39.

ii. For spigot bearing part no. 312 981 06 01 contract circlip pliers, and at the same time extract bearing with drift of special tool part no. 312 589 35 39.

8. Thoroughly clean all parts.

**B. Inspection**

1. Check set no. on tail pinion and crown wheel for conformity.
2. Check tail pinion teeth for scores, burrs, chips, signs of overheating etc. Replace defective tail pinion.

***Note :*** *Crown wheel and tail pinion are to be replaced inset. Check set nos.*

3. Check bearing seats on tail pinion for scores, signs of rotation of the inner race on the seats; replace worn out tail pinion (with crown wheel).
4. Check splines on tail pinion and its coupling flange for wear or burrs. Clean all burrs on the splines.
5. Check threads on tail pinion and ease threads.
6. Check circlip groove on the tail pinion.
7. Check all the bearings for signs of scoring, pitting, burns, over-heating etc. Replace all worn bearings.

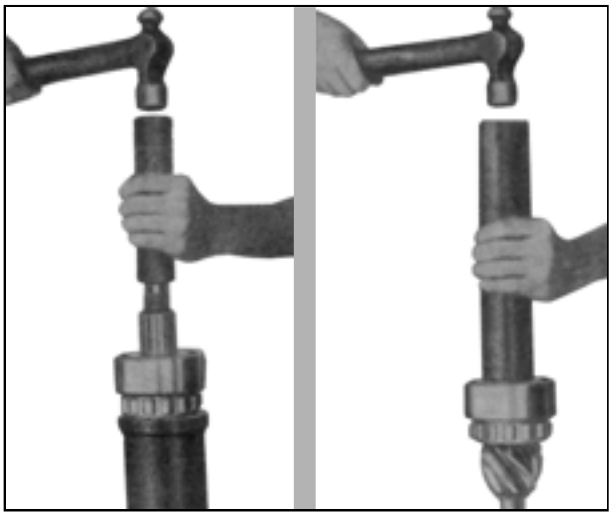


*Fig. 26*



*Fig. 27*

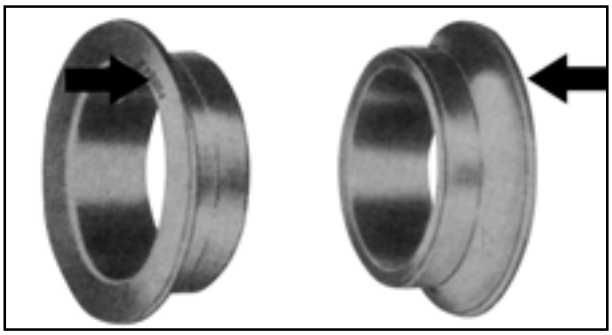


*Fig. 28*

**C. Assembly**

***Note :*** *On axles fitted with spigot bearing part no. 000 981 07 01, insert circlip into bearing support and install spigot bearing with drift of special tool part no. 312 589 35 39 from rear end. The chamfered end of the roller cage should face the pinion teeth.*

*On axles fitted with spigot bearing part no. 312 981 06 01 (circlip fitted on bearing outer race) fit circlip into the groove on the bearing outer race. Install bearing with circlip in tapered ring of special tool part no. 312 589 35 39.*

*Locate bearing with tapered ring in bore and drive it into position from rear end with the drift of special tool part no. 312 589 35 39 till circlip expands and locks bearing in housing.*

1. Press inner race of spigot bearing on tail pinion using special tool part no. 312 589 35 01 or 2574 5890 9904 and install circlip.

***Note :*** *The chamfered edge of the bore of the inner race must face the pinion teeth.*

2. Press inner race with roller cage of cylindrical roller bearing and double row ball bearing on tail pinion by means of special tool part no. 312 589 14 39.

***Note :***

*i. Press both bearings simultaneously on the tail pinion. See fig. 27.*

*ii. The smaller diameter of the roller age of cylindrical roller bearing must face the pinion teeth.*

*iii. The double row ball bearing inner race is of split type. Install bearing on pinion shaft in such a way that markings on the inner races are directly opposite to each other and in the same plane, as shown in fig, 28.*

3. Install thrust washer and bearing retainer flange (with new oil seal) on the tail pinion. Press coupling flange on tail pinion. Fit washer and castle nut. Tighten castle nut to a torque of 30 to 36 mkg holding coupling flange with special tool part no. 321 589 01 31. Fit new split pin.

**D. Tail pinion depth adjustment**

***Note :*** *To ensure correct engagement between crown wheel and tail pinion, the pinion must beset to the exact depth predetermined' during manufacture and etched on the periphery of the crown wheel as shown in fig. 29. The correct adjustment of tail pinion depth is obtained by means of placing suitable shims available in thickness of 0.1 mm, 0.25 mm, and 0.5 mm between the tail pinion cylindrical roller bearing outer race and axle housing. See fig. 30. Check shim thickness with a micrometer.*

1. Insert a 1 mm spacer together with outer race of cylindrical roller bearing into front axle housing.

***Note :*** *For ease of checking of pinion depth, the outer face of a used cylindrical roller bearing may be utilised after*

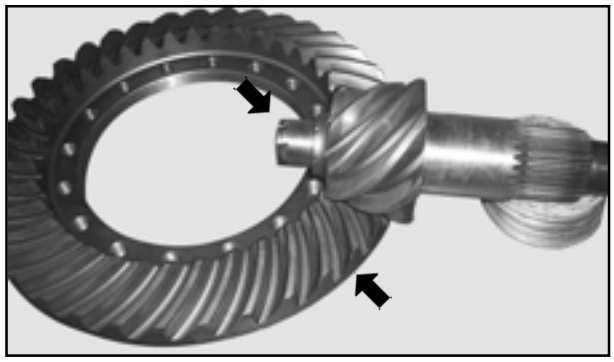


*Fig. 29*

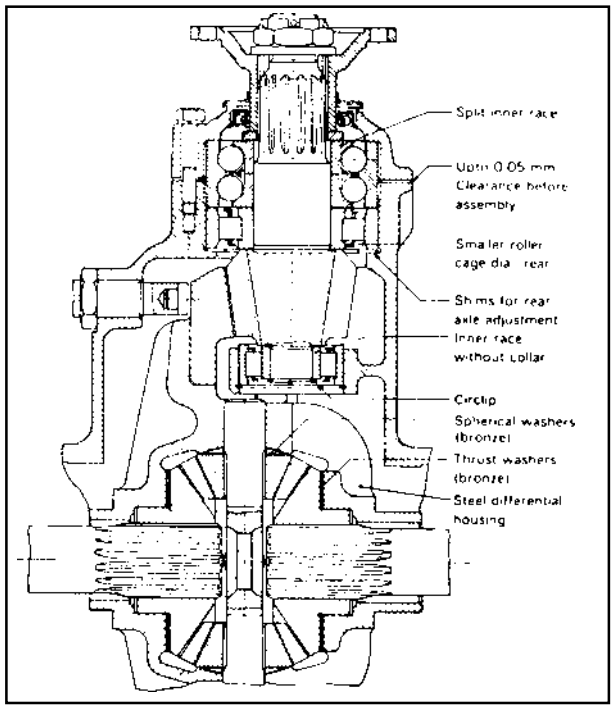



*Fig. 30*

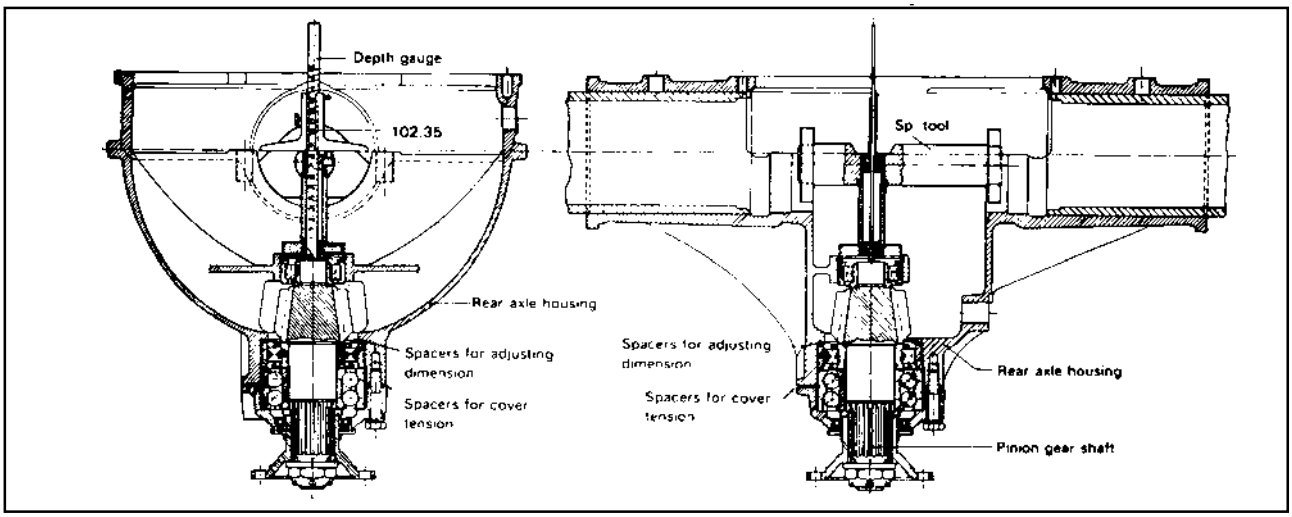



*Fig. 31*

*grinding down the outer diameter by approximately 1 mm instead of using the outer race of the new bearing.*

2. Install the tail pinion and bearing housing and screw the bearing retainer flange to axle housing by means of two hexagonal head bolts diagonally opposite to each other.
3. Tighten the two bolts just sufficiently to ensure proper seating of the bearings in the housing.
4. Place special tool part no. 312 589 00 21 on the differential side bearing bores and insert depth gauge into fixture. See fig. 31.

   Insert vernier depth gauge into special tool part no. 312 589 00 21 and read tail pinion depth. (Ensure that depth gauge is inserted in such a way that it does not enter the machining centre hole on the tail pinion spigot end.) See fig. 31.

   The difference between these two values indicates the thickness of shims necessary to be inserted between outer race of cylindrical roller bearing and the 1 mm thick spacer.

For example :

i. Etching on crown wheel 100.65 mm
ii. Actual reading on vernier of depth gauge 100.15 mm
iii. Distance of tail pinion to be moved out 0.55 mm

(i.e. thickness of shims to be added).

5. Remove tail pinion assy. from differential housing and extract 1 mm spacer and outer race of cylindrical roller bearing with special tool part no. 012 583 00 99J. (In case a reground outer face of a used bearing has been inserted initially as explained under 1, this can be removed without the use of a puller.) Add the required thickness of shims (as per above example 0.5 mm thickness) between 1 mm spacer and the cylindrical roller bearing outer race and remount the same into housing with special tool part no. 2574 5890 35 03 or 012 583 00 18J.
6. Refit tail pinion assy. in housing and again fix bearing retainer flange with 2 bolts.
7. Measure with feeler gauge the clearance between retainer flange and housing.
8. Remove pinion assy. and add shims between tail pinion bearing retainer flange and housing to a total thickness of 0.05 mm less than the clearance measured by the feeler gauge. The difference of 0.05 mm between the measured clearance and the thickness of shims installed assures the correct preload on the tail pinion bearing. Shims are available in thickness of 0.1, 0.25 and 0.50 mm for preload adjustment.

**For example**

Clearance measured with feeler gauge = 1.5 mm.
Add shims of a total thickness of 1.45 mm to ensure Correct preload on the tail pinion bearings.

9. Fully tighten flange mounting bolts.
10. Recheck drive pinion depth as explained in para 4 above. If found incorrect readjust again as necessary by increasing or decreasing the thickness of the tail pinion depth adjusting shims.

**III. Crown wheel and differential assembly**

**A. Dismantling, inspection and assembly**

**a. Dismantling**

1. Extract differential tapered roller bearings by means of special tool part no. 312 589 20 33. See fig. 32.

***Note :***

*i. Fit the legs of puller in the recesses provided in differential carrier.*

*ii. Do not interchange left hand side and right hand side bearing inner races after removal.*

2. Remove the tack-welds by filling/chipping and unscrew the 16 hex. bolts holding crown wheel to differential carrier. Press out the crown wheel from carrier.
3. Remove locking wires from mounting bolts of differential carrier and unscrew the 8 bolts and check for mating marks on the carrier prior to dismantling.
4. Remove differential spider, differential spider gears and axle shaft gears together with their thrust washers.
5. Clean all parts, thoroughly

**b. Inspection**

1. Check crown wheel teeth for scores, burns, chips, signs of overheating etc. Replace worn crown wheel (with tail pinion).
2. Check bearing, seats on the two halves of the differential carrier for scores.
3. Check bearing seats on the two halves of the differential carrier for scores and signs of rotation of the inner races on the seat. If so, replace the carrier as a set.
4. Check mating surfaces of the carrier for proper fit.
5. Check thrust faces of the spider gears and axle shaft gears in the two halves of the carrier for excess wear. If so, replace the carrier as a set.
6. Check differential gear teeth for wear; replace worn gears as a set.
7. Check the thrust washers for wear and replace them, if necessary in sets.
8. Check splines of axle shaft gears.
9. Check the differential spider for wear. Replace if necessary.
10. Check the differential side bearings for signs of wear, scoring, pitting, burns, overheating, etc. Replace worn bearings.

11. Check the threads on the differential side bearing adjusting threaded rings and the corresponding threads in the centre housing and the side bearing caps.

***Note :*** *Side bearing caps should not be interchanged from one housing to the other nor should they be changed from left to right ("L" and "R" stamped on the caps for identification).*

12. Check bearing bore in the front axle centre housing and the side bearing caps.

13. Ease threads on the side bearing cap bolts and in the housing.

**c. Assembly**

***Note :***

*a. Damaged crown wheel or tail pinion must be replaced only in set as these have been carefully matched during production. Under no circumstances must the components of two different sets be installed together. The crown wheel and tail pinion of a set are marked with the same serial number to avoid interchanging. See fig. 29.*

*b. When replacing front axle shaft gears or differential spider gears it is not absolutely necessary to carry out installation in pairs, but care must be taken to ensure that they rotate freely.*

1. Install differential spider gears with spherical washers on differential spider and assemble together with front axle shaft gears and thrust washers into the differential carrier.

***Note :*** *The oil grooves on the thrust washers must be towards the axle shaft gears. See fig. 33.*

2. Align the mating marks on the differential carrier and cover, tighten the 8 cover bolts to 8 mkg torque.

***Note :*** *The assembled differential spider gears and axle shaft gears should rotate freely without binding and the backlash between them should be 0.2 to 0.3 mm. If necessary measure with a narrow feeler strip through holes provided in the carrier. To adjust backlash select suitable thrust washers for the front axle shaft gears.*

3. Lock bolts with lock wires.

4. Before installing crown wheel on differential carrier, ensure that the mating surfaces of the differential carrier cover and the crown wheel are free from dirt or burrs.

5. Warm crown wheel $70^0$C to $80^0$ C and place on differential carrier. Provisionally secure crown wheel to differential carrier by 4 bolts fitted $90^0$ apart and check the radial and lateral run out of the crown wheel.

6. Press differential taper roller bearings on to differential carrier with special tool part no. 312 589 6 39. See fig. 34 and check with feeler gauge



*Fig. 32*

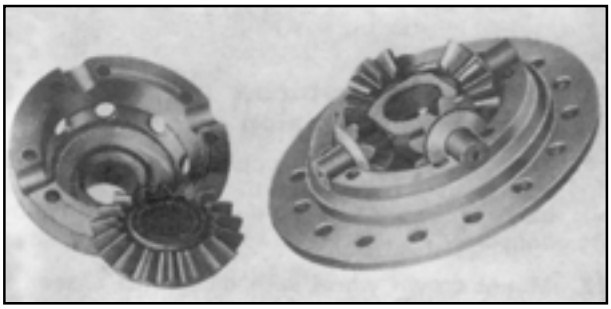


*Fig. 33*

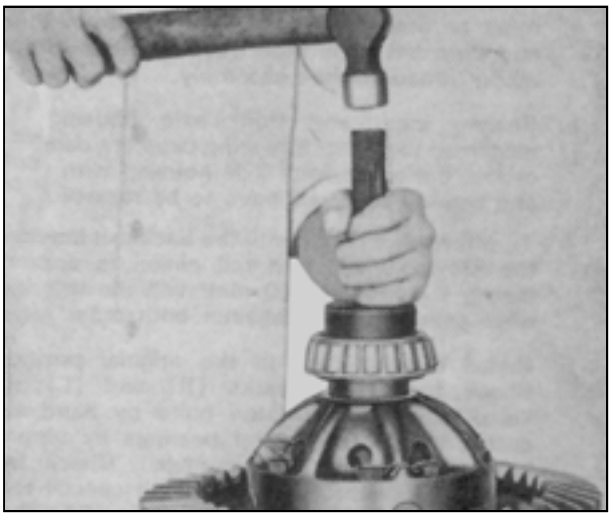


*Fig. 34*

to ensure that the bearings are fully seated and no clearance exists between the bearings inner race and housing shoulder. See fig. 35.

7. Install the taper roller bearing outer races and clamp firmly in position by means of special tool part no. 012 583 00 82J or 042 583 00 82J.
8. Mount crown wheel and differential assembly with taper roller bearings on V-blocks and by means of a dial gauge, check the lateral run out of the crown wheel. See fig. 36.

***Note :*** *Maximum permissible lateral run out of crown wheel : 0.06 mm. If run out is more, remove the crown wheel from the differential carrier and alter its position on the carrier by 180' and check again.*

9. Tighten the crown wheel bolts evenly and equally to a torque of 12 mkg. Secure bolt heads to casing by electric tack-welding.
10. Remove clamping device special tool, part no. 012 583 00 82J from side bearings.

**B. Backlash adjustment of the crown wheel and tail pinion**

1. Thoroughly clean and apply oil on differential side bearing bores, the mating surfaces of the centre housing, and the threading in the centre housing.
2. Mount crown wheel with differential assembly in front axle housing.
3. Screw on threaded rings till tapered roller bearing outer races are snugly seated.

***Note :***

*a. Threads on threaded rings, housing and caps must be absolutely clean and free from burrs and threaded rings must revolve freely. Smear oil on threads before assembly.*

*b. Bearing caps and front axle housing are machined together. If bearing caps are damaged or lost the entire front axle housing with tubes and bearing caps will have to be replaced.*

4. Turn threaded rings, until he backlash between the crown wheel and tail pinion is approximately 0.5 mm to 1.00 mm with the threaded rings seating snugly against both outer races.
5. Install bearing caps in the original position. Check for mating marks (R) and (L) and install cap bolts, Tighten bolts by hand and ensure proper bedding of bearings by tapping bearing caps with plastic mallet. Check free movement of threaded rings with special tool, part no. 312 589 04 07. See fig. 37. Then tighten cap bolts fully to seat bearings and rings properly. Loosen bolts and retighten so that the threaded rings can just be rotated with the help of special tool part no. 312 589 04 07.

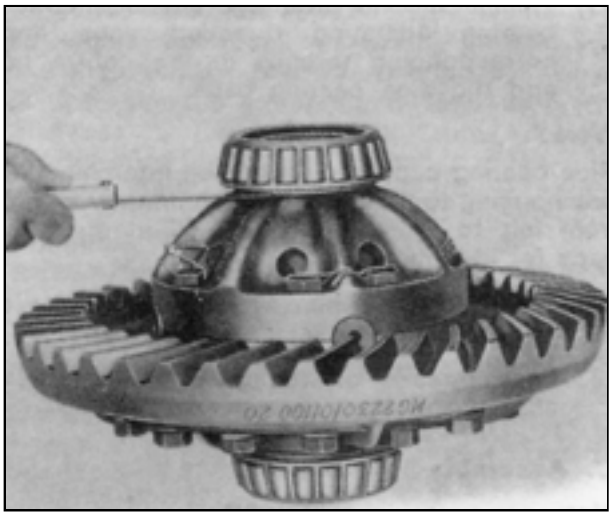


*Fig. 35*

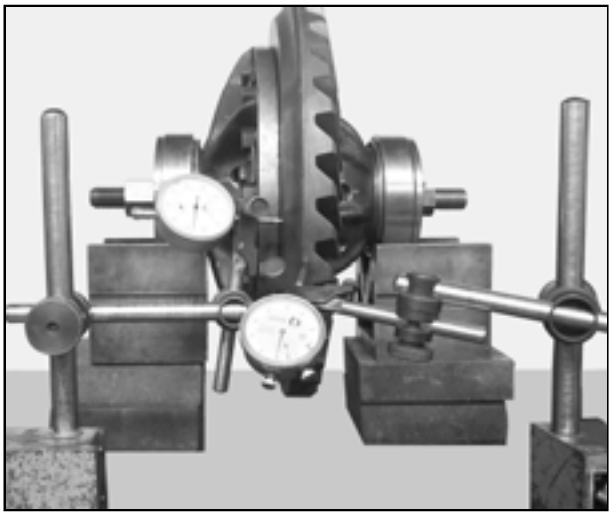


*Fig. 36*

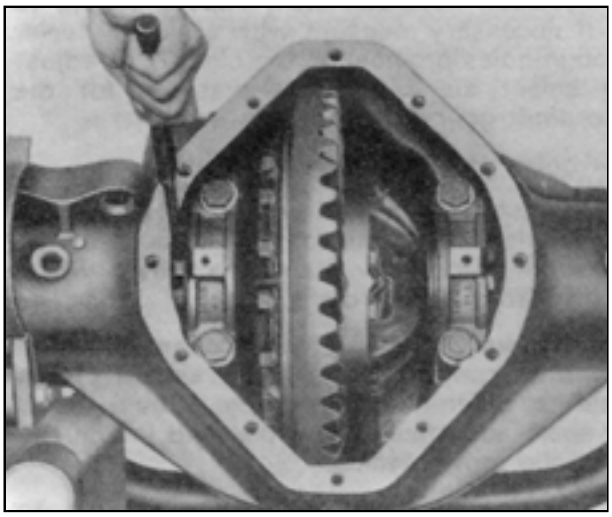


*Fig. 37*

6. Reduce backlash between the crown wheel and pinion from 0.5 mm to 0.14 mm by loosening threaded ring on the crown wheel teeth side (Right hand side) and tightening the threaded ring on the left hand side. After this, the left hand threaded ring should not be rotated further. Tighten left hand side bearing cap bolts to 12 mkg.

***Note :***

*a. For checking backlash use special tool, part no. 321 589 04 63.*

*b. Ensure that spindle of the dial gauge is at right angles to the tooth flank and that the adjacent tooth does not touch the spindle. See fig. 38.*

*c. Hold tail pinion from rotating when checking backlash.*

7. Tighten threaded ring on crown wheel teeth side (right hand side) till a backlash of 0.22 mm is obtained between the crown wheel and tail pinion.

8. Rotate crown wheel and recheck backlash at 4 different points on the crown wheel $90^0$ apart.

***Note :*** *The final backlash is correct when:*

*Gleason design of crown wheel and pinion is adjusted to 0.14 to 0.25 mm,*

9. Tighten bearing cap bolts to a torque of 16 mkg

10. Recheck backlash as explained in para 8.

11. Install locking device for threaded rings on bearing caps.

12. Apply shellac / gasket cement on centre housing and fit cover with gasket. Fit cover with the oil filler and level check plug below the centre line of the centre housing.

13. Screw drain plug firmly in the centre housing.

**C. Thrust pad adjustment**

1. Check condition of the thrust pad and replace if excessively worn.

2. Oil the threads on the screw and tighten screw in the centre housing till the thrust pad just contacts the machined surface of the crown wheel.

3. From this position turn back screw by 1/6th of a turn and lock check nut in this position. This will ensure a clearance of 0.25 mm between the face of the thrust pad and the crown wheel face. See fig. 24.

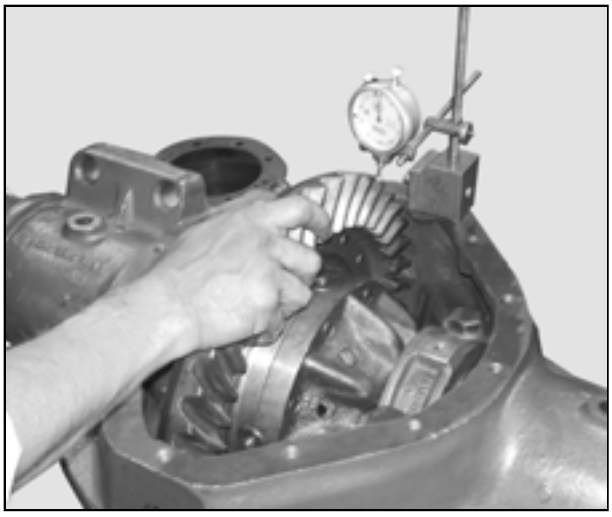


*Fig. 38*

## NOTES

# Rear Axle 35

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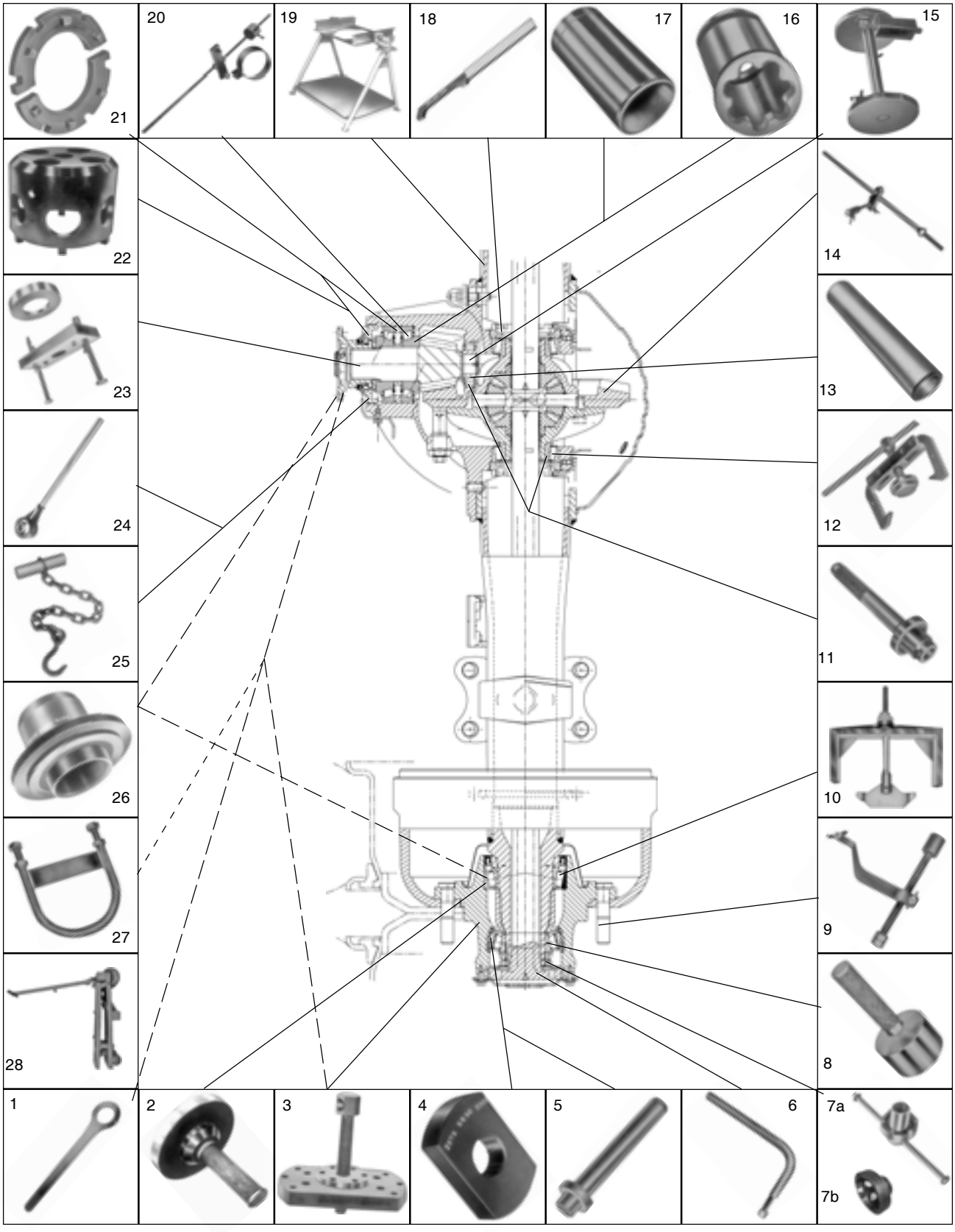

| | | |
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**REPAIR / ADJUSTMENT DATA**

| | | | |
|---|---|---|---|
| Rear axle housing. max. permissible bend | | 2 | mm |
| Backlash between differential spider gears and axle shaft gears | | 0.12 to 0.22 | mm |
| Brass / steel thrust washer (for axle shaft gears) available in thickness | | 1.95 to 2.20<br>in step of 0.05<br>and 2.30 | mm<br>mm<br>mm |
| Maximum permissible lateral run out of crown wheel mounting face on diff. case | | 0.06 | mm |
| Backlash between crown wheel and tail pinion. | Oerlikon | (37/7) 0.21 to 0.27 | mm |
| | Oerlikon | (41/7) 0.21 to 0.27 | mm |
| | Oerlikon | (45/7) 0.24 to 0.30 | mm |
| | Oerlikon | (48/7) 0.20 to 0.26 | mm |
| | Gleason | 0.20 to 0.28 | mm |
| Pre-load on tail pinion bearings to give a friction moment | | 30 to 60 | cmkg |
| Thickness of split ring for tail pinion | | 10.10 to 10.50<br>in steps of 0.02 | mm<br>mm |
| Permissible variation in tail pinion depth | | +/- 0.05 | mm |
| Maximum permissible run-out of axle shaft near neck and centre of shaft | | 0.5 | mm |
| Maximum permissible run-out of axle shaft splines out side dia. | | 0.2 | mm |
| Clearance between thrust pad and crown wheel | | 0.25 | mm |
| Hub play | | 0.04 to 0.12 | mm |
| Hub outer bearing - inner dia<br>- outer dia | | 70.00/69.985<br>125.0/124.980 | mm<br>mm |
| Hub inner bearing - inner dia<br>- outer dia | | 95.00/94.980<br>145.0/144.989 | mm<br>mm |
| Hub inner bearing mounting bore dia | | 144.952/144.912 | mm |
| Hub outer bearing mounting bore dia | | 124.952/124.912 | mm |
| Axle beam inner bearing seat dia | | 94.980/94.955 | mm |
| Axle beam outer bearing seat dia | | 69.980/69.965 | mm |
| Pre-load on differential side bearings | | 0.05 to 0.07 | mm |
| Shims between spacer tube and outer bearing inner race | | 0.05, 0.1, 0.15,<br>0.2, 0.25, 0.3, 0.5,<br>1.0 & 2.5 | mm |
| Tail pinion depth adjusting shims | | 0.10, 0.15, 0.20,<br>0.50 & 1.50 | mm |

**TIGHTENING TORQUES**

| | | | |
|---|---|---|---|
| Nuts/check nuts for mounting carrier assy on the axle beam | Hex nut<br>Lock nut | 8 to 9<br>8 to 9 | mkg<br>mkg |
| Nut holding coupling flange on tail pinion | | 32 to 36 | mkg |
| Propeller shaft coupling flange bolts | | 6.5 to 7.5 | mkg |
| Crown wheel mounting bolts | | 16 to 20 | mkg |
| Differential side bearing cap bolts | | 22 | mkg |
| Bolts for mounting differential case to cover | | 16 to 20 | mkg |
| Tail pinion threaded ring | | 100 to 110 | mkg |
| 'U' bolt nuts/check nuts | | 42 | mkg |
| Wheel nuts | | 50 to 60 | mkg |
| Single coarse pitch nut (for hub assembly with double oil seal) | | 30 | mkg |


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**SPECIAL TOOLS**

| Sl No. | Description | Part No. |
|---|---|---|
| 1 | Holder for coupling flange. | 2576 5890 35 09 |
| 2 | Drift for installing outer race of hub inner bearing and grease seal. | 321 589 04 39 |
| 3 | Puller for removal of coupling flange and hub assembly. | 2576 5890 35 22 |
| 4 | Rocker for removal of outer race of hub outer bearing to be used with SI. No.5. | 2575 5890 35 02 |
| 5 | Drift to be used with SI. No.4. | 312 589 35 39 |
| 6 | Puller for removal of axle shaft - 2 pieces. | 042 589 01 33 |
| 7a | Wrench for hub lock nut - double (for hub assembly with single oil seal). | 2575 5890 35 04 |
| 7b | Wrench for hub lock nut - single (for hub assembly with double oil seal). | 2632 5890 35 02 |
| 8 | Drift for installing inner race of hub outer bearing. | 2505 5890 99 02 |
| 9 | Dial gauge holder for wheel bearing adjustment. | 2576 5890 35 14 |
| 10 | Puller for rear hub inner bearing with seal. | 2576 5890 35 04 |
| 11 | Drift for (i) installation of inner race of differential side bearing<br>(ii) removal and installation of outer race of cylindrical roller bearing. | 2574 5890 99 02 |
| 12 | Puller for differential side bearings. | 312 589 20 33 |
| 13 | Drift for installation of cylindrical roller bearing inner race on tail pinion. | 312 589 14 39 |
| 14 | Dial gauge holder for checking backlash of crown wheel. | 2573 5890 35 01 |
| 15 | Depth measurement gauge for tail pinion. | 31 589 04 21 |
| 16 | Support for removal of tail pinion taper roller bearings. | 321 589 04 35 |
| 17 | Drift for installation of inner races of tail pinion taper roller bearings. | 042 589 01 39 |
| 18 | Wrench for slotted rings on differential side bearings. | 2576 5890 35 20 |
| 19 | Stand for carrier housing assembly. | 2573 5890 37 01 |
| 20 | Device for checking friction moment of tail pinion taper roller bearings. | 338 589 00 21 |
| 21 | Tension jaws for (i) holding split spacer ring in assembly,<br>(ii) tightening tail pinion threaded ring to be used with SI. No. 22. | 2575 5890 35 03 |
| 22 | Pronged wrench for tail pinion threaded ring to be used with SI. No. 21. | 2576 5890 35 21 |
| 23 | Puller for removal and installation of tail pinion assembly with bearings. | 317 589 15 33 |
| 24 | Torque multiplier (ratio 1 :4). | 000 589 37 63 |
| 25 | Holder for torque multiplying wrench. | 042 583 00 67 |

**SPECIAL TOOLS**

| Sl. No. | Description | Part No. |
|---|---|---|
| 26 | Drift for installation of (i) coupling flange on tail pinion splines. (ii) tail pinion oil seal. (iii) hub outer bearing outer race. | 2575 5890 35 01 |
| 27 | Hook for lifting carrier housing assembly. | 2576 5890 35 23 |
| 28 | Trolley for aggregate handling to be used with Sl. No. 29. | 2576 5890 02 19 |
| 29 | Adaptor trolley for removal and fitment of carrier housing assembly on the vehicle to be used with Sl. No. 28. | 2576 5890 35 28 |

**REMOVAL AND INSTALLATION OF REAR AXLE ASSEMBLY ON THE VEHICLE**

**Removal**

1 Place suitable wheel chocks on front and behind the front wheels.
2 Remove the drain plug and drain lubricating oil. Clean and refit drain plug.
3 Disconnect propeller shaft from the tail pinion flange and lay it on the side.
4 Disconnect brake hoses from spring brake actuators.
5 Disconnect shock absorbers, if fitted.
6 Loosen rear wheel nuts slightly and lift rear axle assembly by jacks placed beneath the rear spring seats, so that wheels are lifted from the ground. Fig. 2. Support chassis frame suitably.
*Note: Never place jack under the rear axle centre housing but only beneath the springs seats, especially on a loaded vehicle.*
7 Unscrew the 'U' bolt check nuts and nuts and knock out the 'U' bolts with mallet. Remove 'U' bolt pads.
8 Lower and roll out rear axle assembly with the rear wheels from beneath the chassis towards the rear. Care should be taken to prevent the tail pinion flange spring brake actuators from being damaged during removal

**Installation**

1 Place axle assembly with wheels below the springs such that the spring centre bolts align in their holes in the spring seats.
2 Clean 'U' bolts. Ease the threads before refitting and oil the threads. Check threads of 'U' bolts and nuts for cracks or any damage. Replace damaged parts, if any.
3 Mount 'U' bolts and tighten the 'U' bolt nuts and check nuts to 42 mkg torque. Fig. 3.
4 Connect and tighten shock absorbers, if provided.
5 Clean the area around the filter plug and fill rear axle with recommended oil upto filler plug level.
6 Tighten wheel mounting nuts to a torque of 50 to 60 mkg for spigotted wheel rims or 45 to 55 mkg for non-spigotted wheel rims Fig. 4.
7 Position and fasten propeller shaft to the coupling flange with nuts, lock plates and bolts. Tighten the mounting bolts to 6.5 to 7.5 mkg. torque and lock the bolt heads with lock plates.
8 Connect and tighten brake hoses to spring brake actuators (S-cam brakes).
9 Adjust brakes. Refer Group 42.
10 Road test vehicle.

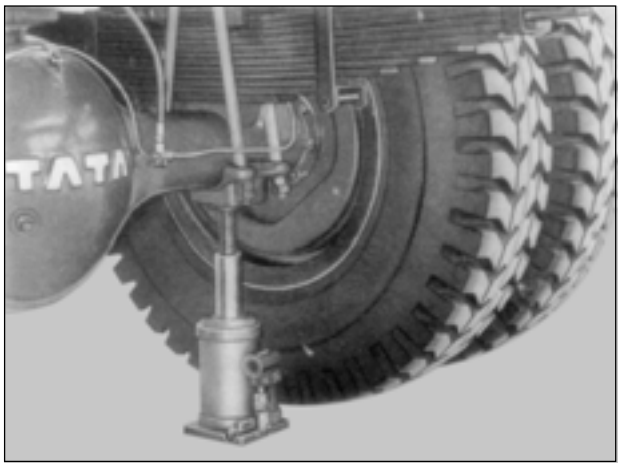


*Fig. 2*

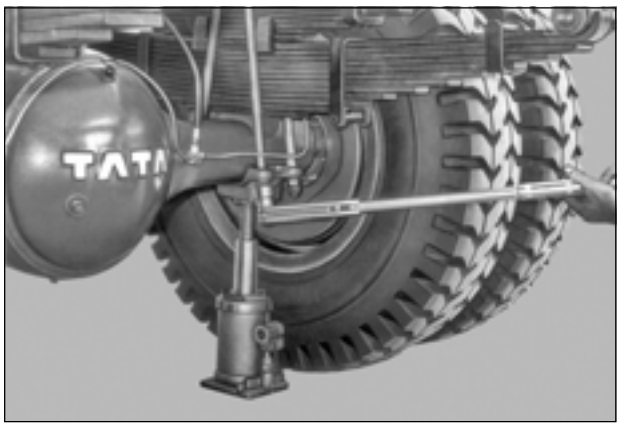


*Fig. 3*



*Fig. 4*

**REMOVAL OF BRAKE DRUM**

(Spherical washers where provided and wheels removed)

1 With suitable lifting arrangement, position rear axle assembly on the work stand.

2 Position a box spanner or ring spanner over adjusting hexagon. By depressing the locking sleeve slacken off the adjusting screw of the slack adjuster until the shoes are fully retracted.

3 Screw in 2 bolts (M12 x 1.5x25 mm long) in the threaded holes provided in the brake drum. Tighten these bolts to separate the drum from the hub. (Fig. 5)

4. For removal, inspection and installation of rear wheel brake aggregates, please refer Group 42.

**REMOVAL OF AXLE SHAFT**

(Brake drum removed)

1. Unscrew the hub cover bolts and remove cover with gasket.
2. Pullout the splined axle shafts from the hubs with puller 042 589 01 33. Fig. 6.

**REMOVAL OF HUB**

(Brake drum and axle shaft removed)

1. For hub assembly with single oil seal.

a. Unlock the lip of the lock plate from the grooved nut slot and unscrew grooved nut with the help of wrench. 2575 5890 35 04 Fig. 8.
Remove the lock plate. Using the same wrench, unscrew the another grooved nut and remove the tongued washer from the spindle.

2. For hub assembly with double oil seal.

a. Unscrew the M8 lock pin on the hub lock nut. Fig. 7.

b. Using the tool 2632 5890 35 02 and torque wrench unscrew the coarse pitch hub lock nut.

3 Pull out the hub with the help of puller 2576 5890 35 22. Mount holder 2576 5890 35 09 over it for grip. Fig. 9.

4 For removal, inspection and installation of rear wheel brake aggregates, refer Group 42.



*Fig. 5*

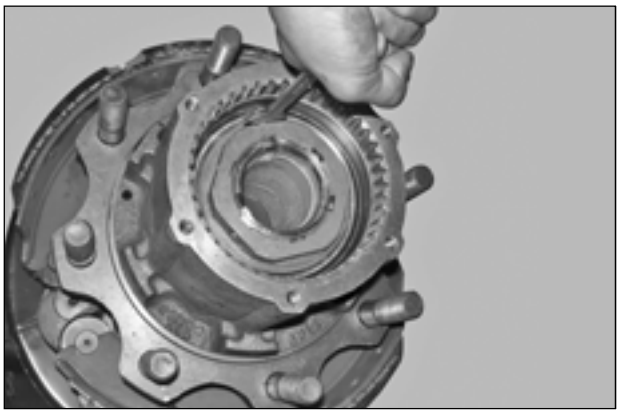


*Fig. 7*

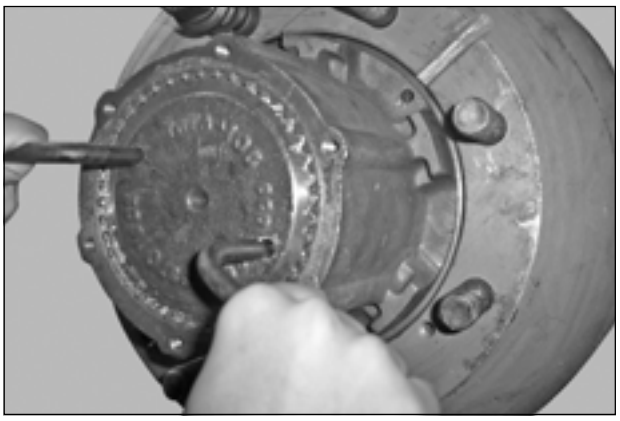


*Fig. 6*

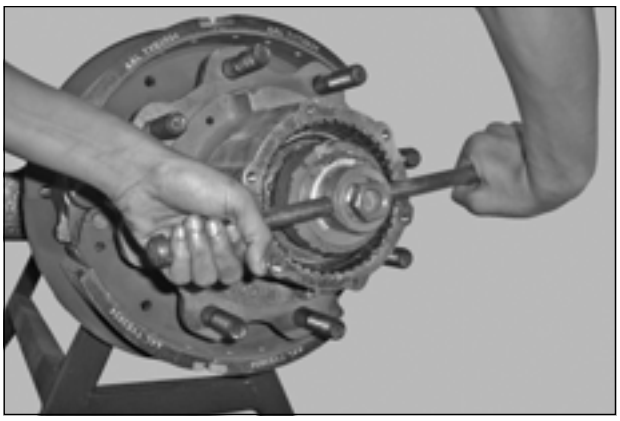


*Fig. 8*

**REMOVAL OF CARRIER HOUSING ASSEMBLY**
(For Banjo type rear axle only)

1 After removing axle shafts turn and mount the axle beam assembly on stand in such a way that tail pinion coupling flange will face upwards.
2 Unscrew check nuts and nut holding carrier housing to the rear axle beam.
3 Screw in 2 bolts (size M12 x 25 mm long) in the threaded holes on the carrier housing. Tighten these bolts to separate the carrier housing assembly from the axle beam, Fig. 10.
4 With the help of hook, 2576 5890 35 23 lift the carrier housing assembly from the axle beam.

**Note**: Carrier housing assembly can be removed from the vehicle using adopter trolley, 2576 5890 35 28 along with trolley, 2576 5890 02 19.

**REMOVAL OF CROWN WHEEL, DIFFERENTIAL ASSEMBLY AND TAIL PINION ASSEMBLY**

1 Lift the carrier housing assembly with the help of hook 2576 5890 35 23. Place the carrier housing assembly on the special stand 2573 5890 37 01, so that the crown wheel aligns with the slot in the carriage plate and bolt the carrier housing to the carriage plate. (Banjo type).
2 Unscrew and remove rear cover from the centre housing (Salisbury type).
3 Adjust position such that crown wheel is facing upwards.
4 Loosen check nut holding thrust pad in the carrier housing and remove thrust screw with pad. Fig. 12.
5 Unlock check nut washers and remove the bolts and lock plates from the differential side bearing cap. Fig. 13.
6 Unscrew bolts holding differential side bearing caps (the side bearing caps are marked 'L' and 'R' for left and right respectively) and remove bearing caps. Do not interchange side bearing caps of different assemblies.

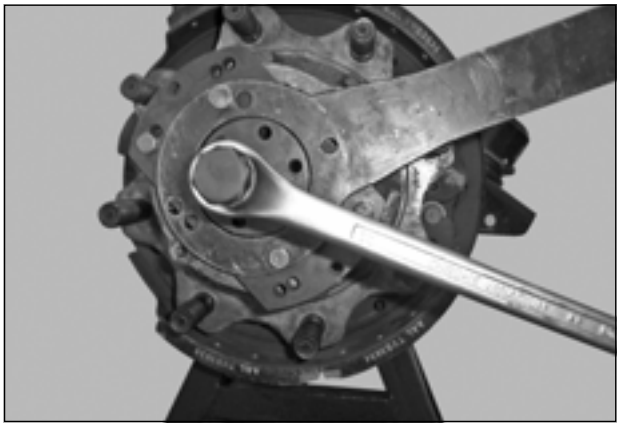


*Fig. 9*

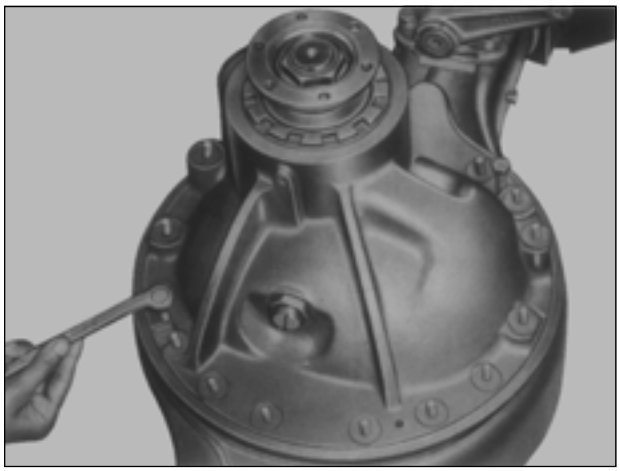


*Fig. 10*

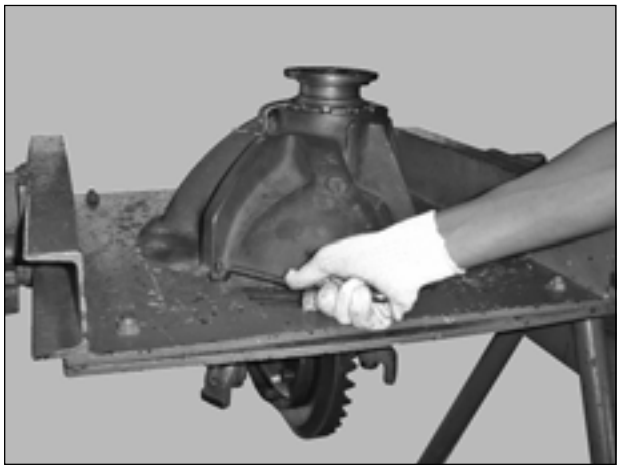


*Fig. 11*

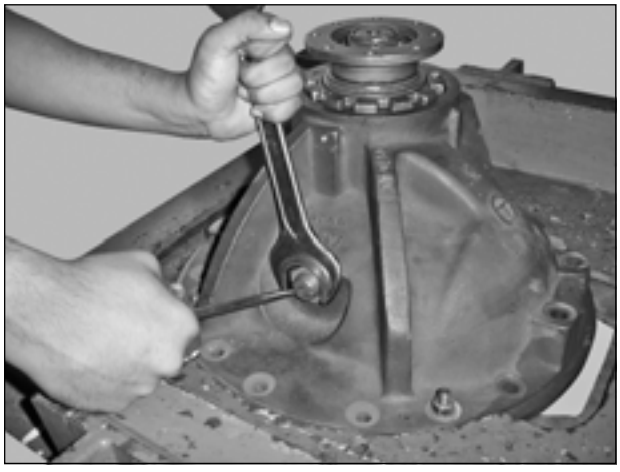


*Fig. 12*

7 Remove the threaded adjusting rings on the left and right of the differential taper roller bearings.

8 Remove carefully the outer races of the differential taper roller bearings and put identification marks. These should not be interchanged.

9 Tilt crown wheel with differential assembly till the crown wheel' aligns with the recesses provided in the housing and remove the assembly out. Fig. 14.

10 Adjust position such that the tail pinion coupling flange is facing upwards,

11 Unlock the tab washer, unscrew the bolt holding lock plate of the tail pinion threaded ring and remove the lock plate. Fig. 15.

12 Unstake the tail pinion collared nut from the groove in the pinion.

13 Mount holder, 2576 5890 35 09 on the tail pinion coupling flange. Grip the holder and unscrew nut with 50 mm socket. Fig. 16. Remove the holder.

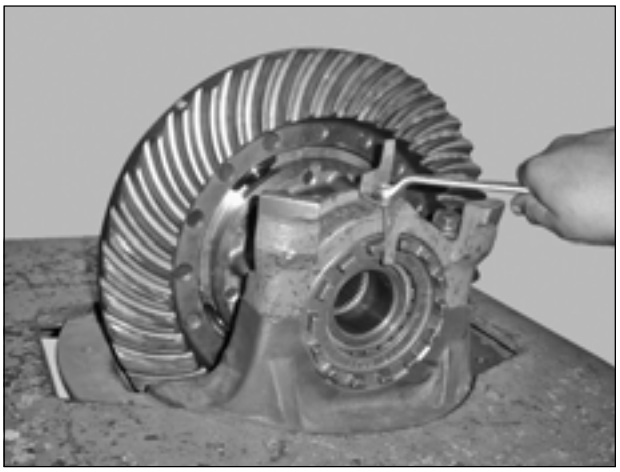


*Fig. 13*

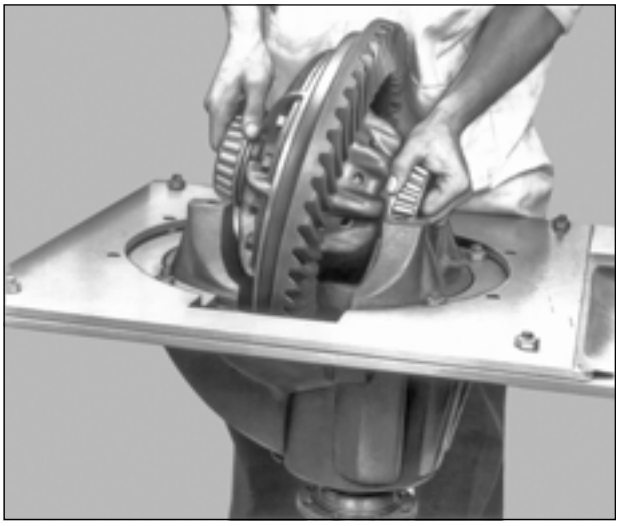


*Fig. 14*

14 Mount puller, 2576 5890 35 22 on the coupling flange. Over the puller, mount holder, 2576 5890 35 09. Grip the holder extract tail pinion coupling flange. Fig. 17.

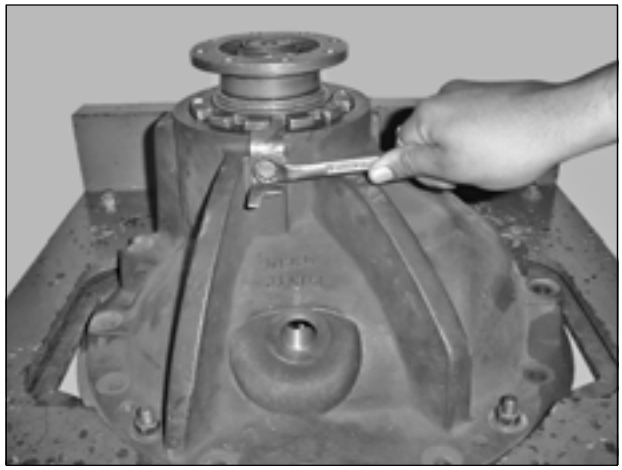


*Fig. 15*

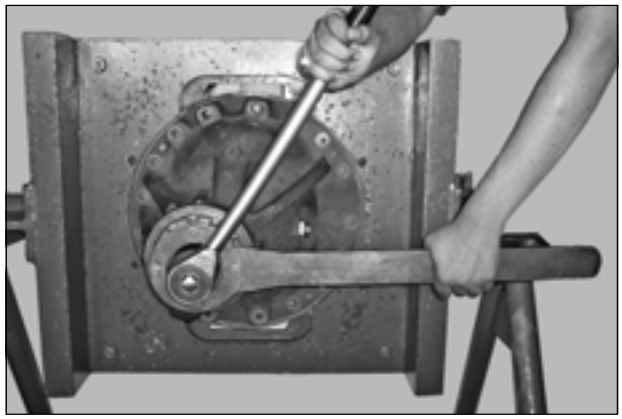


*Fig. 16*

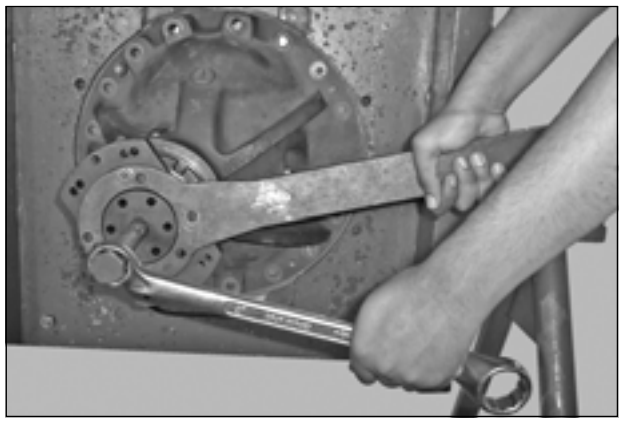


*Fig. 17*

15 Mount tension jaws 2575 5890 35 03 over threaded ring. Unscrew and remove the slotted threaded rings from the housing with the help of pronged wrench 2576 5890 35 21, torque multiplier (ratio 1:4) 000 589 37 63, holder 042 583 00 67 and torque wrench. Fig. 18.

16 Remove tail pinion thrust washer.

17 Fit special tool part no. 321 589 14 33 in the tail pinion bore for the threaded ring and refit tail pinion flange holding nut on flange (A) of the special tool. Uniformly tighten the two inner hex bolts (C) so that the spacer ring (0) is firmly pressed against the outer race of the pinion outer taper roller bearing. This is very essential to prevent the split spacer rings (C) between the outer races of the pinion taper roller bearings slipping into annular groove (b) and thus making it impossible to pull out the tail pinion assembly. The tail pinion assembly can now be removed from the housing by evenly tightening the hex. head bolts (8) against the housing

See figs. 19 and 20. Remove tall pinion assembly from the housing. Unscrew the tail pinion flange nut and remove special tool.

18 Remove tail pinion depth adjusting shims (g) from the seat in the housing.

19 With plier pull out the locking wire from the groove in the housing, Fig. 21.

20 With drift, 2574 5890 99 02 remove cylindrical roller bearing outer race. Fig. 22.

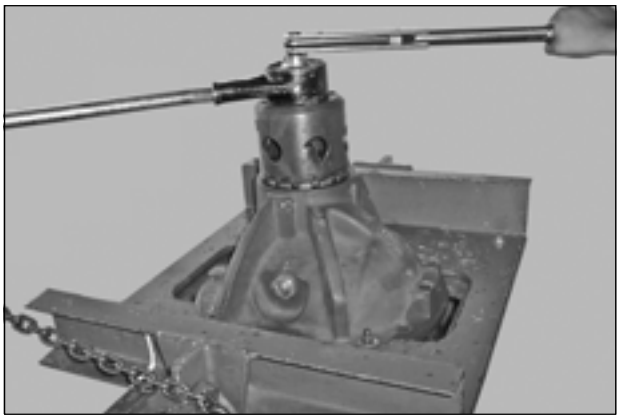


*Fig. 18*



*Fig. 19*

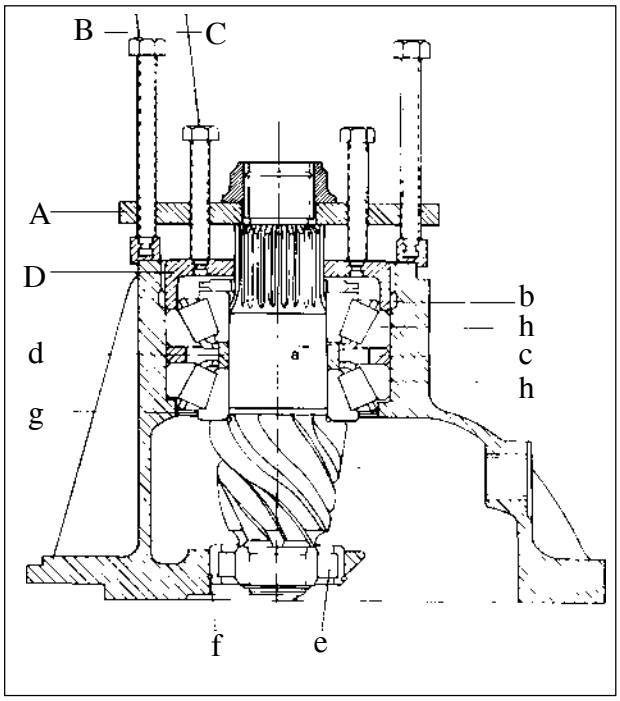



*Fig. 20*



*Fig. 21*

**DISMANTLING OF TAIL PINION**

1 Remove circlip from the tail pinion end. Fig. 23. Remove inner race of the cylindrical roller bearing using universal commercial bearing puller.

2 Rest the inner race of the inner taper roller bearing of the tail pinion on support 321 589 04 35 (Fig. 24) and press tail pinion out of the two taper roller bearings. Remove the outer taper roller bearing assembly, the split spacer rings between the outer races, the spacer washers between the two inner races and the inner taper roller bearing assembly.

3 Put identification marks on inner and outer races of the respective taper roller bearings.

4 Clean thoroughly all parts.

**INSPECTION OF TAIL PINION**

1 Check set numbers on tail pinion and crown wheel for conformity. Fig. 25.

2 Check tail pinion and crown wheel teeth for scoring, burrs, breakages or overheating marks. Also check bearing seats on tail pinion for scoring and circlip groove for damage. Replace the pinion and crown wheel in a set, even if anyone of these is found defective.

3 Check splines on tail pinion and burrs.

Clean all the burrs on the splines.

4 Check threads on tail pinion and ease threads.

5 Replace the collared nut tail pinion with a new one. Since the nut once tightened and staked gets damaged due to unstaking while loosening.

6 Check all bearings for signs of scoring, pitting, overheating, etc. Replace all worn/damaged bearings.

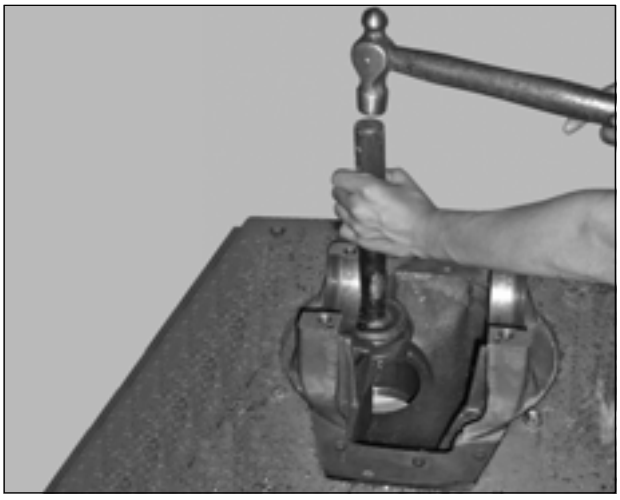


*Fig. 22*



*Fig. 23*

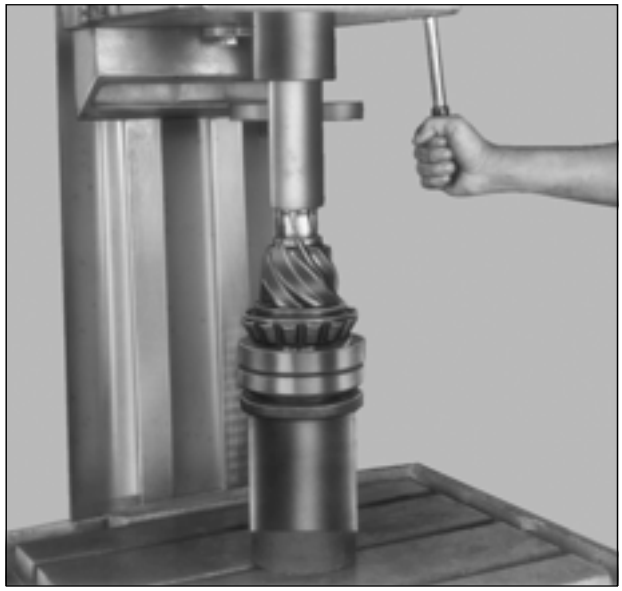


*Fig. 24*

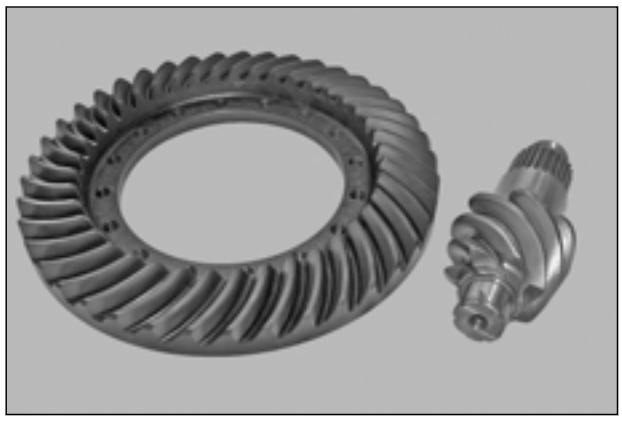


*Fig. 25*

**ASSEMBLY OF TAIL PINION**

1 Locate chamfer on the cylindrical roller bearing inner race on the tail pinion spigot diameter. Press it in with the help of drift 312 589 14 39 Fig. 26.

Fit circlip and check for proper fit.

2 Oil and keep inner race assembly of taper roller bearing on the pinion and press it in with drift 042 589 01 39. Fig. 27. The bigger diameter of taper roller bearing should rest flush on the pinion teeth.

3 Slide spacer ring on the tail pinion.

4 Insert outer races of the taper roller bearing with their larger diameters on opposite ends and towards their respective inner race assembly.

5 Oil and keep inner race assembly of taper roller bearing on the pinion and press it in with drift 04258901 39. Fig. 28. The smaller diameter of the taper roller bearing should rest flush on the spacer ring.

6 Insert the thrust washer on the outer bearing face.

7 Inspect tail pinion oil seal in threaded ring for lip wear, cut or damage. If necessary, replace it using drift 2575 5890 35 01. Fig. 29.

8 Fill up heavy duty molycote grease in the pocket on the oil seal between the dust lip and the sealing lip and insert the assembly on the tail pinion.

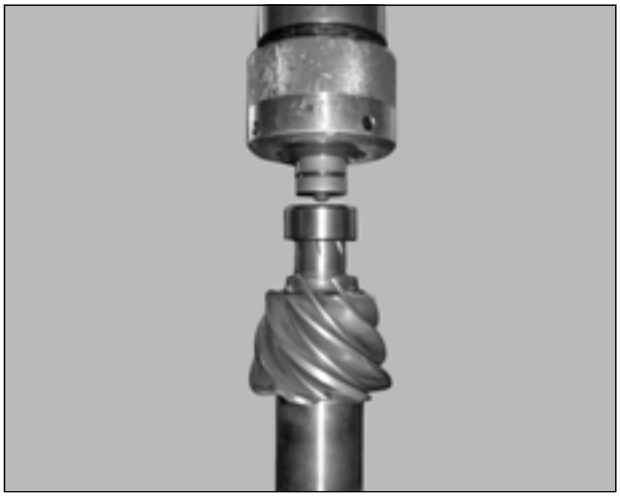


*Fig. 26*

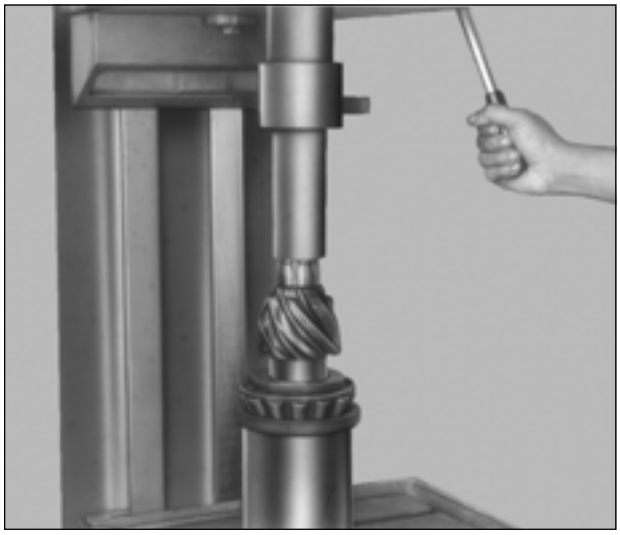


*Fig. 27*

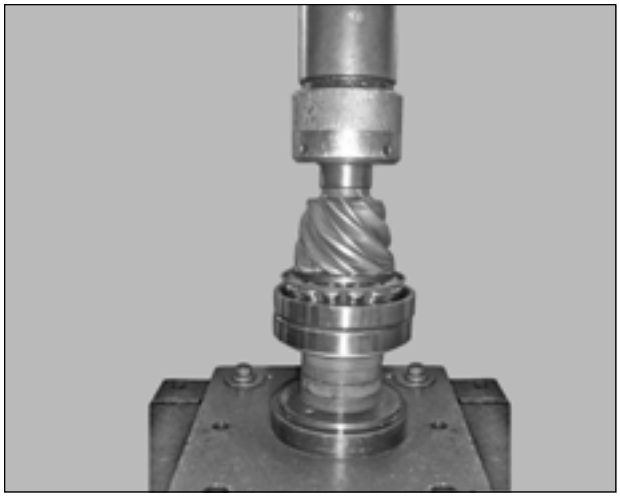


*Fig. 28*



*Fig. 29*

9 Apply oil on the tail pinion and coupling flange splines. Install coupling flange on the tail pinion using drift 2575 5890 35 01 such that it rests flush on the thrust washer. Fig. 30.

10 Screw in new coupling flange nut on the tail pinion.

11 Mount holder 2576 5890 35 09 on the coupling flange and fasten it using three M 10 bolts and nuts. Clamp the holder in the vice. Use 50 mm socket and tighten the nut to 30 to 36 mkg. torque. Fig. 31. Do not stake collar on the nut in tail pinion groove at this stage.

12 Taper roller bearings of the tail pinion assembly have to be assembled with a preload to give a friction moment of 14 to 34 cmkg. For preloading these bearings, a spacer ring is provided between the two outer races of the taper roller bearings. The spacer rings are available in 21 thickness from minimum 10.10 to 10.50 mm maximum rising by 0.02 mm and are supplied as a whole ring. For selection and assembly of the spacer ring proceed as follows:

(i) Insert two spacer rings of equal thickness between the two outer races of the taper roller bearings. Fig. 32. Thickness of the spacer rings should be checked using micrometer. Feel the friction moment with the hand and select spacer thickness for trial assembly.

(ii) Hold the spacer ring of the thickness to be tried, across the 'V' groove on a table vice and split it into two pieces by tapping it with hammer. Round off the split ends of the spacer ring by grinding or remove the burrs by filing.

(iii) Insert these two pieces of the spacer ring between two outer races of the taper roller bearings. Fig. 33.

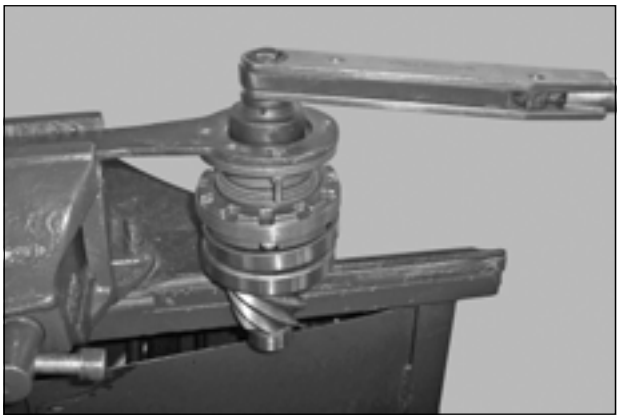


*Fig. 31*



*Fig. 32*

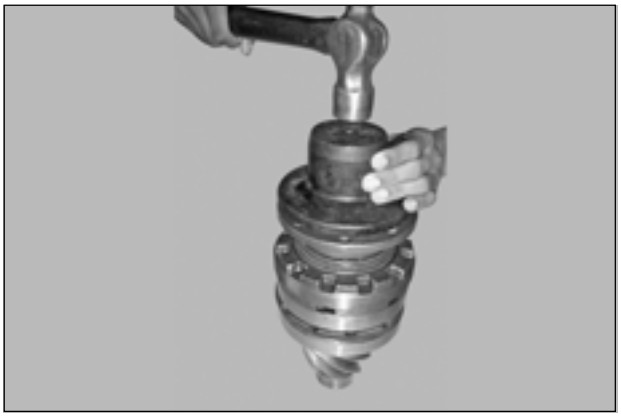


*Fig. 30*

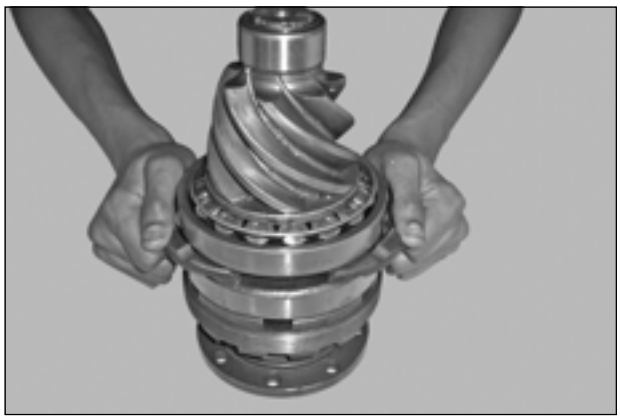


*Fig. 33*

(iv) Measure the friction moment with the help of special tool 338 589 00 21. Fig. 34.

If friction moment is found to be either less than 14 cmkg or more than 34 cmkg, thicker or thinner split spacer rings have to be fitted respectively.

13 Fit two tension jaws 2575 5890 35 03 between threaded ring and coupling flange, using four M 10x40 mm long screws with nuts through the holes on the coupling flange. Align the split spacer rings between the two outer bearings races and tighten the screws provided on the flange to grip the spacer evenly. Figs. 35 and 36.

**INSTALLATION OF TAIL PINION ASSEMBLY**

1 Clean carrier housing/center housing thoroughly. Check the threads and bearing bores for damage.

2 Mount the carrier housing on stand 2573 5890 37 01 and fasten it on the carriage plate of the stand (Banjo type). Mount axle beam on the work stand (Salisbury type). Adjust position such that tail pinion bearing bore faces upwards.

3 Oil cylindrical roller bearing mounting bore and the bearing outer race.

4 Locate the chamfer on the outer race of the cylindrical roller bearing in its mounting bore and tap it in using drift 2574 5890 99 02 till the groove on its outer race is aligned with the corresponding groove in the mounting bore.

5 Insert the locking wire to lock and locate the bearing in corresponding position. Fig. 37.

6 Adjust position such that tail pinion mounting bore faces upwards.

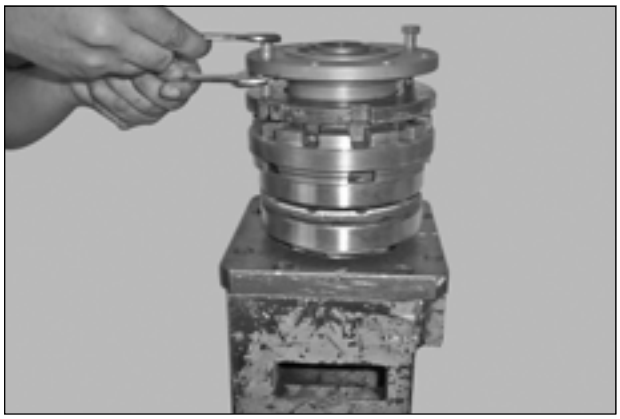


*Fig. 35*

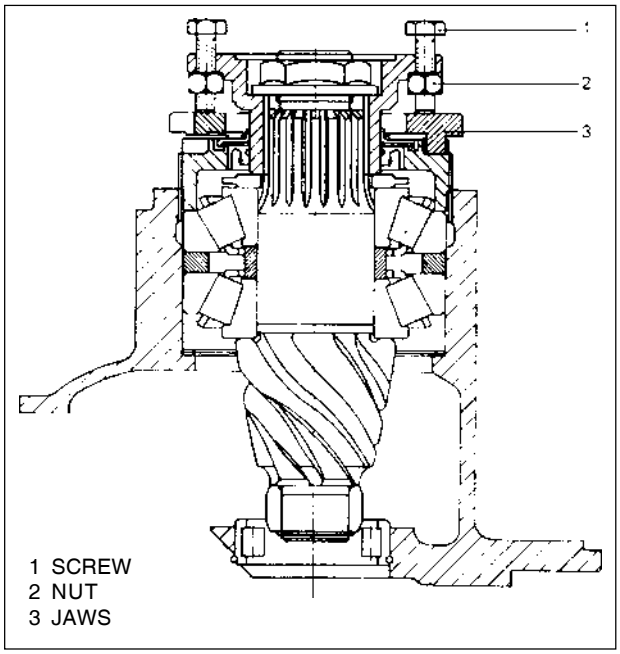



*Fig. 36*

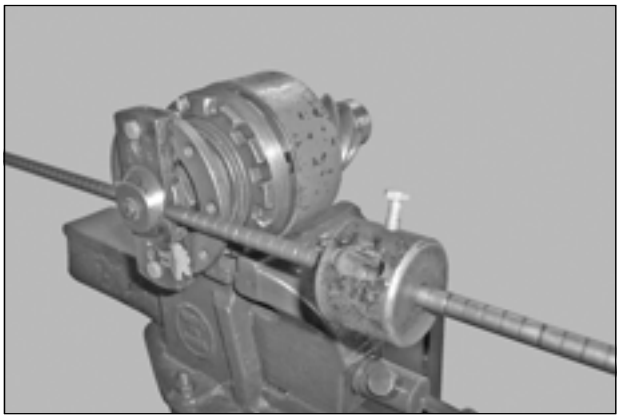


*Fig. 34*



*Fig. 37*

7 Oil tail pinion taper roller bearing mounting bore, threads and also cylindrical roller bearing outer race bore.

8 Insert the tail pinion depth adjusting shims on its seats in the tail pinion taper roller bearing mounting bore.

9 Insert tail pinion assembly along with tension jaws 2575 5890 35 03 in the mounting bore giving light taps with a mallet till the threaded ring aligns with' threads in tail pinion housing. Fig. 38.

10 Mount pronged wrench 2576 5890 35 21 over the tension jaws 2575 5890 35 03 and screw in the threaded ring using suitable tommy bar. Fig. 39.

11 Install torque multiplier (ratio 1:4). 000 589 37 63 over the pronged wrench and tighten it to 25 to 30 mkg torque i.e. the threaded ring is now tightened to 100 to 120 mkg torque. Fig. 40.

*Note: The torque multiplier handle should be firmly held by hooking with holder 042 583 00 67 to the carriage on the stand to enable the threaded ring to be tightened to this high torque. Fig. 40.*

12 Check the tail pinion depth using gauge 321 589 04 21 as follows:

(a) Mount dial gauge (0.01 least count x 10 mm stroke) in the depth gauge.

(b) With the help of the setting piece provided (screwed on the gauge). Set the dial gauge to read zero at the same time preload the gauge to read, say 4 mm (on the smaller pointer in the dial gauge). The above reading gives a basic setting of 83.50 mm measured from the centre of the differential side bearing bore to the tail pinion spigot face.

(c) The pinion depth required to be adjusted or a particular pair of crown wheel and pinion is etched on the, periphery of the crown wheel. For instance, the depth dimension etched is 83.30 mm. Ensure that the set number etched on crown wheel as well as on tail pinion is the same.

(d) Clean the differential bearing bore halves in the housing, the spigot face and the centre hole for tail pinion.

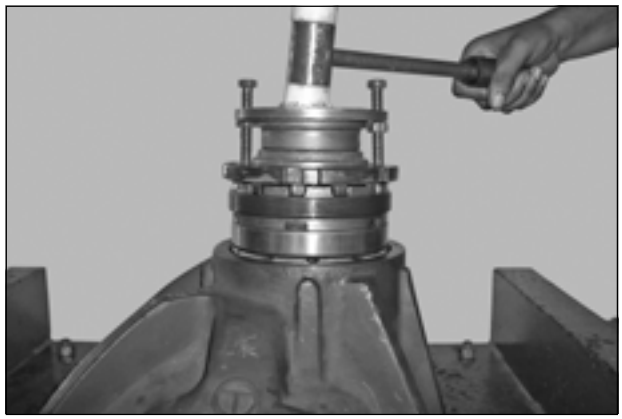


*Fig. 38*

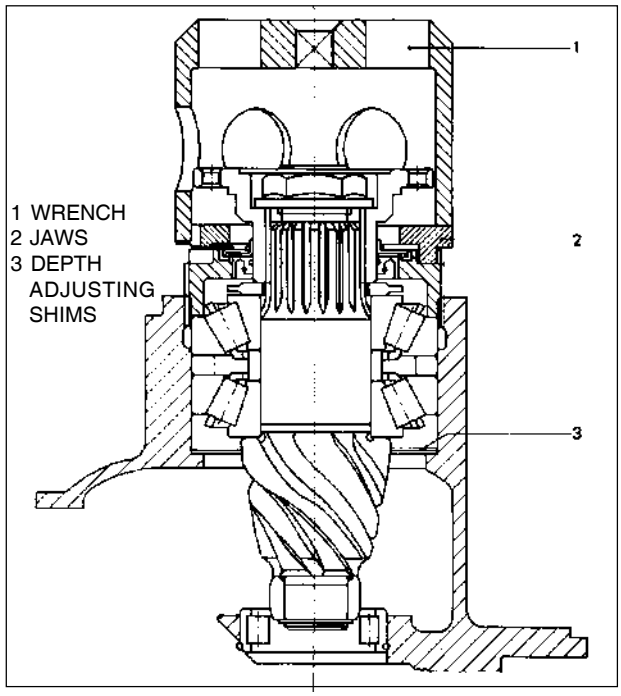



*Fig. 39*

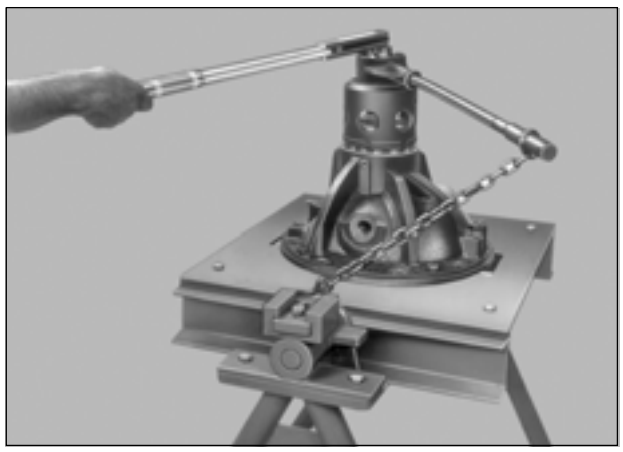


*Fig. 40*

(e) Insert the tail pinion depth measuring gauge preset to the basic setting value into the centre housing taking precaution to see that the centre pin of the tool registers in the centre hole of the tail pinion and measuring plunger of the gauge rests on the spigot face of the tail pinion. Fig. 41 and 42.

(f) If now the dial reads zero with the smaller pointer at 4 mm, it means that the tail pinion depth is same as the actual basic setting value of the gauge i.e. 83.50 mm.

(9) For example, if the tail pinion depth for this particular set is required to be adjusted to 83.30 mm all that is required is to reduce the thickness of the tail pinion depth adjusting shims by 0.20 mm. The tail pinion depth adjusting shims are available in following 5 thicknesses: 0.10, 0.15, 0.20, 0.50 and 1.50 mm.

13 Remove the pinion depth adjusting gauge from the housing.

14 Remove tail pinion assembly from housing as per the procedure outlined earlier under removal of tail pinion assembly.

15 Measure total thickness of the adjusting shims and reduce it by 0.2 mm by selection of correct thickness of shims.

16 Reassemble the tail pinion assembly in the housing with shims of the selected thicknesses. Smear the threads of the threaded ring with Shellac before assembly, and tighten the threaded ring to 100 to 120 mkg torque (item 9 to 11). Remove tension jaws, etc.

17 Recheck and confirm the tail pinion depth, to etched value.

**Note:**

(a) To increase or decrease the tail pinion depth, increase or decrease the thickness of the adjusting shims.

(b) Maximum permissible variation in the pinion depth from the etched value on the crown wheel should be within +0.05 mm.

(c) When the dial gauge reads to the left of the zero, it indicates an increase in the depth from the setting value and vice versa.

18 Stake collar on the coupling nut in the slot provided in the tail pinion, such that the nut is locked against loosening. Fig. 43.

19 Fit the lock plate with tap washer in the slot of tail pinion threaded ring and lock in position. Fig. 15.

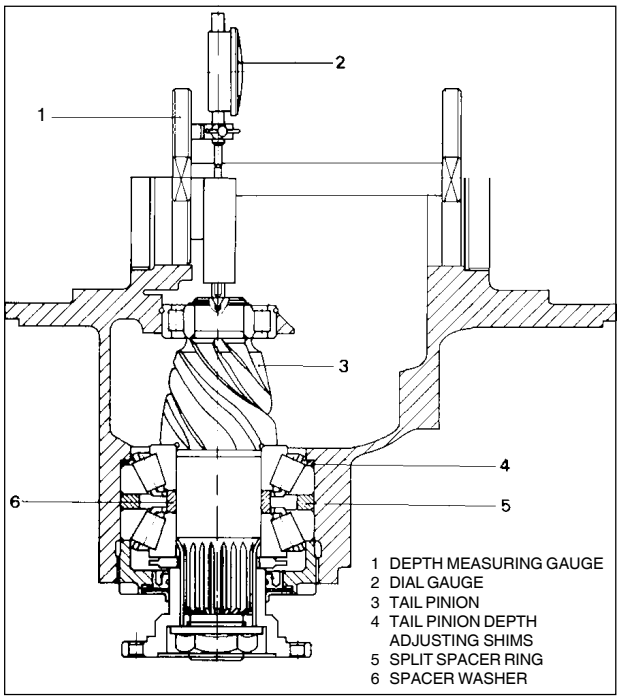



*Fig. 41*

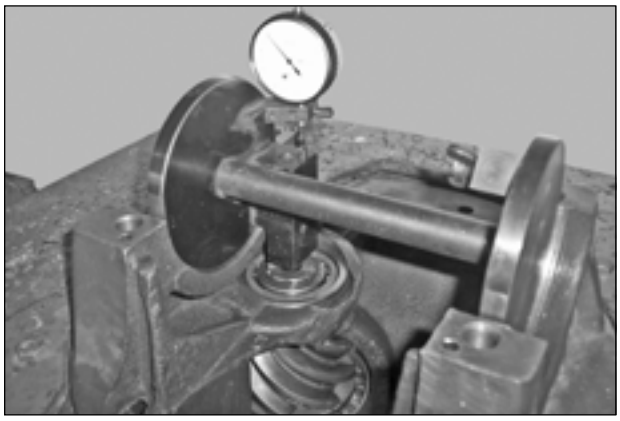


*Fig. 42*



*Fig. 43*

**DISMANTLING OF CROWN WHEEL AND DIFFERENTIAL ASSEMBLY**

1 With the help of puller 312 589 20 33 extract the differential side bearing inner race with roller cage from the differential cover. Fig. 44. Turn the assembly and remove bearing from the case side.
*Note: The finger of the puller must fit in the two slots provided in the differential case/cover, so that the inner race is properly gripped prior to extraction.*
2 Chip off welding and remove the lock plates holding crown wheel and differential carrier mounting bolts.
3 Unscrew the crown wheel mounting bolts and tap the crown wheel from the differential carrier using mallet.
4 Check the mating marks on the differential case and cover halves. (Fig. 45). Unscrew the differential cover mounting bolts and separate out the cover from the differential case.
5 Remove axle shaft gears, thrust washers, spider, bevel gears and spherical washers.
6 Clean all parts thoroughly.

**INSPECTION OF CROWN WHEEL AND DIFFERENTIAL COMPONENTS**

Check the following:

**Crown Wheel**

1 Teeth for scores, burrs, overheating mark, etc. If any of these defects are observed, replace crown wheel and tail pinion in a set.
2 Condition of bolt mounting threads. Ease threads.

**Differential Case/Cover**

1 Differential side bearing mounting diameter for scores and sign of bearing inner face rotation.
2 Axle shaft gear thrust washer mounting face and bevel gear spherical washer resting surfaces for scoring/pitting marks.

**Gears**

1 Splines on the axle shaft gear.
2. Spider for wear.
3 Spherical face on the bevel gears for scoring/ pitting marks.
4 Teeth of shaft gear and bevel gears for scores, burrs etc. If any damage is observed, replace the parts.

**Thrust Washers and Spherical Washers**

Check washers for wear or damage, if necessary replace them in sets.

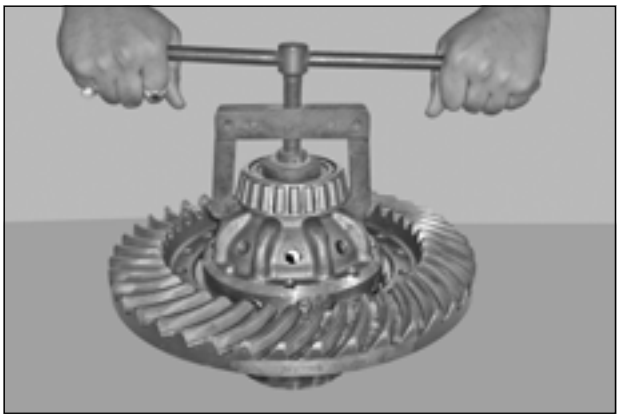


*Fig. 44*



*Fig. 45*

**Side Bearings**

Check for signs of pitting, scoring, burrs, overheating, etc. Replace bearing, if necessary.

**ASSEMBLY OF DIFFERENTIAL AND CROWN WHEEL**

1 Clean the parts.
2 Oil and assemble the differential side gear with brass thrust washer in the differential cover. The grooved face of the thrust washer must face toward the axle shaft gear. Fig. 46.
3 Oil and assemble the spider, bevel gears with spherical washers in the differential cover.

**Note**: The assembly of differential spider bevel gears and axle shaft gears should rotate freely without binding and the backlash between them should be 0.12 to 0.22 mm. To adjust backlash, select brass thrust washers of correct thickness. Thrust washers are available in seven thicknesses from 1.95 to 2.20 mm in steps of 0.05 mm and 2.30 mm.

4 Oil and assemble the differential side gear with thrust washer (oversize) on the bevel gears.
5 Align mating marks and assemble the differential housing on the cover. Fig. 45.
6 Oil threads of the differential cover and screw in mounting bolts. Tighten bolts to 16 to 18 mkg torque.
7 Support differential assembly on two 'V' blocks and check lateral run-out of the crown wheel mating surface on the housing. Fig. 47. Maximum permissible face run-out 0.06 mm.
8 Oil and press differential side bearing inner races using drift 2574 5890 99 02 on the differential assembly till they flush on the collars. Fig. 48.
9 Warm up crown wheel in hot oil to 70°C to 80°C. Locate crown wheel 011 differential case and align its holes with the mounting holes. Oil threads of mounting bolts and screw them with lock plates. Tighten the bolts evenly to 16 to 18 mkg torque. Fig. 49.
10 Locate new lock plates on the differential and crown wheel mounting bolts. If necessary, for proper seating of the lock plates, adjust bolt heads within 16 to 18 mkg torque by further tightening, if necessary.
11 Lightly tack weld with an electric arc individual lock plates to the carrier at the hole provided in the lock plate. Clean and blowout slag. Ensure that no particles enter differential carrier. Check for proper welding.

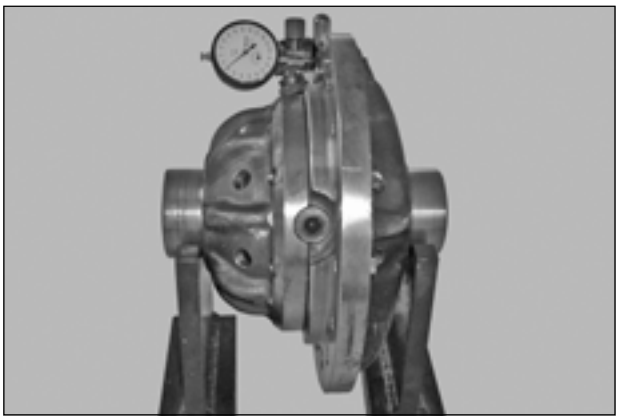


*Fig. 47*

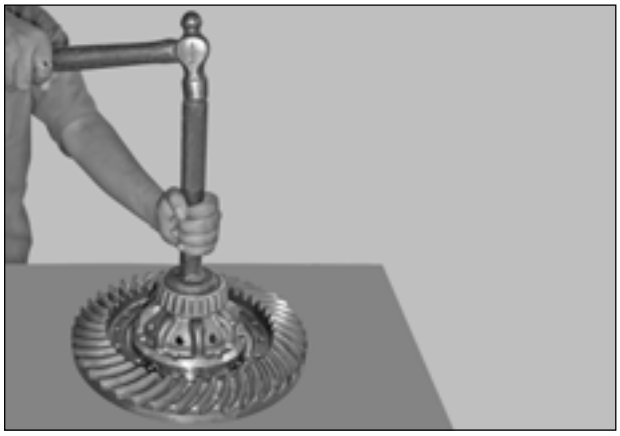


*Fig. 48*

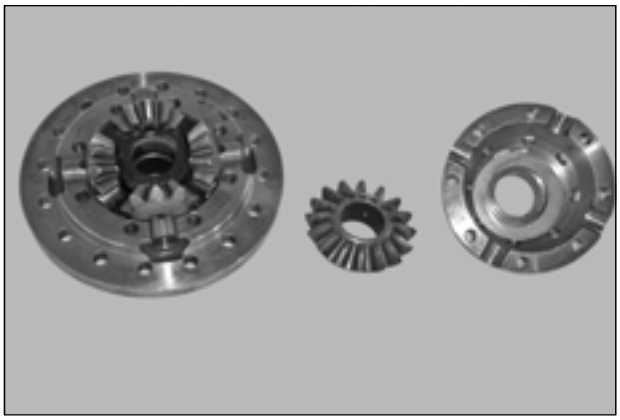


*Fig. 46*



*Fig. 49*

**INSTALLATION OF DIFFERENTIAL CROWN WHEEL ASSEMBLY**

Carrier housing with tail pinion assembly mounted on stand, 2573 5890 37 01 with differential mounting face upwards (Banjo type).

Axle housing with tail pinion assembly mounted on stand, with differential mounting face upwards (Salisbury type).

1 Thoroughly clean and oil differential bores / threads in the housing/bearing caps.

2 Tilt the differential/crown wheel assembly till the crown wheel aligns with recess in the housing and carefully insert the assembly with the appropriate outer races of the taper roller bearings.

3 Fit the outer races of the side bearings snugly against their respective roller cages. Position differential/crown wheel assembly centrally in the side bearing bores.

4 Clean and oil threads of the threaded rings. Rest them against the bearing outer races, the threadings in the carrier housing. Fig. 50.

5 Thoroughly clean the differential side bearing cap specially the mating surfaces. Check condition of dowel pins in the cap and their mating holes in the carrier housing.

6 Fit bearing caps, aligning the dowel pins and matching the threads in the ring. Lightly tap caps for proper seating.

**Note:** Bearing caps are not interchangeable and are not serviced separately. Check for the markings 'L' and 'R' on the side of the bearing caps for their correct location before assembly.

7 Clean and oil threads of the bearing cap mounting bolts. Screw in the bolts by hand. If it if hard to screw in the bolts, it indicates that the threads in the threaded ring and in the cap have not aligned. Do not attempt to tighten the bolts by force, as it will damage the threads. If any of the bolts is hard to screw in, remove the cap Fig. 50 and reposition threaded ring. Reassemble the cap, till the threaded ring can be turned freely with the cap bolts tightened to 3 mkg torque.

8 Tighten side bearing cap mounting bolts to 22 to 24 mkg torque. Fig. 51. Loosen them by quarter turn.

9 With the help of wrench 2576 5890 35 20 tighten both the threaded rings evenly and equally at the same time revolve the crown wheel assembly. Fig. 52. This will be possible if the crown wheel if the crown wheel assembly has been correctly centred in the side bearing bores. Check that no lateral

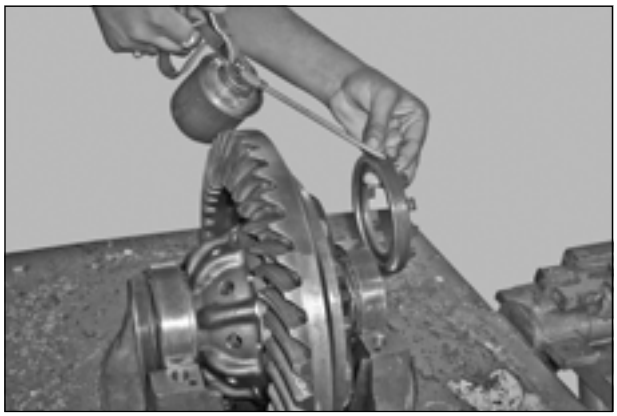


*Fig. 50*

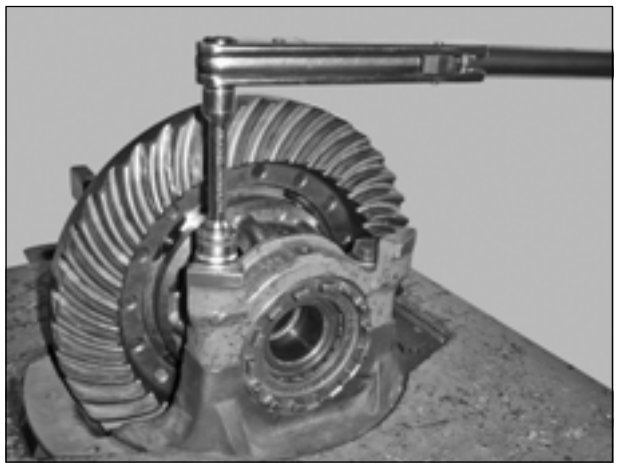


*Fig. 51*

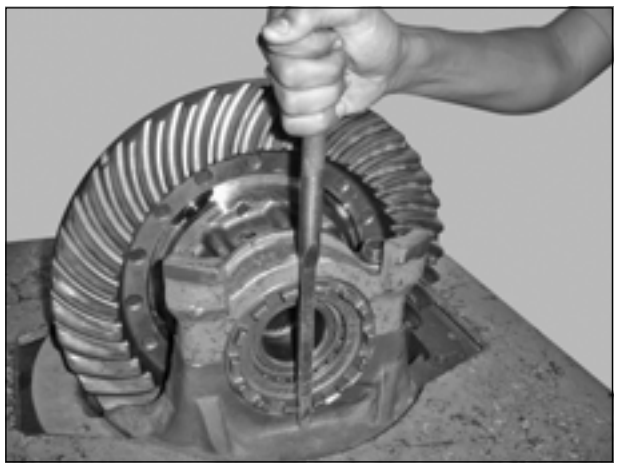


*Fig. 52*

play is present between differential assembly and side bearing.

10. Mount dia gauge with the help of holder 2576 5890 35 24 on the carrier housing Fig. 53.
11. To measure the backlash between crownwheel and tail pinion teeth, hold the tail pinion firmly and move the crown wheel. The crown wheel assembly should be roughly positioned in the carrier housing such that backlash should read between 0.5 and 1.00 mm.

**Note**: If backlash is less than 0.5 mm loosen the left adjusting ring and equally tighten the right one to increase backlash. With this adjustment crown wheel moves away from tail pinion. If backlash is more than 1.0 mm, loosen the right adjusting ring and equally tighten, the left adjusting ring to decrease backlash. Crown wheel will move towards pinion.

12 When .this provisional setting of 0.5 to 1.0 mm is achieved, loosen the right threaded ring with the help of wrench 2576 5890 35 20 by about two turns and tighten the left threaded ring till the backlash between the crown wheel and pinion is reduced to or 0.15 mm.

13 Rotate crown wheel and check backlash at four places 90° apart.

14 Tighten left hand side cap mounting bolts to 12 to 15 mkg torque.

15 Tighten right side threaded ring till the backlash of 0.24 mm (Oerlikon 45/7) or 0.20 mm (Oerlikon 48/7 & Gleason).

16 Check crown wheel for free rotation.

17 Tighten both the differential side bearing cap mounting bolts to 22 to 24 mkg torque.

18 Recheck backlash at four places 90°C apart. The mean of these backlashes should be between 0.20 and 0.28 mm (Gleason) or 0.20 to 0.26 mm (Oerlikon 48/7) or 0.24 to 0.30 mm (Oerlikon 45/7), If not, loosen the ‘cap mounting bolts and reset by adjusting threaded rings.

19 Mount dial gauge with the help of holder 2573 5890 3501 on housing and check lateral run-out of the crown wheel.. Fig. 54. Maximum permissible lateral run-out of crown wheel 0.06 mm.

20 Mount threaded ring .Lock plates on the bearing caps. Screw in the bolts along with the plate washer. Tighten the bolts fully and lock the tab washer. Fig. 55.

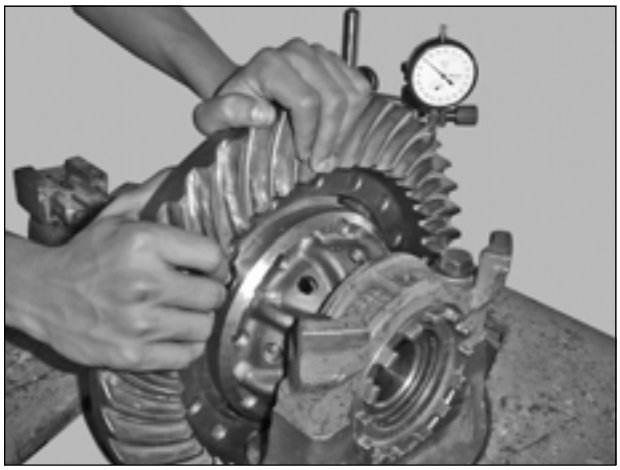


*Fig. 53*

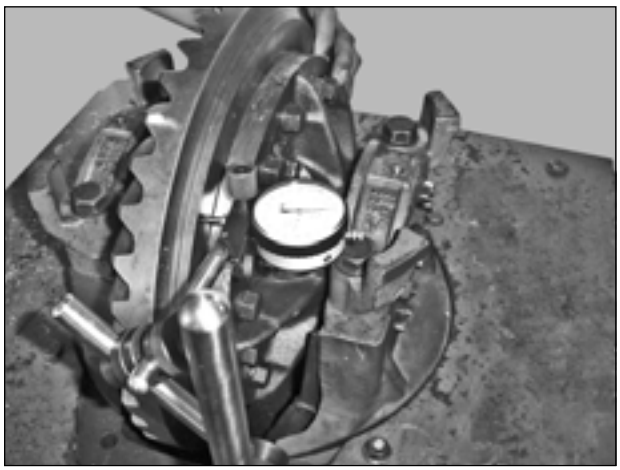


*Fig. 54*

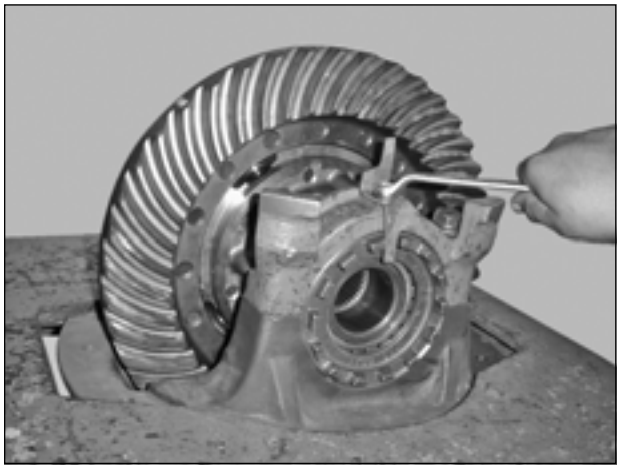


*Fig. 55*

**ASSEMBLY OF THRUST SCREW IN THE HOUSING**

(Differential and crown wheel assembly installed in the housing)

1 Check the condition of the thrust pad and replace, if excessively worn out.
2 Oil the threads of the screw and also in the carrier housing.
3 Assemble the screw in housing till the thrust pad rest on the machined face of the crown wheel.
4 From this position turn the screw back by 1/6th of a turn and lock the check nut. This will ensure a clearance of 0.25 mm between the face of the thrust pad and crown Fig. 56

**CROWN WHEEL/TAIL PINION CONTACT CHECKING**

Correct tail pinion depth and backlash between the teeth of crown wheel and pinion will ensure correct tooth contact. The correct tooth contact is essential for proper distribution of load on the teeth and noiseless operation of the gears.

Tooth contact may be checked as given below.

1 Lightly smear red lead paste on three or four consecutive teeth of the crown wheel.
2 Turn the tail pinion in normal forward drive direction several times. Load the crown wheel slightly by putting a wooden wedge between the crown wheel periphery and carrier housing.
3 Study the contact pattern on drive (convex) and coast (concave) face of the teeth. Fig. 57 and 58.

**Note**: In practice, it may not be possible to obtain the ideal contact exactly as shown. However, it must be ensured that the contact is not confined to either the root top, toe or heel portion of the crown wheel but is generally around the pitch line of the crown wheel.

4 Apply shellac on centre housing and fit rear cover with filler plug and new gasket properly (Salisbury type).
5 Screw drain plug firmly (Salisbury type).

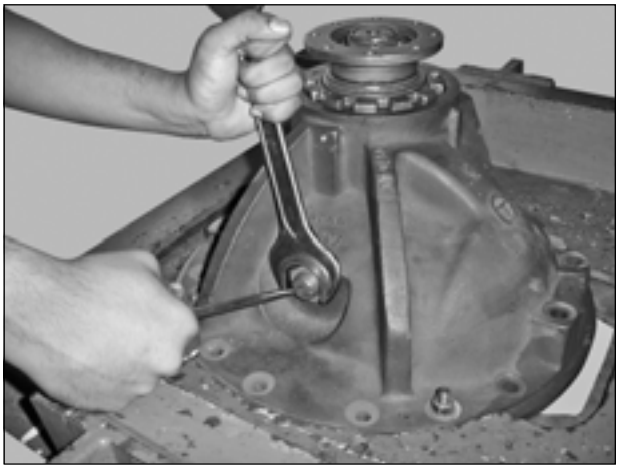


*Fig 56*

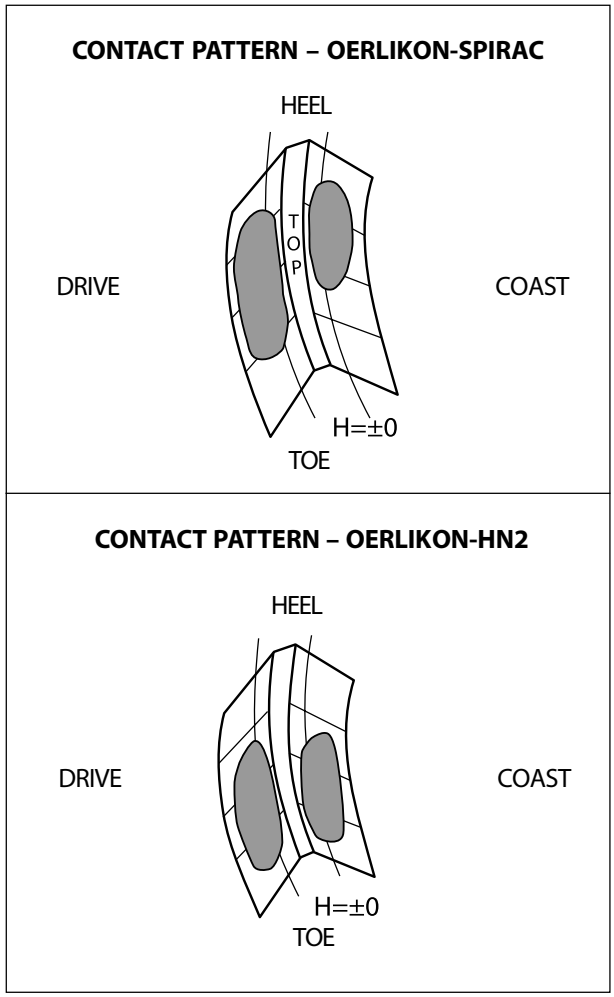



*Fig. 57*

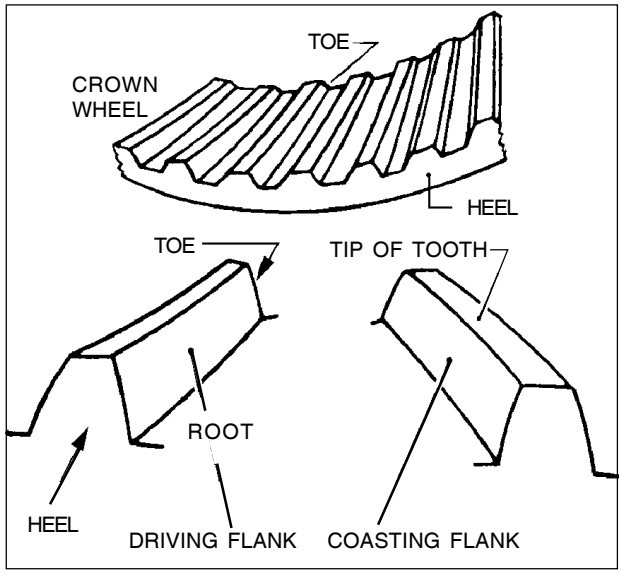



*Fig. 58*

**INSPECTION OF AXLE BEAM**

Check the following.

1 Hub nut mounting threads for damage ease threads.
2 Beam for cracks, especially in welded portions (Banjo type).
3 Clean and ease carrier housing mounting stud threads (Banjo type).
4 Hub bearing seat diameter.
5 Concentricity of bearing mounting spindle diameters. It should not exceed the limit of 0.03 mm.
6 Axle beam for bend. Fig. 59. Replace the beam if any of the above referred defects are observed.
7 Carrier housing mounting spigot diameter for damage and burrs. Rectify, if any.
8 Visually check oil seal pressure ring on beam for groove formation. Replace the pressure ring if groove formation is noticed.
9 Check oil deflector for correct fitment with the oil hole at the bottom.

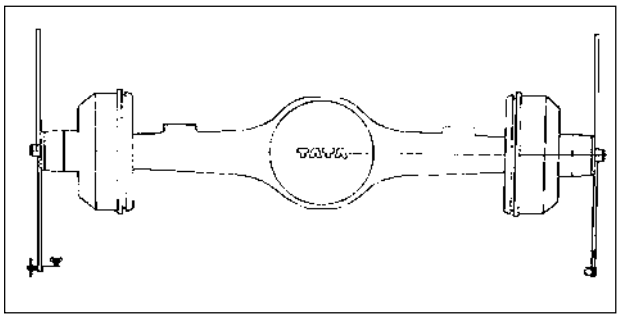


*Fig. 59*

**INSTALLATION OF CARRIER HOUSING ASSEMBLY ON THE AXLE BEAM**

(For Banjo type rear axle only)

Carrier housing assembly installed on stand 2573 5890 37 01.

1 Clean and ease the threads of the mounting studs on the beam. Also clean the mounting face, dowel pins and the spigot bore in the axle beam.
2 Dismantle carrier housing assembly from the carriage of the assembly stand and lift it with the help of hook 2576 5890 35 23.
3 Remove the gasket from the carrier housing and clean the gasket mounting face, the spigot diameter and stud holes thoroughly.
4 Stick new gasket on the carrier housing mounting face with shellac. Apply shellac on axle beam carrier housing mounting face.
5 Smear shellac on the threads of the mounting studs.
6 Mount the carrier assembly on the beam by locating it on the dowel pin. Fit studs in the rear axle beams firmly.
7 Install washers on the studs and screw in the nuts.
8 Tighten the nuts and check nuts to 11 mkg torque. Fig. 60.

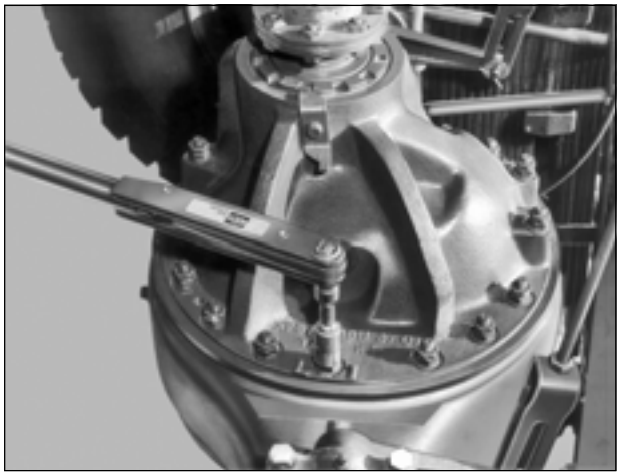


*Fig. 60*

**Note**: Ensure that spigot diameter of the carrier housing has properly registered in the locating bore on the beam.

9 Screw drain plug firmly.

**DISMANTLING OF HUB ASSEMBLY**

1 Remove inner race of outer bearing shims and spacer. Position rocker of the puller 2576 5890 35 04 on the outer race of the inner bearing and extract the hub inner bearing assembly with grease seal and spacer ring. Fig. 61.

2 Rest rocker 2575 5890 35 02 on the outer race of hub outer bearing. Tap the bearing race out using drift 312 589 35 39. Fig. 62.

3 Paint indentification marks on inner/outer races of the respective LH and RH hub taper roller bearings.

4 If necessary, knock out grease catcher through two holes provided in the hub with a punch. Fig. 63.

5 Clean all the parts thoroughly.

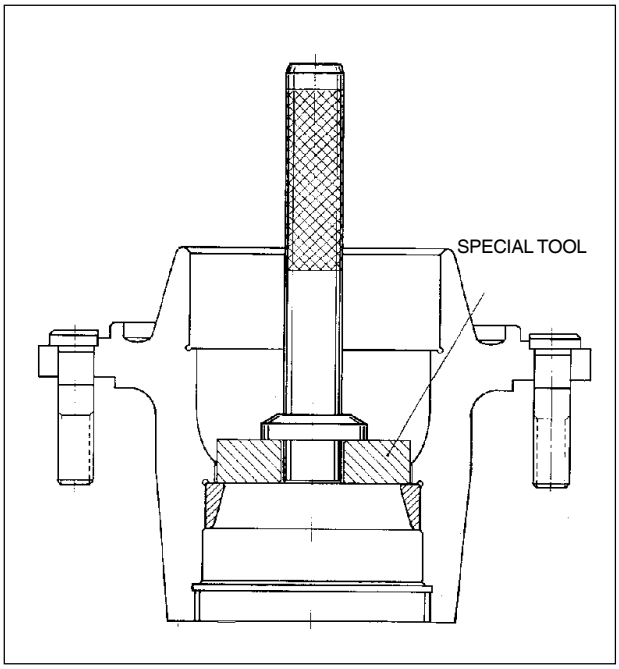



*Fig. 62*

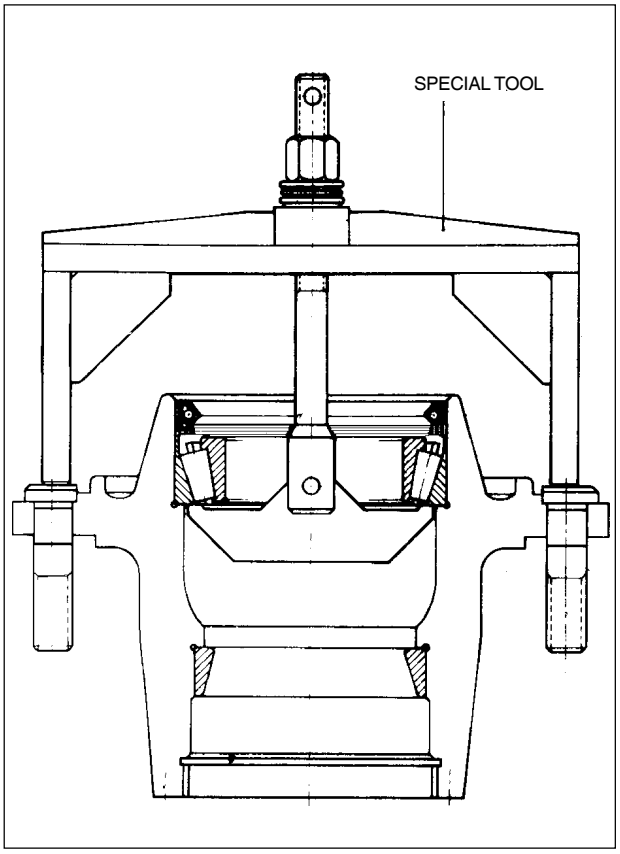



*Fig. 61*



*Fig. 63*

**INSPECTION OF HUB COMPONENTS**

Check the following.

1 Hubs

a For Cracks.

b Internal splines for damage.

c Brake drum locating collar for damage.

d Axle shaft cover mounting tapped holes for conditions of threads.

e Bearing seats for wear, pitting, etc.

f Concentricity between inner and outer bearing mounting bores.

2 Hub bearings for signs of scoring, pitting, overhearing, etc.

3 Grease seal for lip wear.

4 Wheel mounting pins for fit in hub and condition of threads.

5 If any of the above mentioned defects is observed, replace the respective parts.

**ASSEMBLY OF HUB**

1 Clean hub thoroughly and oil bearing seat surfaces in the hub.

2 With drift 2575 5890 35 01 press outer race of the outer bearing flush to the stop provided in the hub. Fig. 64.

*Note: Check identification marks on the taper roller bearings before assembly, if these are reused.*

3 Similarly with drift 321 589 04 39 press outer race of the inner bearings. Fig. 65.

4 Position the inner race with cage of inner bearing in the hub.

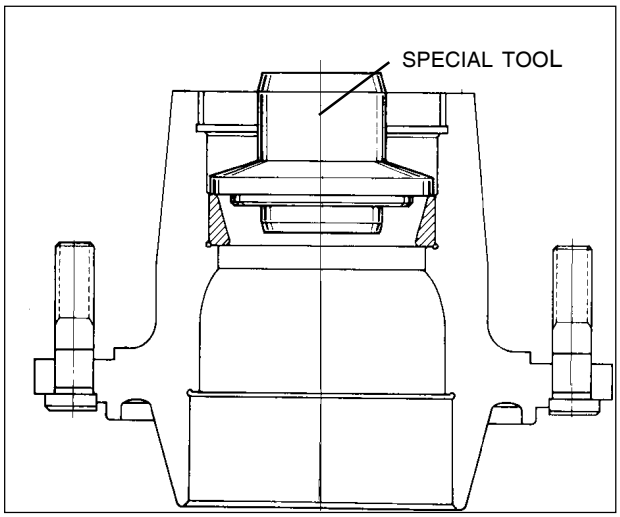



*Fig. 64*

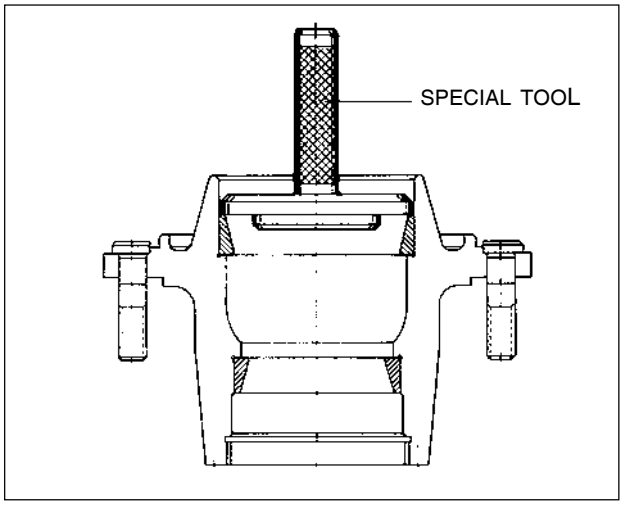



*Fig. 65*

## INSTALLATION OF HUB ASSEMBLY

### Selection of shims

1 Thoroughly clean the bearing seats on the rear axle tube.

2 Insert hub assembly on the axle tube.

3 Assemble the tubular spacer on the axle tube.

4 Insert a shim of 2.50 mm thick on the tubular spacer.

5 Fit the inner race of outer bearing on the axle tube using drift pt. no 2505 5890 99 02. Fig. 67.

6 Insert tongue washer on the axle tube. Fig. 68.

7 Screw in the first grooved nut with modified pronged wrench pt. no. 2575 5890 35 04 and tighten to 20 mkg. torque. Fig. 71.

8 Pull the hub with special tool pt. no 2576 5890 35 22.

9 Measure hub play after fixing the dial gauge with holder pt. no 2576 5890 35 14 on the wheel mounting pin.

For example, the measured hub play is 1.5 mm. Then correct shim size for hub play of 0.04 mm will be (2.50 - 1.50 + 0.04) =1.04 mm. The recommended hub play is between 0.02 to 0.06 mm. To achieve this hub play shim may be added or removed. For increasing the play, shims to be added and for decreasing the play, shims to be removed.

10 Loosen and remove grooved nut and pull out the hub with bearings.

### Installation of hub on axle tube

11 Thoroughly clean bearing seats on the axle tube and oil them. Fig. 66.

12 Pack inner-race with cage of inner bearing with grease and rest it properly in its outer race.

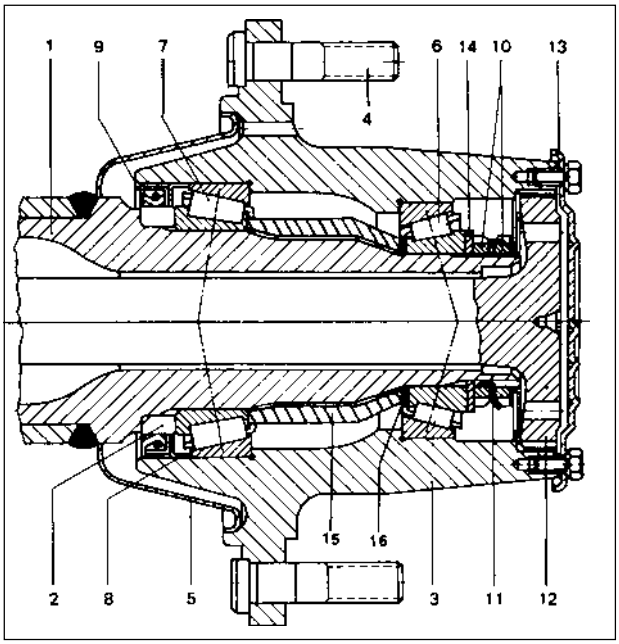
13 Insert spacer ring for oil seal in the inner bore in the proper direction. Fig. 66.

14 Press oil seal with drift pt. no. 321 589 04 39. Fig. 67.

15 Pack each hub with approximately 450 gms. of recommended grease.

16 Refit the grease catcher in the hub if it is removed.

17 Locate tubular spacer alongwith preselected shims (as mentioned in step 9) and inner race of outer bearing on the axle tube.




| | | | |
|---|---|---|---|
| 1 | AXLE BEAM | 9 | OIL SEAL |
| 2 | PRESSURE RING | 10 | LOCKING RING |
| 3 | REAR HUB | 11 | LOCK WASHER |
| 4 | WHEEL MOUNTING PINS | 12 | AXLE SHAFT |
| 5 | OIL CATCHER | 13 | COVER REAR HUB |
| 6 | TAPER ROLLER BEARING (OUTER) | 14 | TONGUED WASHER |
| 7 | TAPER ROLLER BEARING (INNER) | 15 | TUBULAR SPACER |
| 8 | SPACER RING | 16 | SHIMS |

*Fig. 66*

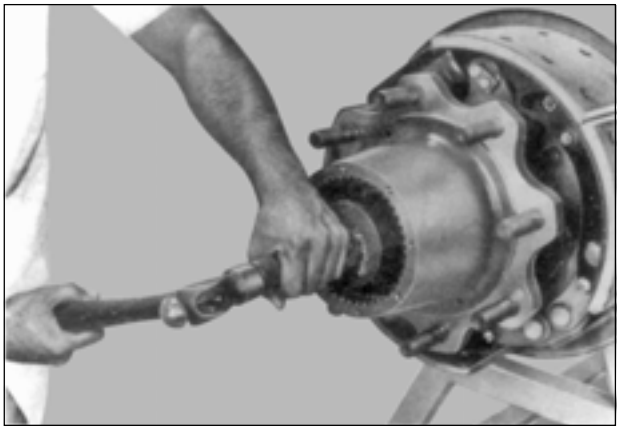


*Fig. 67*

18 Rest drift 2505 5890 99 02 on inner race of the outer bearing and tap it gently with mallet till it rests on its outer race.

19 For hub assembly with single oil seal.

a Fit tongued washer on the axle tube and screw in the first grooved lock nut with modified pronged wrench pt. no. 2575 589035 04 and tighten to 20 mkg. torque. Fig no. 71.

b Insert a new lock washer on the axle tube to rest over the inner grooved nut.

c Screw on the 2nd grooved lock nut and tighten the nut till any slot on the nut aligns with lip of the lock washer. Torque should be in the range of 15 - 20 mkg.

d Hammer the hub front face gently so that the wheel bearings seat and run freely.

e Recheck and confirm the hub play. It should be between 0.02 to 0.06 mm.

f Bend the lip of the lock washer in the slot on the nut and lock it. Fig. 70.

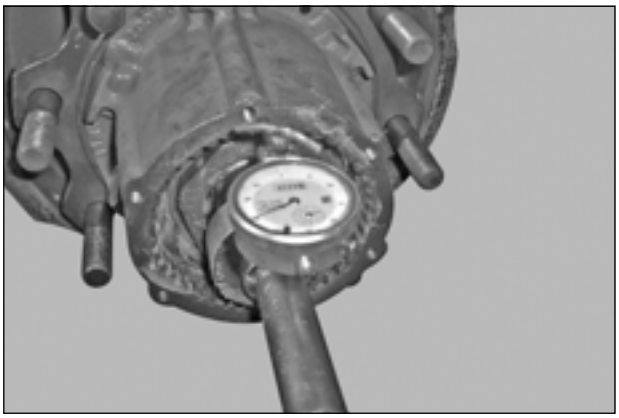


*Fig. 69*

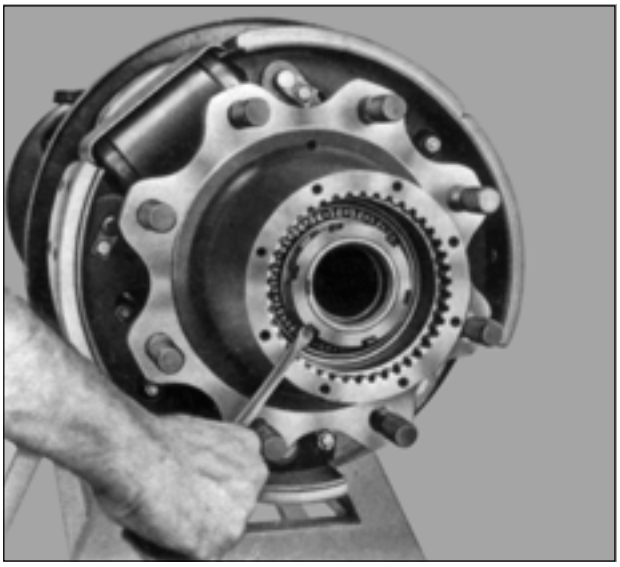


*Fig. 70*

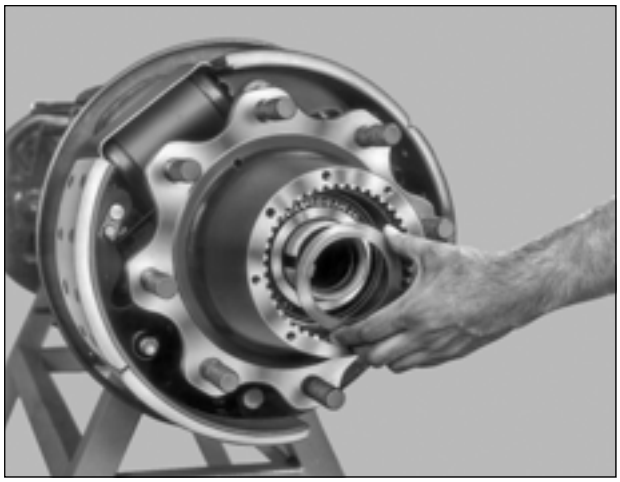


*Fig. 68*

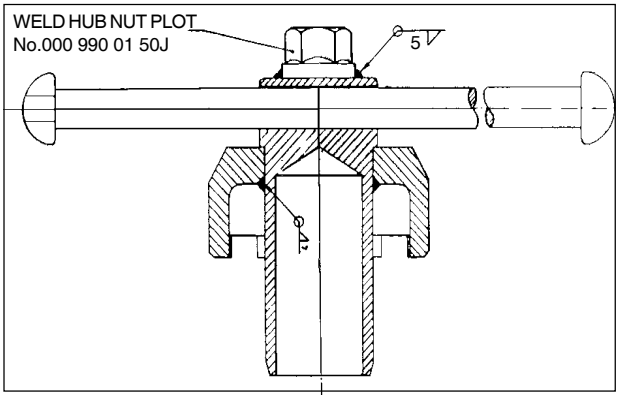



*Fig. 71*

20 For hub assembly with double oil seal.

a Insert the oil seal into the hub such that it butts against the shoulder in the hub.

b Mount the tongued spacer to butt against the spacer. Screw the hub lock nut on the beam and tighten it to minimum 30mkg torque by using the wrench for hub lock nut 2632 5890 35 02 and torque wrench. Fig. 73.

Care should be taken to ensure that atleast one out of six tightening holes provided along the circumference of the hub lock nut matches with one of the slots provided on the beam.

*Note : In no case should the hub lock nut be loosened to match the beam slot and the hole on hub lock nut. The tightening torque can be increased as required.*

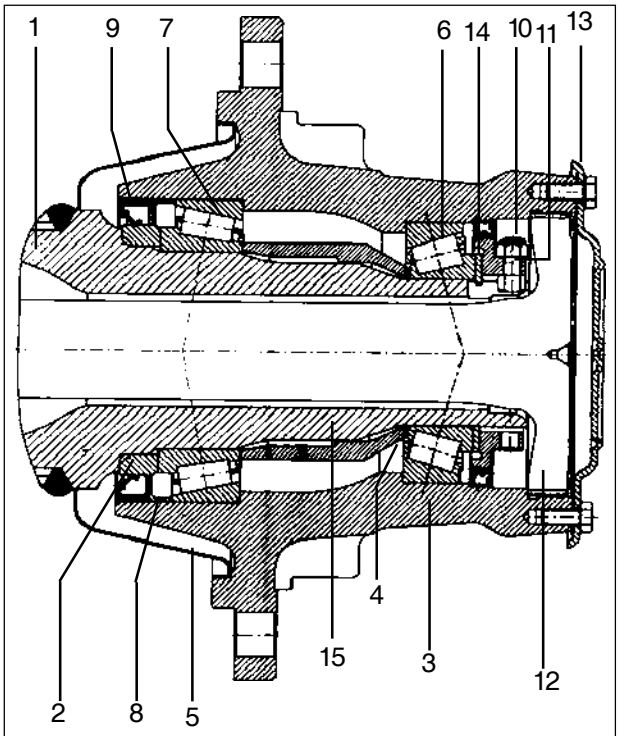
c Hammer the hub front face gently so that the wheel bearings seat and run freely.

d Insert the bolt from the beam slot such that it passes through the matching hole on the nut and use M8 Nyloc nut to lock the hub lock nut in place.

e Mount the dial with gauge holder 2576 5890 35 14 on the wheel mounting pin and rest the dial spindle on the axle spindle. Fig. 74.

f Measure the hub play. Ensure that it is within 0.02 to 0.06 mm.

g Tighten the M8 Nyloc nut to 2.5mkg torque.




| | | | |
|---|---|---|---|
| 1 | AXLE BEAM | 9 | OIL SEAL |
| 2 | PRESSURE RING | 10 | LOCK NUT (M8) |
| 3 | REAR HUB | 11 | LOCK PIN |
| 4 | SHIMS | 12 | AXLE SHAFT |
| 5 | OIL CATCHER | 13 | COVER REAR HUB |
| 6 | TAPER ROLLER BEARING (OUTER) | 14 | WASHER |
| 7 | TAPER ROLLER BEARING (INNER) | 15 | TUBULAR SPACER |
| 8 | SPACER RING | | |

*Fig. 72*

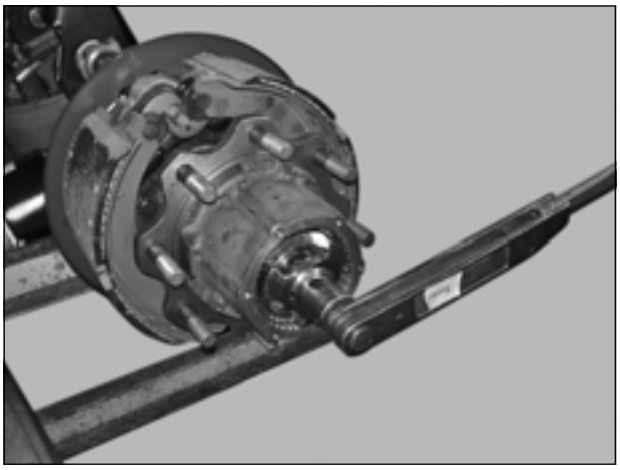


*Fig. 73*

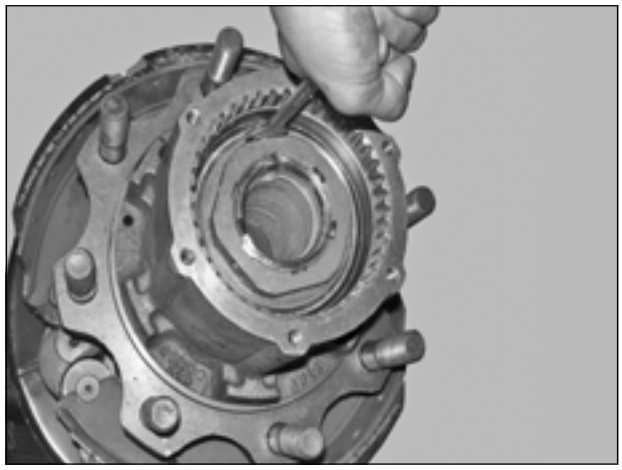


*Fig. 74*

**INSPECTION OF AXLE SHAFT**

Check the following:

1 Axle shaft for bend. Fig. 75.

2 Splines for damage.

3 Cracks.

4 Axle shaft gear flange.

If any of the above defects is observed, replace the axle shaft

**ASSEMBLY OF AXLE SHAFT**

1 Insert axle shaft in the axle beam taking care not to damage the oil deflector provided in the beam.

2 Tap the axle shaft with mallet till it engages fully with the splines provided in the hub. Fig. 76.

3 Stick new gasket with Shellac on the cover and mount the cover with the screws. Tighten the screws fully.

**INSPECTION AND ASSEMBLY OF BRAKE DRUM**

**Inspection of brake drum**

Check the following:

1 Check for cracks.

2 If deep scoring is observed on the friction surface rectify by skimming the friction surface.

3 If necessary replace the brake drum. Refer Group 42 for repair data.

**Assembly of brake drum**

1 Clean thoroughly the brake drum specially the friction surface. The friction surface should be dry and free from oil etc. for effective braking.

2 Install brake drum, locating its bore on the spigot diameter on the hub.

3 Assemble spherical washers on all the wheel mounting pins.

4 Mount inner and outer wheel drums.

5 Assemble spherical split washers on all the wheel mounting pins.

6 Screw in wheel nuts fully.

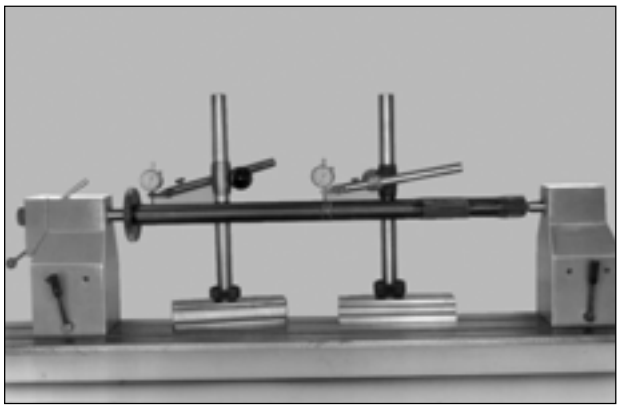


*Fig. 75*



*Fig. 76*

NOTES

# Propeller Shaft 41

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**TECHNICAL SPECIFICATIONS**
**UNIVERSAL JOINT ASSEMBLY**

| Dia. of bearing cup mounting bores in propeller shaft yokes | Colour code | Bearing cup outer diameter |
|---|---|---|
| 46.025/46.000 mm | Pink | 46.055/46.035 mm |
| 46.050/46.025 mm | Orange | 46.080/46.055 mm |
| 46.070/46.050 mm | Steel Grey | 46.100/46.080 mm |
| Bearing cup inner dia. | | 34.683/34.650 mm |
| Needle roller dia. | Set 1 | 3.000/2.993 mm |
| Number of needles per cup | | 33 Nos. |
| Dia. of cross spigots | | 28.620/28.611 mm |
| Max. permissible imbalance of propeller shaft | | 70 cm. gm |
| Straightness of propeller shaft (Total indicator reading over entire length) | | 0.3 mm |
| Axial play of universal joint assembly | | 0.02 to 0.04 mm |

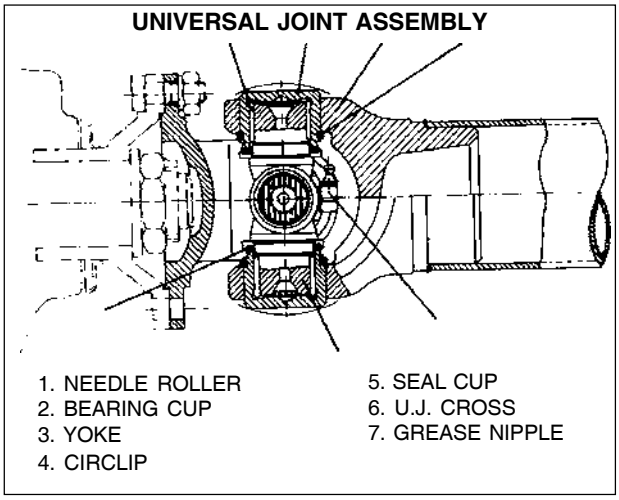



*Fig. 1 Universal joint assembly*

TIGHTENING TORQUES

| | | |
|---|---|---|
| Nut holding coupling flange on propeller shaft. | 32-36 | mkg |
| Propeller shaft coupling flange bolts | 9 | mkg |
| Centre bearing bracket mounting bolts | 8.5 | mkg |

**SPECIAL TOOLS**

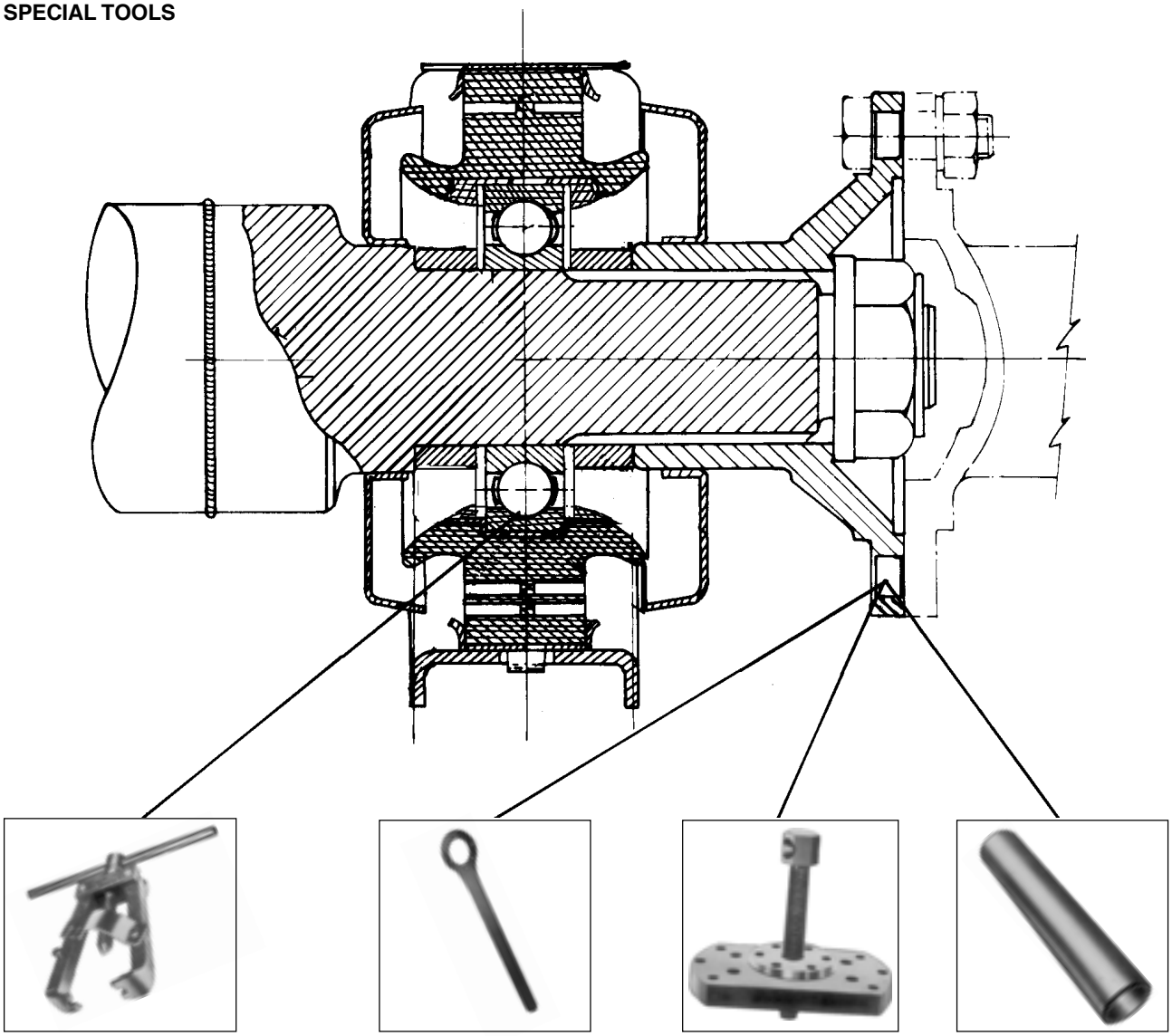


*Fig. 2*

| Sl. No. | Description | Part No. |
|---|---|---|
| 1. | Puller for centre bearing | 312 589 25 33 |
| 2. | Holder for coupling flange | 2576 5890 35 09 |
| 3. | Puller for removal of Coupling flange | 2576 5890 35 22 |
| 4. | Drift for installing Coupling flange | 042 589 02 39 |

**REMOVAL OF PROPELLER SHAFTS FROM VEHICLE**

1. Unlock and unscrew coupling flange fastening screws/nuts to disconnect rear propeller shaft from front propeller shaft. Carefully place front end of rear propeller shaft on ground.
2. Unlock and unscrew coupling flange fastening screws to disconnect rear propeller shaft from tail pinion. Remove rear propeller shaft.
3. Unscrew nuts to remove centre bearing bracket from cross member. Fig. 3. Carefully place rear end of front propeller shaft on ground.
4. Unlock and unscrew coupling flange fastening screws to disconnect front propeller shaft from gear box. Remove front propeller shaft.

**INSTALLATION OF PROPELLER SHAFTS ON VEHICLE (Ref. Fig. 5.)**

For installation proceed in reverse order of removal.

Note:

i Assemble in such a way that all the three yokes of propeller shafts are in one plane. Fig. 4.

ii Use new lock plates for coupling flange fastening screws/nuts.

iii Tighten coupling flange screws/nuts to specified torque and lock them with lock plates.

iv. Tighten centre bearing bracket fastening screws/ nuts to specified torque. Fig. 6.



*Fig.4 Propeller Shaft assembly*

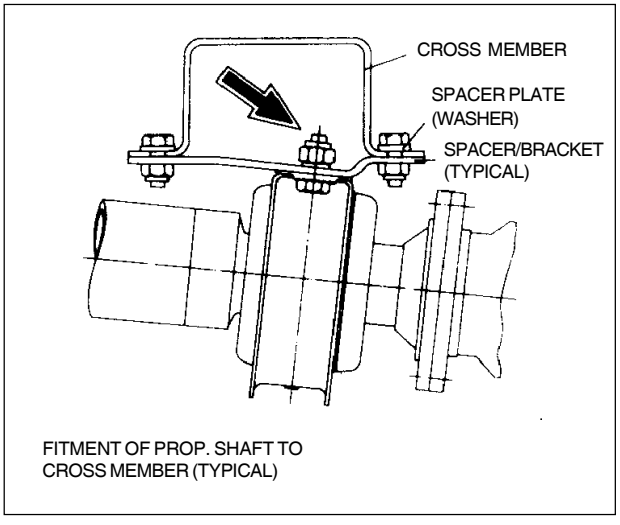



*Fig.3. Removal of centre bearing bkt.*

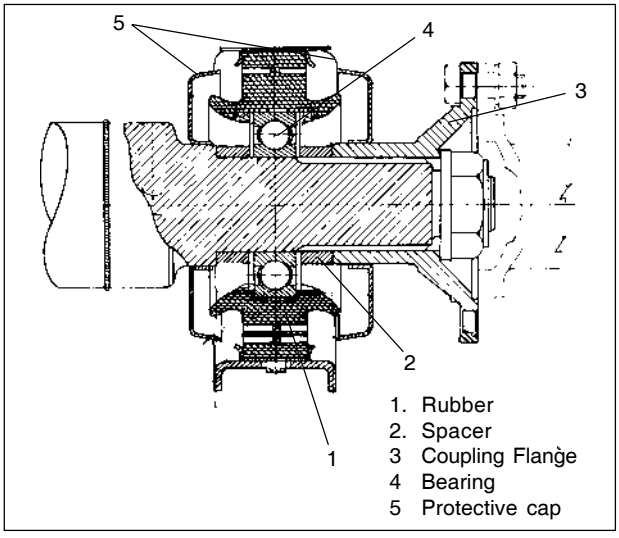



*Fig.5 Propeller shaft*

**REMOVAL OF CENTRE BEARING FROM FRONT PROPELLER SHAFT**

Centre bearing mounting arrangement. (Ref. Fig. 5)

1. Unstake coupling flange nut from groove on front propeller shaft.
2. Mount holder 2576 5890 35 09 on coupling flange. Grip the holder in vice. Unscrew and remove coupling flange nut with 50 mm socket. Fig. 7. Remove holder.
3. Mount puller 2576 5890 35 22, and pull out coupling flange. Fig. 8.
4. Unstake clamping strap and remove centre bearing bracket.
5. Displace rubber housing from its seating with a screw driver if necessary. Slide of rubber housing from centre bearing assembly.
6. Remove rear spacer ring.
7. With puller 312 589 25 33 pull out centre bearing assembly from front propeller shaft. Fig. 9.
8. Remove front spacer ring.

**INSPECTION OF CENTRE BEARING**

1. Clean all components thoroughly.
2. Check condition of splines and threads on front propeller shaft.
3. Check condition of splines and holes on coupling flange.
4. Check condition of bore and mounting holes of centre bearing bracket.
5. Check condition of rubber housing. Replace with new one, if necessary.

   *Note : The rubber housing is made from natural rubber of high strength. Replace only with genuine part.*
6. For checking of centre bearing proceed as follows:
   a. Clean centre bearing assembly with diesel only. Do not use kerosene or petrol for cleaning.
   b. Bearing should not bind when rotated manually.
   c. The bearing should have negligible radial play.

   *Note: If any of the above is defective complete centre bearing assembly should be replaced.*
7. Check both spacer rings for wear/score marks. If found defective, replace with new one.

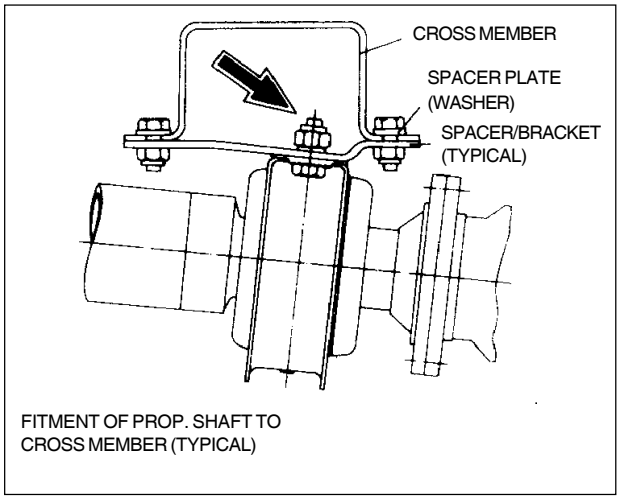



*Fig. 6 Tightening centre bearing bracket fastening nuts*

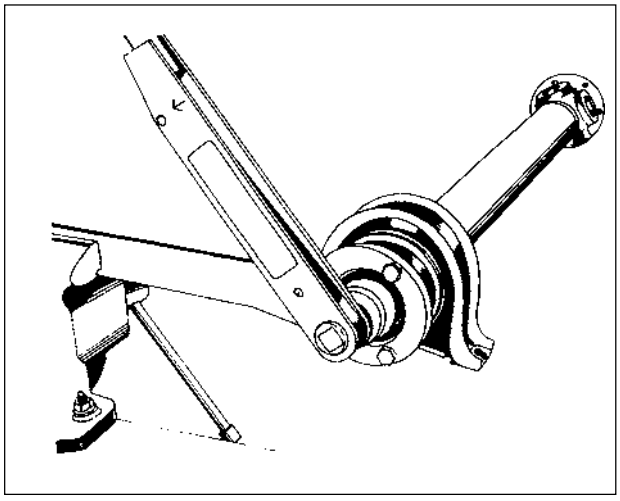


*Fig. 7 Removal of coupling flange nut*

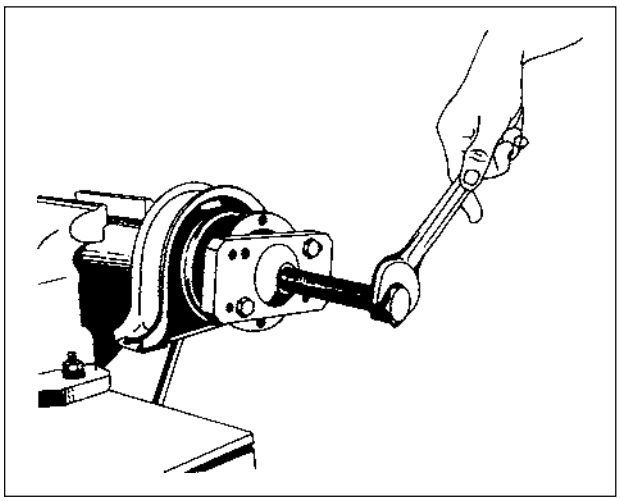


*Fig. 8 Removal of coupling flange with puller*

**INSTALLATION OF CENTRE BEARING ON PROPELLER SHAFT**

1. Unscrew and remove grease nipple for centre bearing from front propeller shaft.
2. Clean lubrication passage for centre bearing in the front propeller shaft rear end.
3. Screw back grease nipple (if found defective, use new grease nipple).
4. Check condition of protective caps on front propeller shaft and coupling flange. If found damaged, replace with new ones. These are tack welded to respective components.
5. Install one centre bearing spacer ring in such a manner on front propeller shaft rear end that its chamfered surface with notches comes in contact with inner race of centre bearing.

   *Caution: Installing spacer ring in reverse way will lead to centre bearing lubricant starvation.*
6. Apply grease to centre bearing assembly (centre bearing and seals).
7. Install centre bearing assembly on front propeller shaft rear end. Fig. 10.
8. Install other spacer ring for centre bearing on front propeller shaft rear end, in such a manner that its chamfered surface with notches will come in contact with inner race of centre bearing.
9. Apply glycerine on inner periphery of rubber housing and slide it on to centre bearing assembly, so that recess on rubber housing is matched with lugs on centre bearing.
10. Apply grease on splines of front propeller shaft and coupling flange.
11. Insert coupling flange on front propeller shaft using drift 042 5890 239 such that it rests fully against spacer ring for centre bearing. Fig. 11.

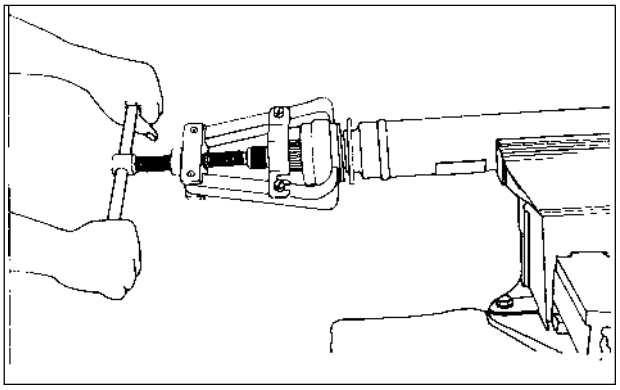


*Fig. 9 Removal of center bearing*

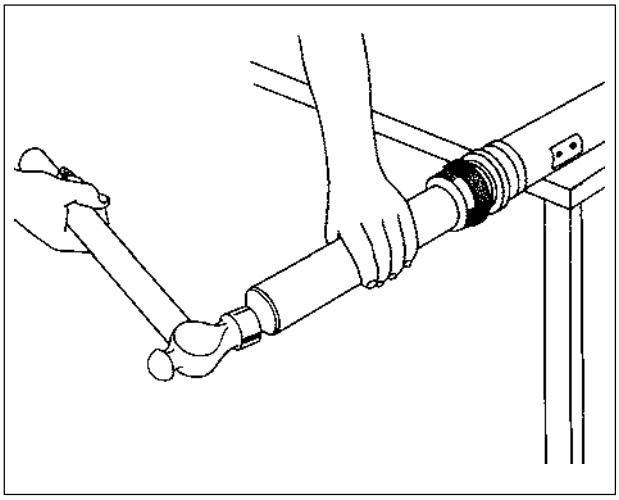


*Fig. 10 Installation of center bearing*

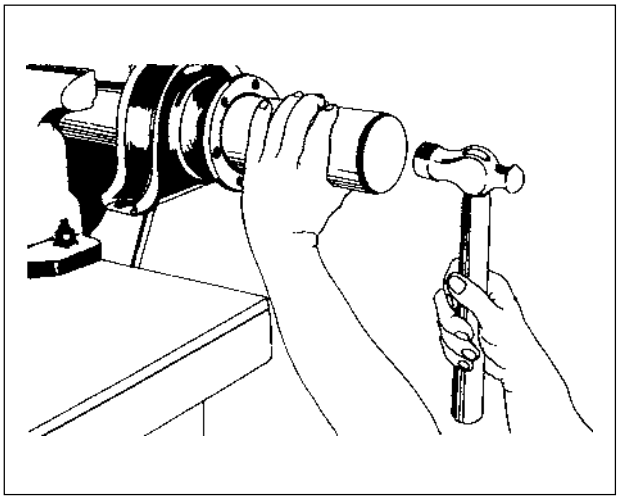


*Fig. 11 Installation of coupling*

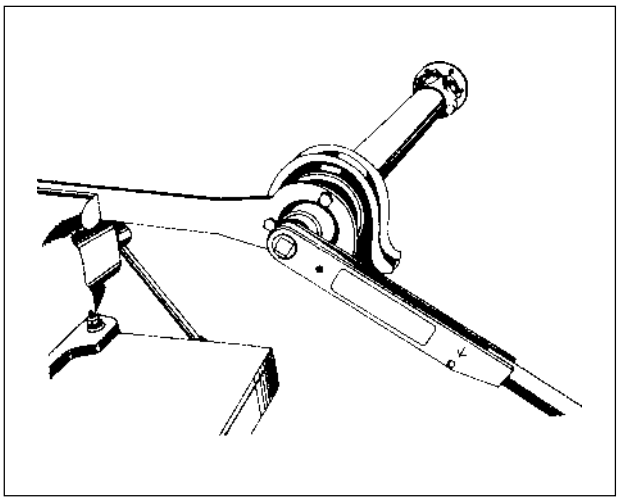


*Fig. 12 Tightening coupling flange nut*

12. Screw in new coupling flange nut on front propeller shaft.
13. Mount holder 2576 5890 35 09 on coupling flange. Clamp holder in vice and tighten coupling flange nut. Fig. 12.
14. Stake collar on coupling flange nut in the slot provided on front propeller shaft such that coupling flange is locked against loosening Fig. 13.
15. Assemble centre bearing bracket and clamping strap on rubber housing. Crimp clamping strap on to bracket at both ends. Ensure that there are no cracks at crimping. Also check for proper crimping of rubber housing retainer.

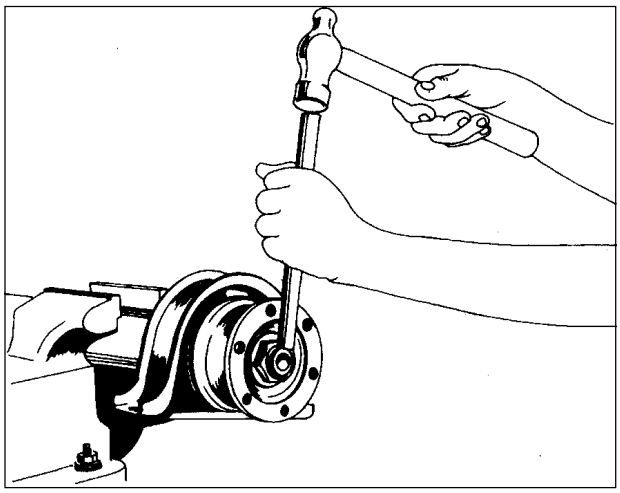


*Fig. 13 Staking collar on coupling flange nut*

**DISASSEMBLY OF UNIVERSAL JOINT**

Exploded view of universal joint assembly Fig. 14. For disassembly of universal joint proceed as below:

1. Clean paint and dust from snap rings and top of bearing cups.
2. Remove all snap rings by pressing with a screw driver. If necessary, tap bearing cups lightly with mallet.
3. Rest yoke on suitable support and press out bearing cup using suitable spacer on a hand press. Fig. 15.
4. Rest opposite side of yoke on support and press out other bearing cup using suitable spacer Fig. 16.
5. With same procedure press out the remaining two bearing cups.

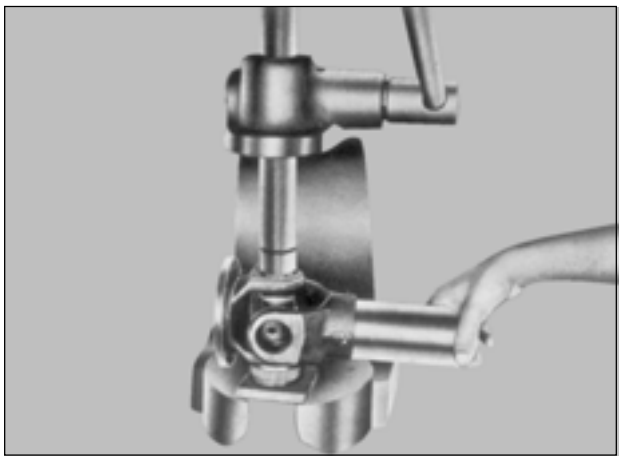


*Fig. 15 Pressing out bearing cup*

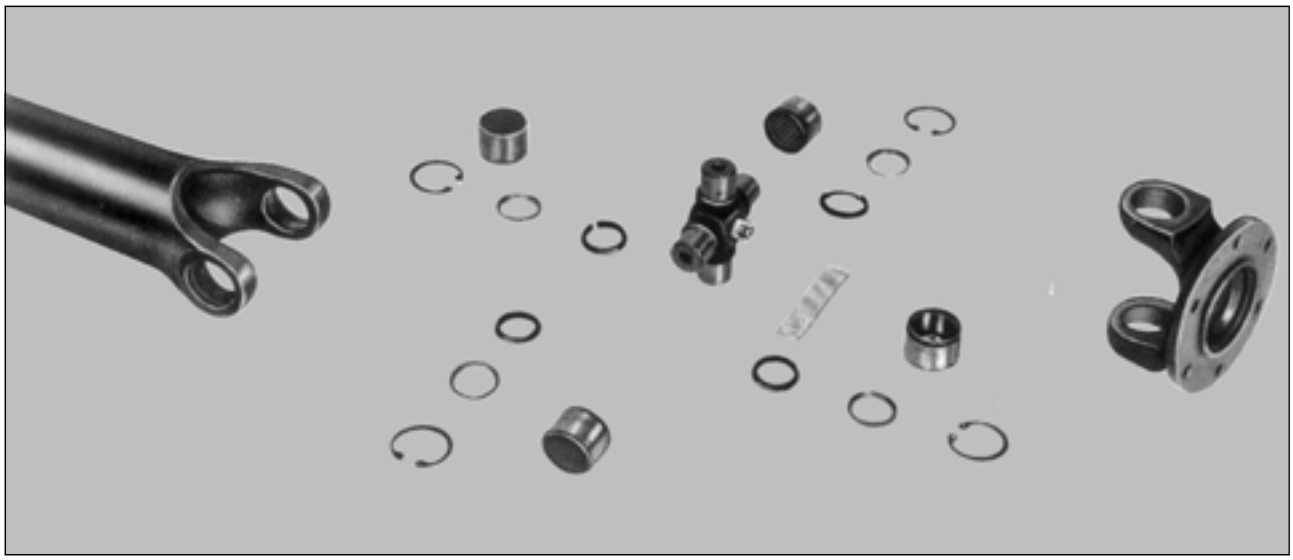


*Fig.14 Exploded view of universal joint assembly*

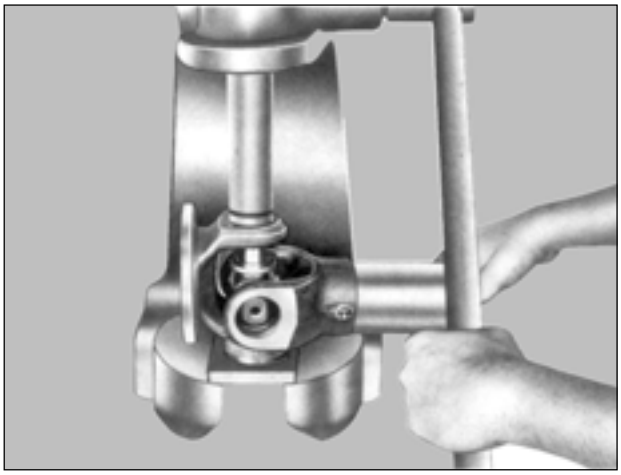


*Fig. 16 Pressing out bearing cup*

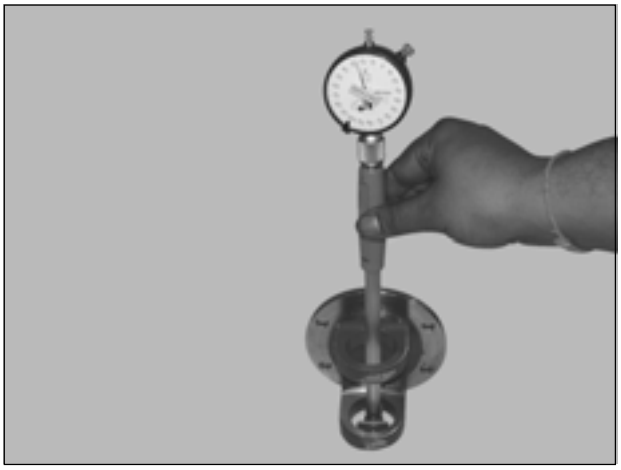


*Fig. 17 Measuring diameters of bearing cup mounting bores*

6. Unstake sheet metal retainer from bearing cup and remove rubber seal.
7. Remove the cross.
8. Remove dust caps.

**INSPECTION OF UNIVERSAL JOINT**

1. Clean all metal parts thoroughly in a cleaning solvent, but wipe rubber parts only with a dry cloth.
2. Measure the diameters of bearing cup mounting bores in propeller shaft yokes. Fig. 17.
3. Measure inner bores of bearing cups. Check for wear, damage, overtightening. etc. Fig. 18.
4. Measure outer diameter of bearing cups and check for required fit in corresponding mounting bores in propeller shaft yokes. Both should have same colour code mark for correct fit.
5. Check needle rollers for pitting, damage, wear, overheating, etc.

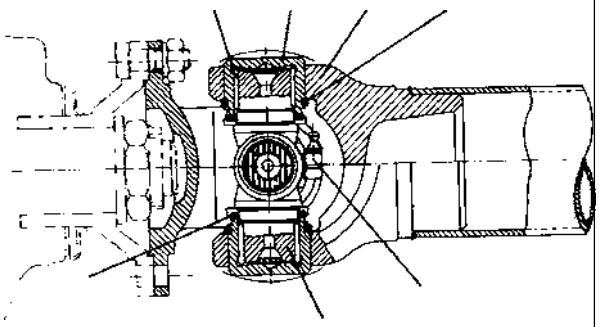
   *Note : All needle rollers in four bearing cups of* a *cross assembly should be from same set.*
6. Check cross for damage, wear, overheating, etc. Measure diameters of cross spigots.
7. Check rubber seal and sheet metal retainer for damage. Replace these, if necessary.
8. Check lubrication passage in cross.

   *Note: If any of the above defect is observed replace complete cross assembly.*



*Fig. 18 Measuring inner bores of bearing cups*

**UNIVERSAL JOINT ASSEMBLY**



1. NEEDLE ROLLER
2. BEARING CUP
3. YOKE
4. CIRCLIP
5. SEAL CUP
6. U.J. CROSS
7. GREASE NIPPLE

*Fig. 19 Universal joint assembly*

**ASSEMBLY OF UNIVERSAL JOINT (Fig. 19)**

1. Clean thoroughly needle rollers and bearing cups.
2. Smear grease on the needle rollers and bearing cups.
3. Assemble needle rollers in the bearing cups.

   *Note: Ensure that each cup is assembled with 33 needle rollers. All four bearing cups of an universal joint should have same colour code mark and should be assembled with needle rollers from same set.*
4. Fit the rubber seal with the sheet metal retainer. Stake the retainer in the groove provided on the body of the bearing cup.
5. Fit grease nipple on the cross and install the cross in the propeller shaft yokes.

   Note: Grease nipple on the cross should face propeller shaft and not coupling flange.
6. Press new dust caps on the cross using suitable tubes.
7. Press the needle roller bearing cup assembly in the yokes using suitable spacer on a hand press, Fig. 20. Ensure that colour code on yoke and bearing cup are same for correct fit.
8. After pressing in the bearing cups, secure them in position with appropriate thickness of snap rings.
9. The universal joint should be assembled with 0.02 to 0.04 mm axial play. After assembly, slightly tap the yokes with a mallet to ensure proper assembly.
10. Grease the universal joint.

**INSPECTION OF PROPELLER SHAFTS**

**Rear propeller shaft**

1. Unscrew and loosen hose clips from both ends of rubber boot.
2. Slide off yoke from shaft.
3. Remove rubber boot and check its condition.
4. Clean and apply grease to splines on shaft and yoke.
5. Install rubber boot on splined shaft.
6. Slide yoke onto shaft ensuring alignment of mating arrows. Fig. 21.
7. Check for free sliding of yoke on shaft.
8. Tighten hose clip at both ends *of* rubber boot such that screws on hose clip strap are diametrically opposite to each other.

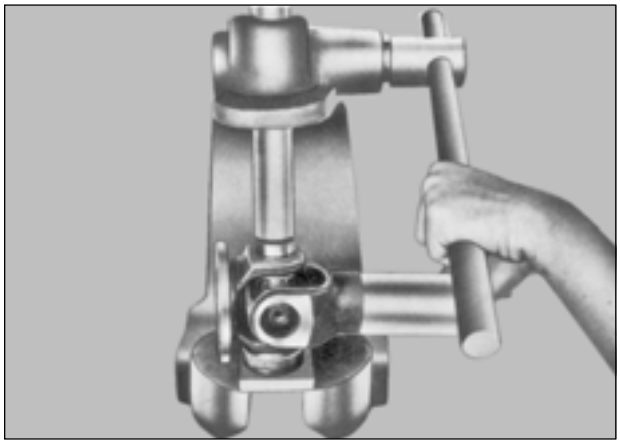


*Fig. 20 Pressing bearing cup in yoke*

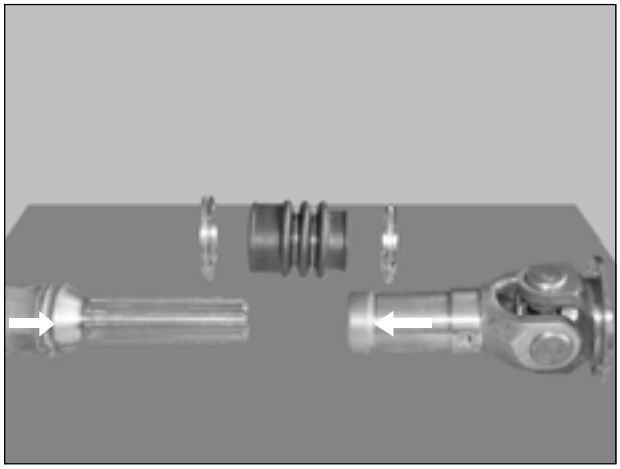


*Fig. 21 Alignment of arrows*

9. Check rear propeller shaft for bend by suitably clamping coupling flanges at both ends. If necessary straighten.

   Note: All straightening operations are to be done with complete shaft assembly.
10. Check rear propeller shaft for dynamic imbalance.
11. Pack grease in sliding joint with grease gun through grease nipple.

    *Caution: Avoid over greasing. Since this may burst the rubber boot.*

**Front propeller shaft**

1. Remove coupling flange and centre bearing with bracket from front propeller shaft.
2. Check front propeller shaft for bend. If necessary straighten.
3. Check front propeller shaft for dynamic imbalance.
4. Install centre bearing with bracket and coupling flange on front propeller shaft.

NOTES

# Brakes 42

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## 1 GENERAL

The vehicle's compressor takes in filtered air, either at atmospheric pressure from the outside (or already at an increased pressure, from the engine turbocharger in some cases), and compresses it. The compressed air is delivered to the Air dryer / Drying Distribution Unit where water and a small amount of oil is removed. The air then travels into the air reservoirs ("air tanks") - typically delivered to a rear brake system reservoir and a front brake system reservoir. For each system, the air pressurizes the reservoir and the air hoses all the way to the next control valve, where the air pressure remains, ready to be used. A vehicle may use compressed air for many tasks. Some examples are: to provide force for braking, to deliver air to a particular component, to off-load bulk goods, etc.

When the driver applies the foot brake, a plunger within the foot brake valve moves, opening channels within the valve that allow the air pressure waiting there to pass through and be delivered to the rear and front brake systems. The pressure quickly increases in the brake chambers and applies force to the push rod, transferring the force to the S-Cam brake. Frictional forces slow the wheels and the vehicle comes to a stop. When the brakes are released, the air in the brake chambers is able to be quickly released and enable the driver to drive away. Vehicles are parked using powerful springs which are part of the spring brake assembly, to engage the brakes and hold the vehicle in position. When the driver prepares to move away and releases the parking brake, the spring force is countered by the introduction of air pressure.

### 1.1 Specification

#### 1.1.1 System

| | | |
|---|---|---|
| Service brake | : | Dual circuit, S-cam full air brakes - leading/trailing shoe drum brakes. |
| Parking brake | : | Integral with spring brake actuator on rear axle - graduated control. |
| Engine exhaust brake | : | Pneumatically operated - Coupled with service brake. |
| Drum dia (Front & Rear) | : | 410mm |
| Lining width | : | Front : 160 mm<br>Rear : 180 mm |
| Lining thickness | : | 17mm tapered |
| Wearable lining thickness | : | Approx 13.3 mm |
| Lining area | : | Front : 2180 $cm^2$<br>Rear : 2470 $cm^2$<br>Total : 4650 $cm^2$ |
| Type of lining | : | Moulded, Non-asbestos based. |
| Brake actuators | : | Front : Air brake chambers<br>Type : 24<br>Stroke : 57 mm<br>- 2 Nos. |
| | : | Rear : Spring brake actuators<br>Type : 24/24;<br>Stroke : 57mm<br>-2 Nos. |
| Air tank capacity | : | Sensing tank : 10 litres<br>-1 No.<br>Front and rear : 30 litres each<br>-2 Nos. for all vehicles. |
| Air compressor piston | : | 94 mm dia x 30 mm stroke (For Tata 697 Engine) |
| Air delivery at 3000 engine rpm | : | 312 lpm free delivery (For Tata 697 Engine) |

| | | | | |
|---|---|---|---|---|
| System pressure | : | Cut out | : | 8.1 $\pm$ 0.3 bar |
| | | Cut in | : | 6.9 min. |
| Low air pressure (service and parking brake) warning signal operation below | | | : | 4.7 + 0.5 bar. |
| Parking brake hold off pressure | : | 4.8 $\pm$ 0.4 bar | | |

**1.1.2 Maintenance Data**

| | | |
|---|---|---|
| Clearance between drum and lining | : | 0.5 + 0.1 mm |
| Brake pedal free play | : | 10-15 mm |
| Pump up time from zero to cut out pressure at full engine rpm | : | 210 secs. |
| System protection valve Opening pressure | : | 6.5 + 0.3 bar - service ports (21, 22)<br>6.3 + 0.3 bar - auxiliary ports (23, 24) |
| Min. port closing pressure When pressure in one of the circuit is zero | : | Port No 21 22 23 24<br>0 6.8 6.6 6.6 bar<br>6.8 0 6.6 6.6 bar<br>4.7 4.7 0 6.6 bar<br>4.7 4.7 6.6 0 bar |
| Drop in air pressure due to leakage (after pressure in the system stabilizes) | :<br>: | Max. 0.3 bar / 20 minutes (with brakes off)<br>Max. 0.3 bar / 5 minutes (with brakes on) |
| Max. brake chamber stroke in brakes applied condition (front and rear) before which brakes have to be adjusted. | : | 53 mm |
| Stand out of push-rod fork eye centre to mounting face of brake chamber | : | 72 mm |

**1.1.3 Repair Data**

| | | | |
|---|---|---|---|
| Brake drum dia | : | Normal | : 410 mm |
| | | Repair size I | : 412 mm |
| | | Repair size II | : 414 mm . |

**Precaution :**

Brake drums should not be used beyond 416 mm dia. After that, there will not be any service braking or parking brake left, due to cam roll over. Drums should be discarded.

| | | |
|---|---|---|
| Lining thickness (For M/s BIL) | Normal<br>Repair size I<br>Repair size II | : 17 mm<br>: 18 mm<br>: 19 mm |
| Lining thickness (For M/s AAL) | Normal<br>Repair size I<br>Repair size II | : 17 mm<br>: 17 mm<br>: 17 mm |
| Cam shaft end play | 0.8 mm max. | |
| Radial play of cam shaft / fulcrum pin in their bushes | 0.6 mm max. | |

**1.1.4 Tightening Torques**

| | |
|---|---|
| Brake mounting bolts | 18 mkg (Front - with castle nut and split pin)<br>20 mkg (Rear – with collar Hex. nut). |
| Air brake chamber / spring brake actuator mounting bolts | 10-11 mkg* |

***Precaution :** Do not over tighten as it is likely to cause damage of brake chambers.

| | | |
|---|---|---|
| Spring brake actuator mounting bracket to rear axle | : | 8 mkg |
| Cam shaft bearing block to rear axle | : | 5 mkg |
| Brake chamber mounting bracket to front torque plate | : | 10-11 mkg |

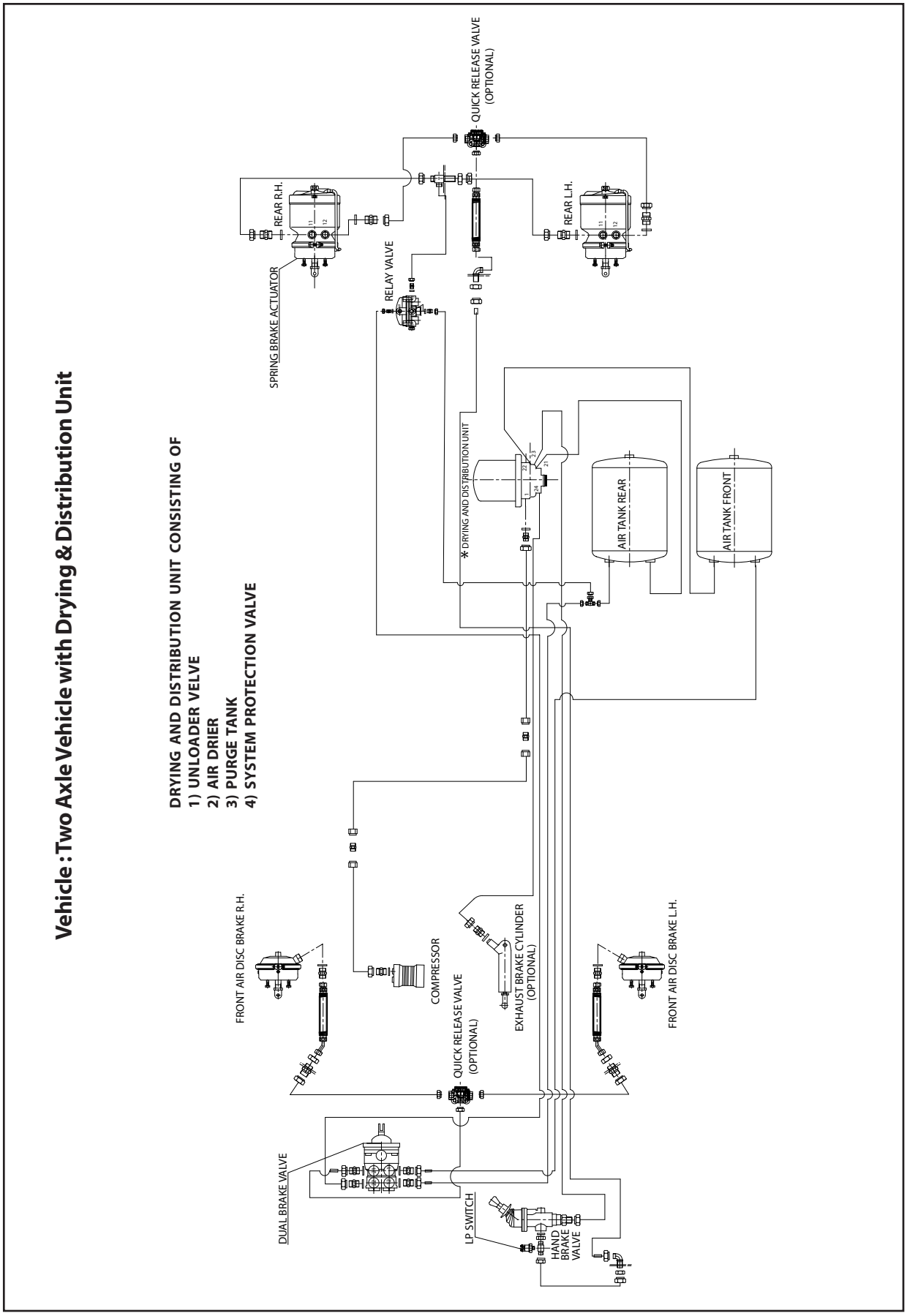



*Fig 1A : Schematic circuit for 'S' Cam Full Air Brakes*

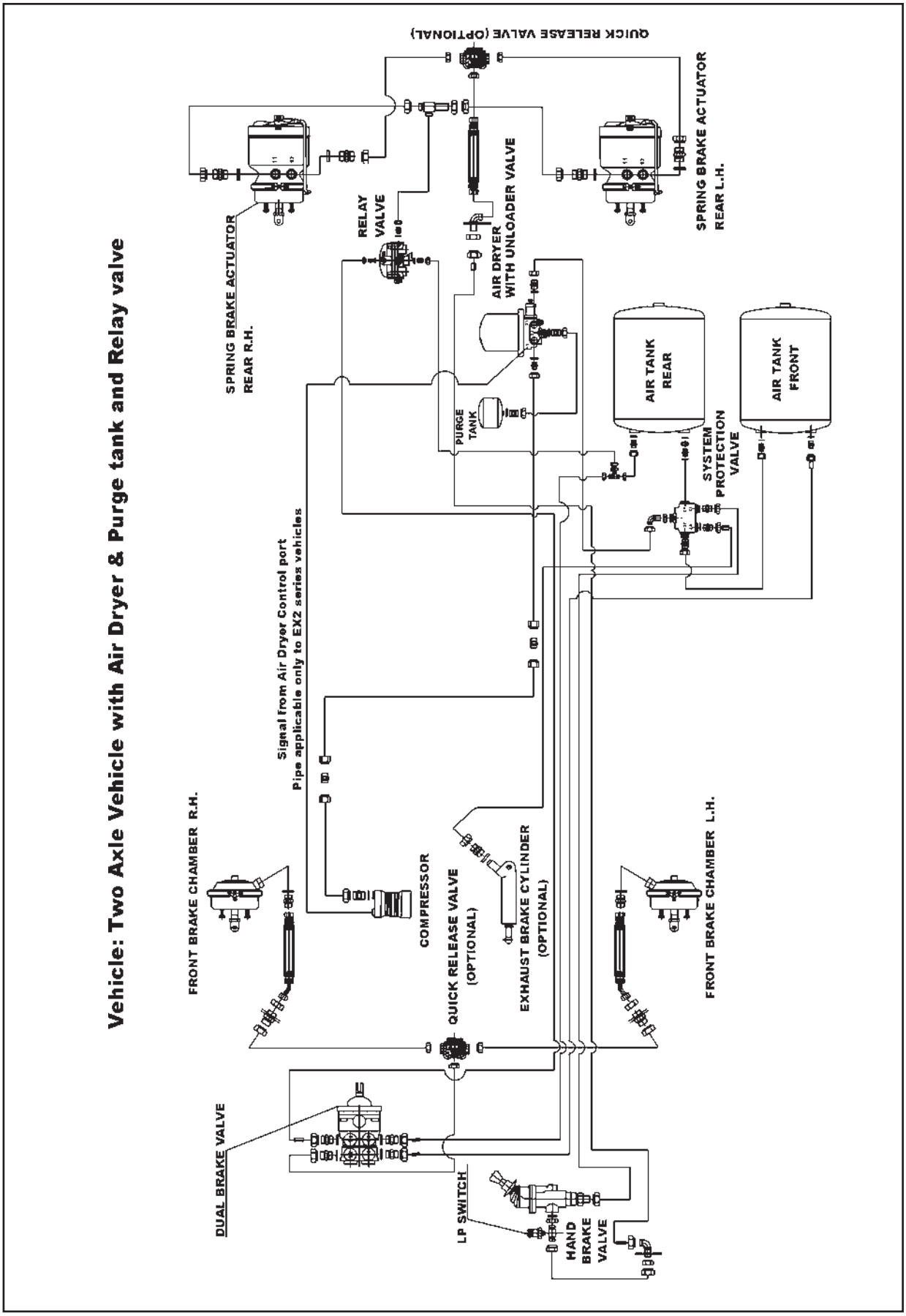



*Fig 1B : Schematic circuit for 'S' Cam Full Air Brakes*

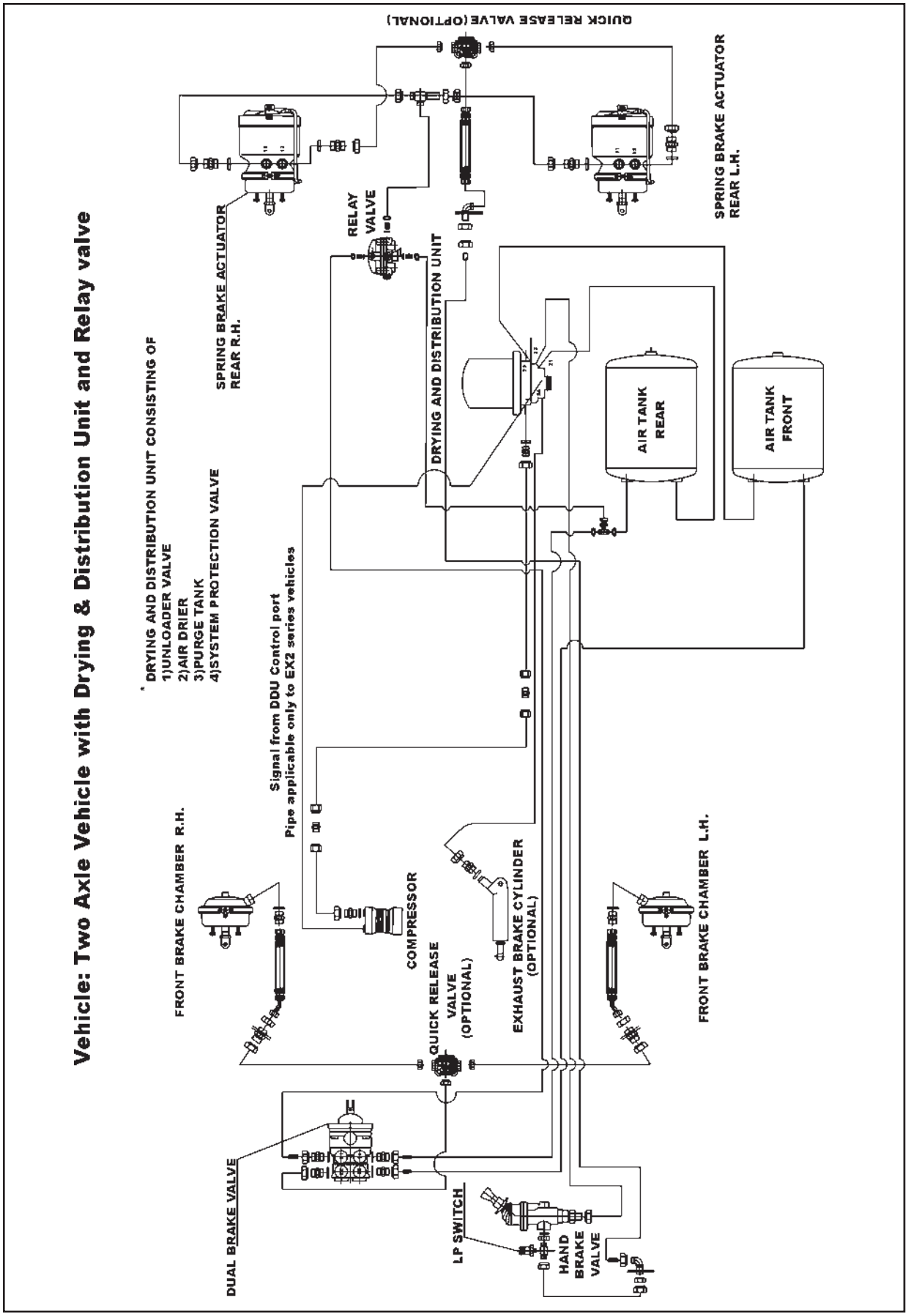



*Fig 1C : Schematic circuit for 'S' Cam Full Air Brakes*

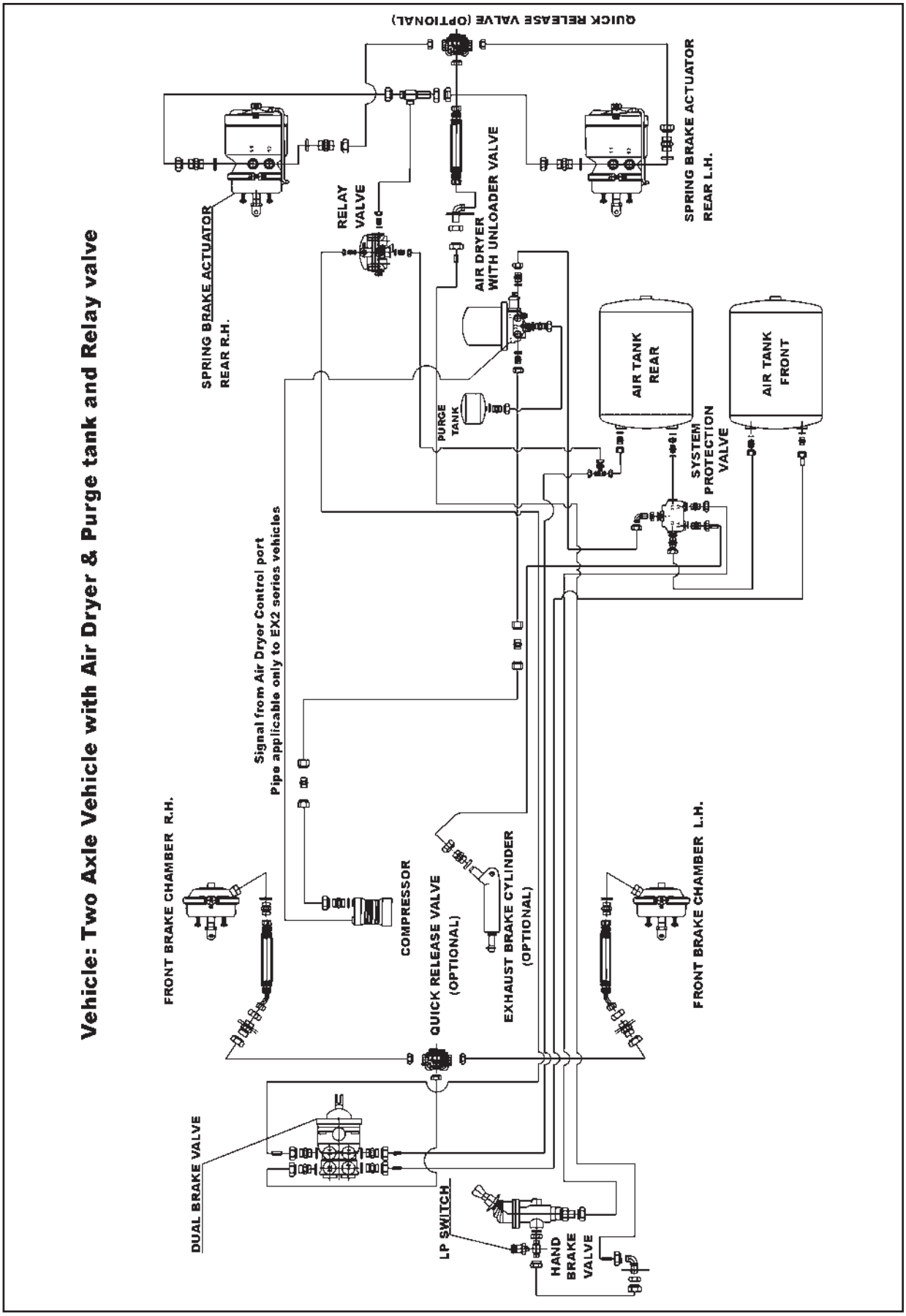



*Fig 1D : Schematic circuit for 'S' Cam Full Air Brakes*

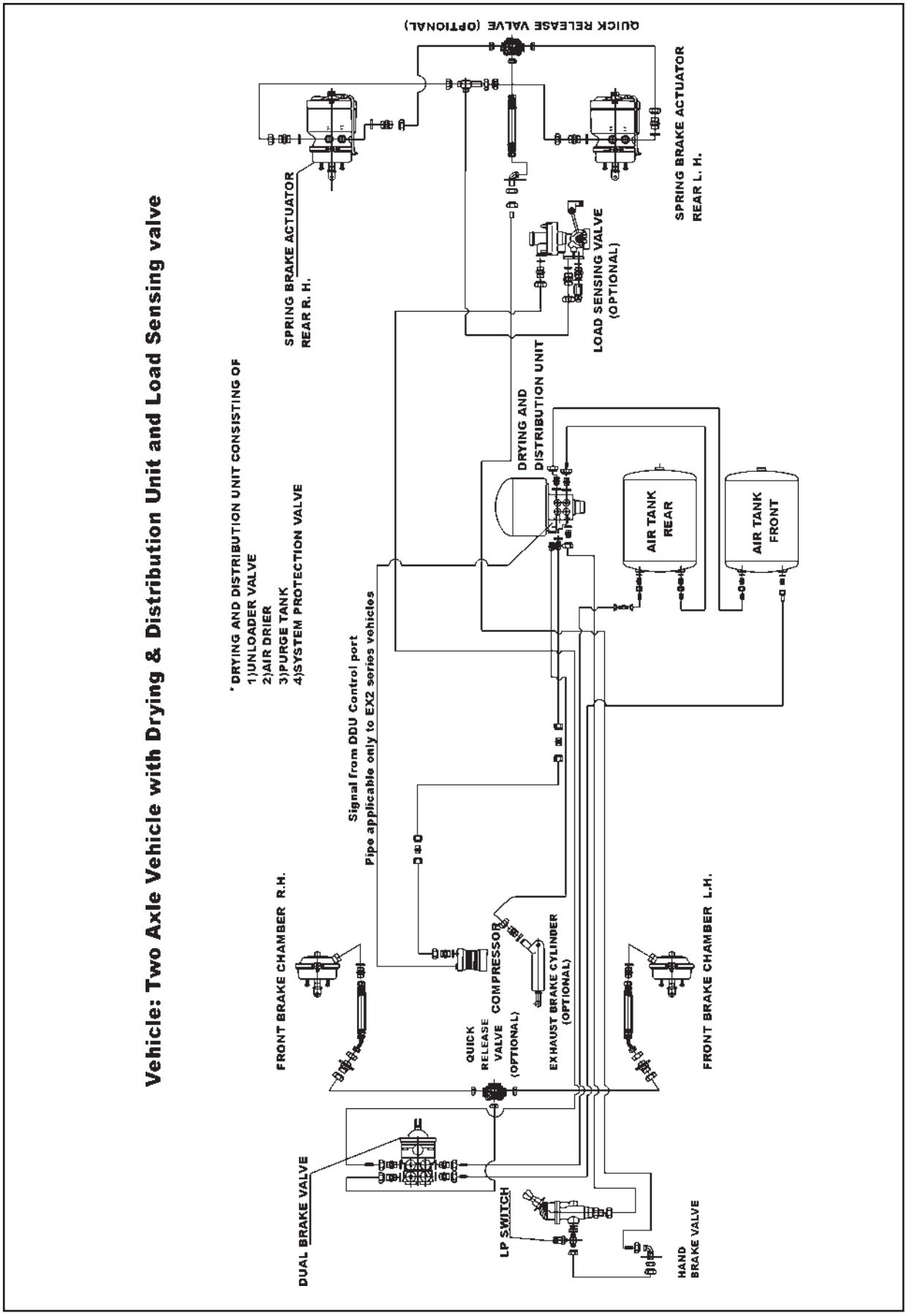



*Fig 1E : Schematic circuit for 'S' Cam Full Air Brakes*

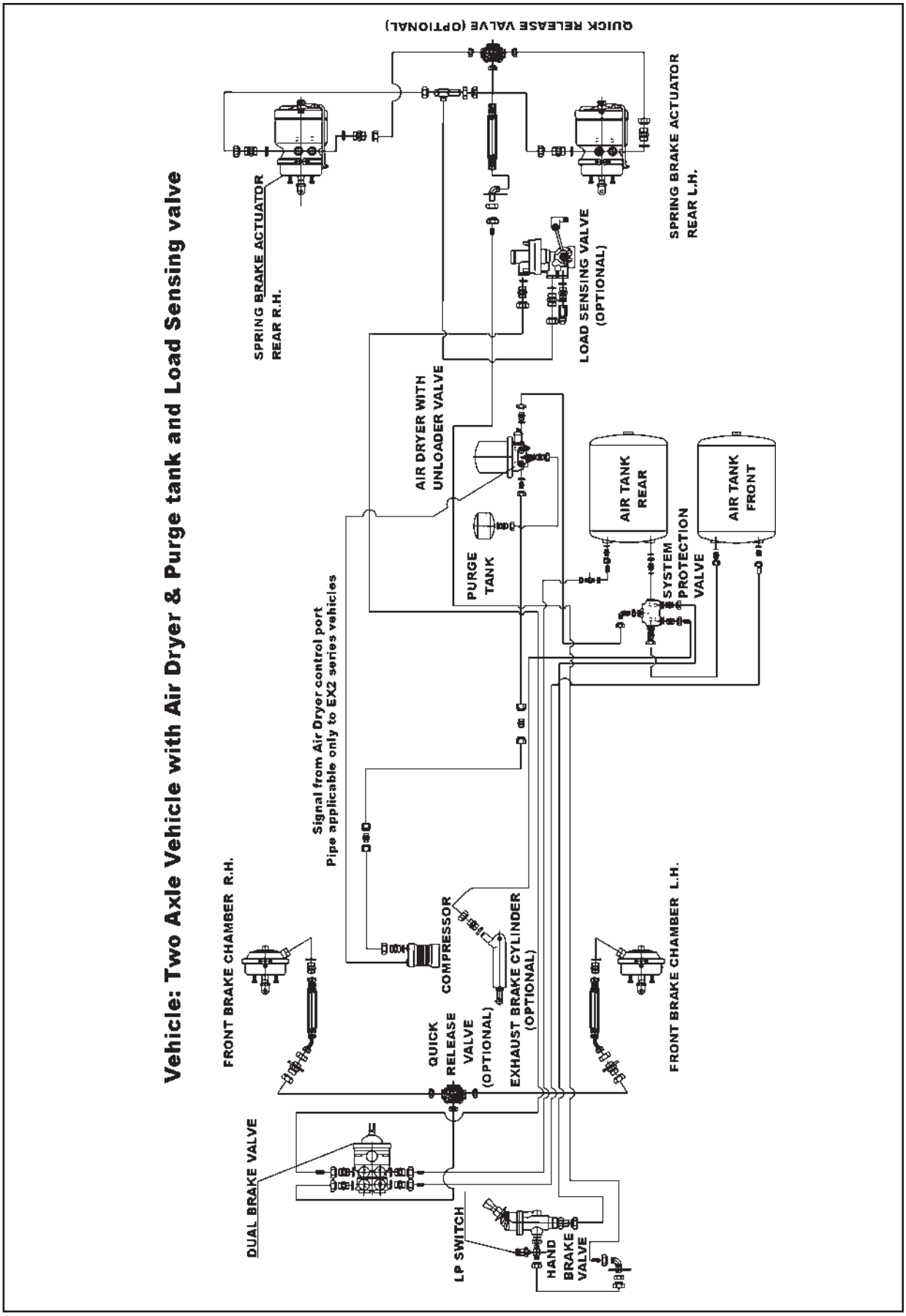



*Fig 1F : Schematic circuit for 'S' Cam Full Air Brakes*

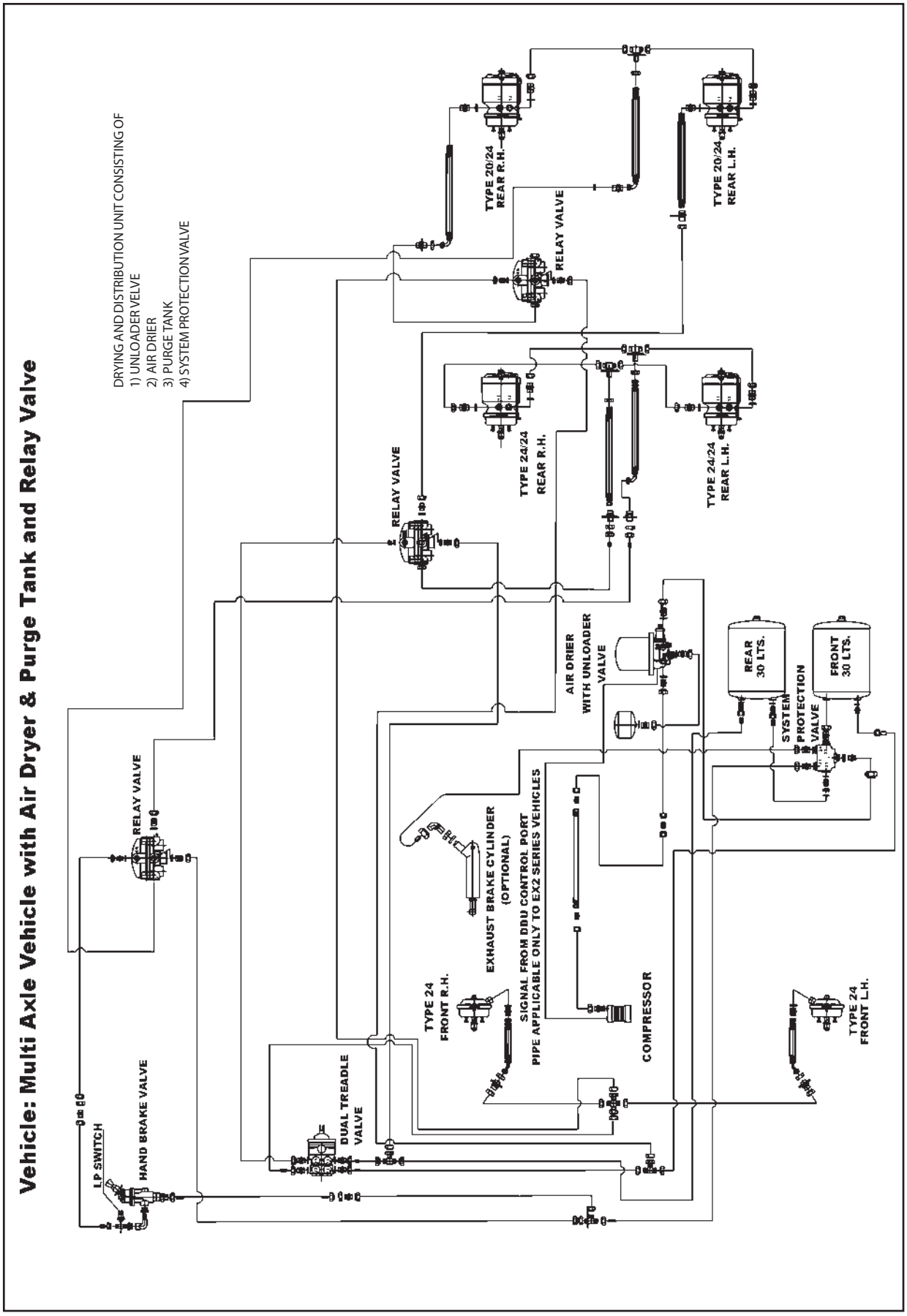



*Fig 1G : Schematic circuit for 'S' Cam Full Air Brakes*

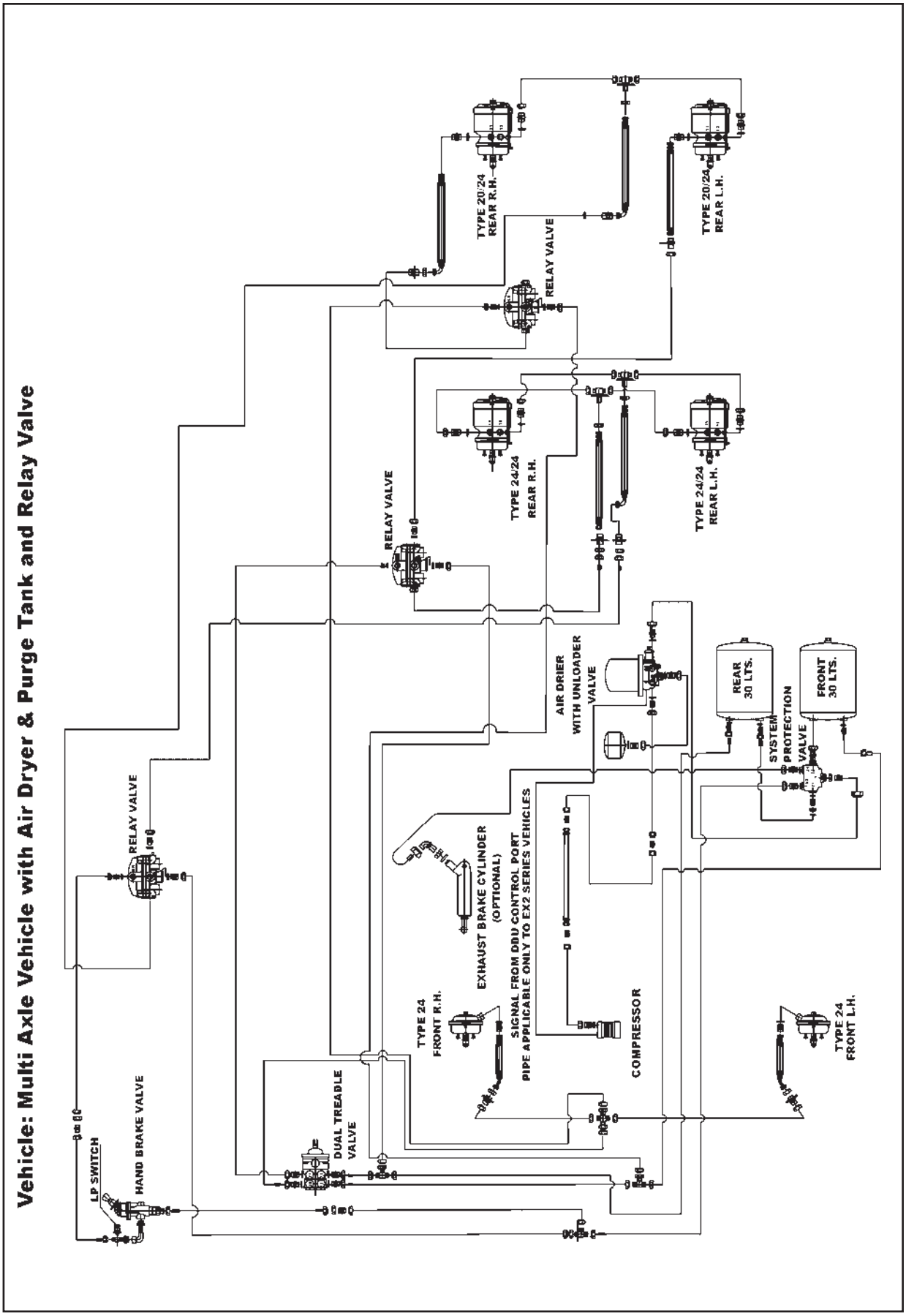



*Fig 1H : Schematic circuit for 'S' Cam Full Air Brakes*

### 1.2 Layout of S-Cam Full Air Brake System (Fig.1)

S-cam brakes are fully air operated brakes. Brake actuators at front and rear axles are externally mounted outside the foundation brake assemblies. Air is fed to brake actuators through dual brake valve (Operated by brake pedal, proportional to braking requirements).

Push-rods of brake actuators act on slack adjusters, which convert linear motion into circular motion of cam shaft. S-shaped cam portion of shaft expands brake shoes against drum, thus applying brakes.

S-cam is of equal displacement design, resulting in equal wear of leading and trailing shoes. In addition wider, thicker and tapered linings result in high brake lining life.

The brake system provides a safe and reliable braking and is of dual circuit full air brakes. The brake circuit consisting of various pneumatic components is as shown in circuit diagram. Service brakes consist of two separate circuits. One for front wheels and the other for rear wheels. Both are operated by a single brake pedal. The main feature is that in the unlikely event of failure of any one circuit, other circuit remains still operative and guarantees a certain degree of braking for the vehicle.

One of the auxiliary outlet of system protection valve connected through a graduated hand brake valve to spring brake chamber portion integral with rear brake actuator. During normal running, inside springs are kept in compressed condition by pressurised air, thus releasing parking brake. For parking/emergency braking, hand brake valve is operated for depleting air to atmosphere, thus applying parking brakes.

Second auxiliary outlet of system protection valve is connected to exhaust brake air cylinder through exhaust brake solenoid valve which is coupled with service brake pedal operation through stop light switch. Exhaust brake utilises engine braking and thus reduces brake lining wear.

Isolator switch can be used to cut off air to exhaust brake, isolating exhaust brake whenever required e.g., while starting of vehicle on a steep gradient.

Exhaust brake Isolator switch is provided on instrument panel which can be used to cut-off exhaust brake, isolating exhaust brake whenever required e. g. while starting the vehicle on steep up-gradient.

The function of various pneumatic components is briefly explained below :–

#### 1.2.1 Air Compressor

It is engine mounted and driven directly by the engine camshaft. It delivers compressed air to the sensing tank through the combined unloader valve with tyre inflator valve and charges the air tanks of the system.

#### 1.2.2 Air Dryer with Unloader Valve and Tyre Inflator

The function of the Air Dryer with unloader valve and tyre inflator is to dry and clean the compressed air delivered by the compressor and to control the system pressure. It also removes air system contaminates in solid, liquid and vapour form before they enter the brake system. The unit also provides facility for inflating tyre tube when necessary.

The Air Dryer consists of an aluminium body which houses the components of unloader valve and tyre inflator. Molecular sieve desiccant is contained in a sealed cartridge which secured to the body through a heavy coil spring and a steel housing.

#### 1.2.3 System Protection Valve

This can be considered as the heart of the entire brake system. This is line mounted with its inlet port connected to the sensing tank. The four delivery ports supply air separately to four different circuits i.e., service brakes for front and rear, handbrake and auxiliaries like exhaust brake, air horn, pump engagement for dumpers, etc. For safety reasons auxiliaries should not be connected in main brake or hand brake circuit. In normal working condition, all the four delivery ports are interconnected inside the valve. In the case of failure in any one of the circuits, the defective circuit gets seal and isolated keeping the rest of the system still healthy.

#### 1.2.4 Drying And Distribution Unit

Drying and distribution unit (DDU) combines the function of the Air dryer with unloader valve, purge tank (fitted with the air dryer) and the Quadruple System Protection Valve (QSPV).

Air Drying – Removes moisture completely from the compressed air

Unloading – Regulates system pressure by exhausting the compressor delivery air to atmosphere when system pressure is reached and allows recharging of the system when the system pressure reduces.

Safety Valve – In case of any malfunctioning of the unloader, protects the compressor and system by blowing off the excess pressure. This device is integral with the unloader mechanism.

Tyre inflator – This device helps in tapping air from the DDU for inflation of vehicle tyres.

Quadruple System Protection Valve (QSPV) – This function is integrated into the DDU, which protects the healthy circuits of the air brake system, in case of failure in one of the circuits. The non-return valves in this portion prevent back flow of stored compressed air upstream.

Purge tank – This tank which is integral with the DDU stores dry air for regeneration of desiccant bed.

### 1.2.5 Service Air Tanks

Two air tanks - one for the front and another for the rear brake - store and deliver the compressed air separately to the inlets of the dual brake valve.

### 1.2.6 Dual Brake Valve

It houses in one single body two valve elements, which are operated by single pedal. It controls front and rear brakes independently. Graduated degree of braking is possible with various pedal movements. It is connected to brake pedal through proper linkage.

### 1.2.7 Air brake chambers - Front

Brake chambers convert compressed air energy into mechanical force through linear motion of push rod assembly. Spring loaded push rod assembly rests against diaphragm. When pressurised air acts on the diaphragm, the rod assembly is pushed forward, exerting mechanical force on slack adjuster. When brakes are released, air from behind the diaphragm is exhausted to atmosphere through dual brake valve.

### 1.2.8 Spring Brake Actuators - Rear

Brake chamber for rear service brake and spring brake chamber for parking brake are combined into one unit. Conventional rear parking brake linkages are dispensed with. Spring brake chamber piston ram acts on the same diaphragm and push rod of service brake chamber.

In case of emergency due to any brake failure, automatically applied parking linkages can be released mechanically by wind off screw.

### 1.2.9 Slack Adjusters

Push rod assembly of brake actuators act on slack adjusters, converting linear motion into circular motion of S-Cam shaft. Slack adjusters provide quick and easy method of adjusting brakes.

### 1.2.10 Graduated Hand Brake Valve

The inlet is connected to 4-way system protection valve and one delivery port is connected to the spring rake chamber.

With this valve, gradual application of release of the hand brake is possible for easy maneuverability on gradients.

### 1.2.11 Engine Exhaust Brake Solenoid Valve

One of the four outlets of system protection valve is connected to exhaust brake solenoid valve, which is coupled with service brake pedal operation through stop light switch. On depressing brake pedal, stop light switch gives signal to electrical solenoid valve to open and supplies compressed air to exhaust brake cylinder. This operate butterfly valve in the exhaust system and applies the exhaust brake.

## 1.3 Port Identification

All ports of pneumatic valves are generally, designated by numbers for easy identification while connecting pipelines. The number consists of two digits. The first digit denotes the following

1. denotes inlet port
2. denotes delivery port
3. denotes exhaust post

If more than one inlet or delivery port exist, the second digit indicates serial number.

The details of all ports and their connections are given below :-

| | Description | Port No. | | Port connection |
|---|---|---|---|---|
| 1) | Air Dryer | Port | 1 | From compressor |
| | | Port | 2 | To system protection valve |
| 2) | System protection valve | Port | 1 | From Air Dryer |
| | | Port | 21 | To service tank (rear) |
| | | Port | 22 | To service tank (front) |
| | | Port | 23 | To graduated hand brake valve |
| | | Port | 24 | To auxiliaries like, engine exhaust brake, air horns, etc. |
| 3) | DDU | Inlet Port | 1 | Delivery from compressor. |
| | | Port | 21 | Reservoir (Rear axle braking circuit reservoir.) |
| | | Port | 22 | Reservoir (Front axle braking circuit reservoir.) |
| | | Port | 23 | Delivery for hand brake circuit. |
| | | Port | 24 | Delivery for auxiliary circuit like exhaust brake. |
| | | Port | 4 | (Optional) Control port (for compressors with cylinder head unloading device) |

| | | | | |
|---|---|---|---|---|
| 4) | Dual brake valve | | | |
| | On side face | Port | 11 | From service tank (rear) |
| | | Port | 12 | From service tank (f ront) |
| | | Port | 21 | To spring brake actuators (rear) |
| | | Port | 22 | To brake chambers (front) |
| | On bottom face | Port | 11 | To LP switch (rear) |
| | | Port | 12 | To LP switch (front) |
| | On top face | Port | 11 | To air pr. gauge (rear) |
| | | Port | 12 | To air pr. gauge (front) |
| 5) | Brake chamber front | | | From dual brake valve port 22. |
| 6) | Spring brake actuators rear | Port | 11 | From dual brake valve port 21. |
| | | Port | 12 | From graduated hand brake valve port 2. |
| 7) | Graduated hand brake valve | Port | 1 | From system protection valve port 23. |
| | | Port | 2 | To spring brake actuator port 12 at rear. |
| 8) | Exhaust brake solenoid valve | Port | 1 | From exhaust brake isolator valve port 2. |
| | | Port | 2 | To exhaust brake air cylinder. |

### 1.4 Electrical Indicators/Gauges

In S-cam full air brakes, following indicators gauges are provided for warning about any failure in the system.

#### 1.4.1 Low air pressure indicator (Red)

Two low pressure (LP) switches are connected separately for front and rear air circuits at dual brake valve. Both switches are connected to one [Low air pressure] indicator on instrument panel. When pressure is below specified value indication comes on panel.

#### 1.4.2 Hand brake indicator (Red) and beeper

One LP switch is connected at graduated hand brake valve outlet. This is connected to [Hand brake] indicator on panel. When pressure is below specified value or whenever hand brake is applied, [Hand Brake] indication on panel and audio beeper signals come together.

#### 1.4.3 Mechanical stop light switch

A mechanical stop light switch is mounted below brake control lever mounting box. Whenever brake pedal is depressed for applying brakes, stop light switch comes into operation and lights at rear tail lamps glow. This also providers signal to exhaust brake solenoid valve.

#### 1.4.4 Two air pressure gauges

Two air pressure gauges are provided separately for front and rear air brake circuits. Air connection are taken from dual brake valve.

#### 1.4.5 Engine Exhaust Brake Indicator

Exhaust brake operation is coupled with service brake . Whenever brake pedal is depressed for applying brakes, exhaust brake also gets applied and indicator lamp (E) glows on the instrument panel.

Stop light switch provides signals both for rear tail lamps as well as for exhaust brake solenoid valve.

Solenoid valve opens, allowing the compressed air to flow to air cylinder thus, operating the exhaust brake, if isolator switch is kept 'ON'.

#### 1.4.6 Isolator Valve (Exhaust Brake)

In certain situations like starting of vehicle on an upgradient, simultaneous acceleration and partial braking of vehicle are required, Isolator switch can be used to cut off air supply to exhaust brake, by putting in off (disengaged) position. Isolator switch should be put on (engaged), as soon as isolation requirement is over.

**2. FOUNDATION BRAKE (S-Cam )**

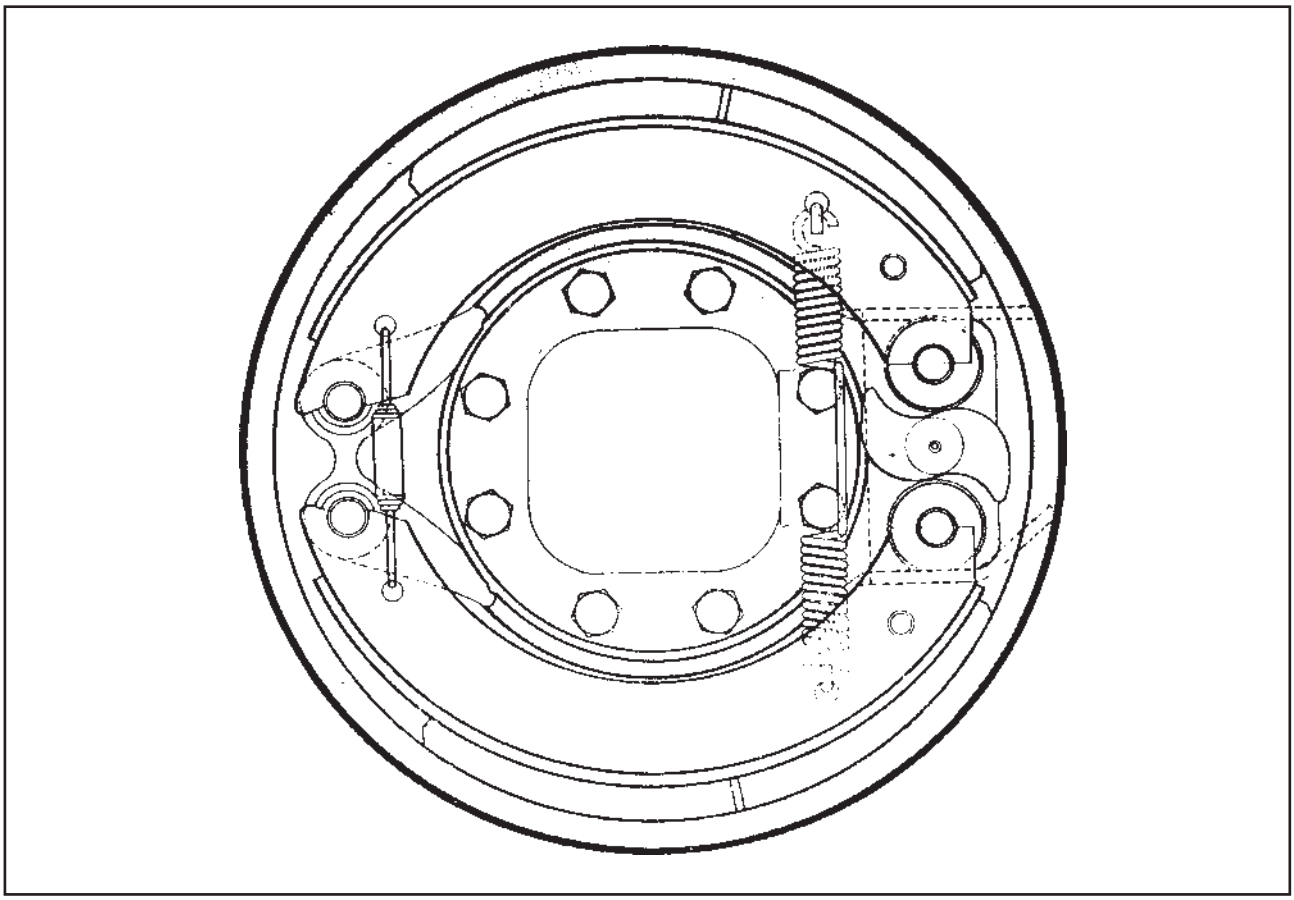


*Fig. 2: Front view of S-Cam brake (Front)*

### 2.1 S-CAM BRAKES (M/S BRAKES INDIA)

#### 2.1.1 Description

The S-Cam brake is of sound rugged construction combining simplicity with strength, designed for use on heavy commercial vehicles. The brake is operated by a 'S' form cam, which is an integral part of the cam shaft, the shaft being mounted in delrin bushes in the cast torque plate. The force is applied to the shoes thro' rollers seated between the shoe webs. A slack adjuster, which provides a quick and easy method of adjusting the brakes, to compensate for lining wear, is fitted to the splined end of the cam shaft.

The brake is actuated by air chamber thro' push rod connected to the slack adjuster.

The brake twin web shoes are of pressed steel construction and are pivoted onto two hardened steel fulcrum pins which are fitted into the stainless steel bushes pressed to the torque plate. Two semi circular shields cover the rear of the brake assembly to protect the brake components from dust / road pebbles.

#### 2.1.2 Major Overhaul - Front

**a) Removal of Shoes (Fig. 3)**

Jack up the front axle of the vehicle.

Remove the wheels.

Slacken off the adjusting screw of the slack adjuster until the shoes are fully retracted.

Remove the brake drum remove dust covers, if necessary.

Insert shoe horn or a screw driver on the shoe rim at cam end. Lift the shoe to an extent so that the roller (3) can be taken off from the shoe and remove the roller. Similarly remove the other roller also from the other shoe.

By lifting the shoe at the fulcrum end, remove the fulcrum pin (4) from the fulcrum pin bush. Similarly, remove the other fulcrum pin also by lifting the other shoe. Press the shoes towards each other at fulcrum end and remove the springs. Press the shoe towards hub by lifting the shoe from the cast torque plate at the fulcrum end. Now, remove the shoe return spring (5) at cam end by rotating the staked anchor pin. Take off the shoes (2) from the torque plate (1).

**b) Re-Lining the Shoes**

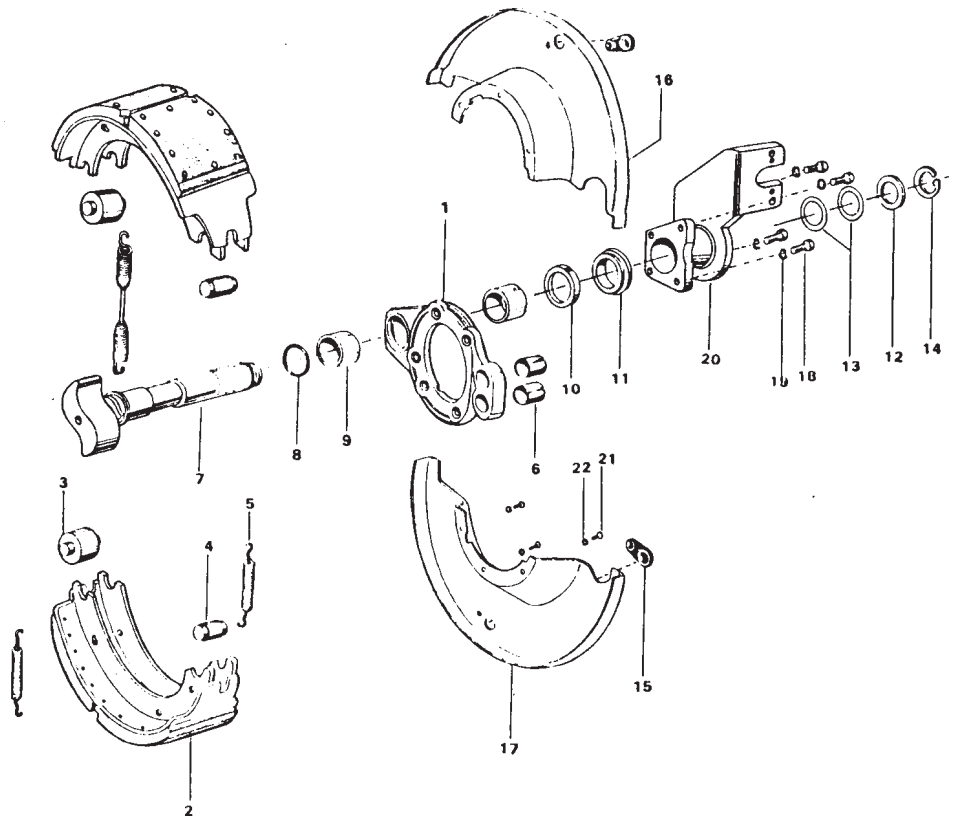



*Fig. 3 : Exploded view of S-Cam brake (Front)*

Lining should not be allowed to wear down upto the rivet heads. If the linings are worn out and the lining thickness is only 1 mm above the rivet head, the linings must be replaced.

De-rivet them carefully. Ensure that the rivet holes in the shoe rim are not enlarged during de-rivetting. Clean the shoe rim to ensure a smooth / even surface for re-lining.

Note : Always use genuine Tata Motors approved service replacement linings along with the rivets supplied during relining

Since the linings are tapered make sure that the thinner end of lining blocks are towards cam/fulcrum ends of shoes before rivetting. Clamp the lining evenly to the shoe rim and start rivetting at the lining centre progressing outwards to the ends of the lining segment. A flat ended anvil of the correct diameter should be used against the rivet head, and the tubular shank of the rivet should be properly clinched.

Care should be taken, since over rivetting may crack the linings. Also ensure that no gap exists between the lining and shoe rim.

Do not contaminate the lining surface with oil or grease.

After rivetting, refit the shoes in accordance with the following instructions

**c) Fitment of Shoes**

Clean the torque plate and lubricate the fulcrum pin bushes (pressed in the torque plate) with recommended grease. Examine the fulcrum pin/ bush for any wear and renew if necessary. Smear recommended grease on the fulcrum pin and roller seatings of the shoe.

Note : S-Cam profile and the rollers should be dry. No lubricant should be applied to the rollers.

Place the top shoe on the torque plate. By supporting the bottom shoe on the torque plate in tilted condition, fit the cam end shoe return spring and place it in position. Close the shoes at fulcrum end.

Now assemble the fulcrum end shoe return springs between webs with the help of a screw driver (both hub and dust cover sides). Supporting the bottom shoe, lift the top shoe with a screw driver or shoe horn at fulcrum end and put the fulcrum pin in the bush and seat the shoe on the pin. Similarly fix the other fulcrum pin by lifting the bottom shoe at fulcrum end and assemble. Now, by lifting the top shoe at cam end, place the roller on the shoe seat and leave it. Repeat the same for the bottom shoe also.

**Caution**

Lift the shoe to an extent so that the roller can be fitted easily. Do not over stretch the shoe return spring since over stretching may cause permanent set of the spring resulting dragging of the shoes. Always use new shoe return springs at the time of relining.

Completely retract the shoes, refit the brake drum and wheel.

Adjust the brake as described earlier.

**d) Servicing of Camshaft**

The camshaft is supported in two Delrin Bushes one in the torque plate and the other one in the chamber bracket. The slack adjuster is mounted on the splined end of the camshaft and is retained by a circlip. Shims of selected thickness are inserted between the slack adjuster and the clip, such that the axial float of 0.5 mm (Max.) is maintained to allow free rotation of the camshaft.

**e) Removal of Camshaft (Fig. 3)**

1. Disconnect operating linkage from the slack adjuster by removing the cotter pin after taking out the split pin.
2. Remove wheel, brake drum, hub and shoes as explained earlier under 'Removal of Shoes'.
3. Remove the circlip (14) with the help of a circlip plier from the end of the camshaft. Remove the Shims (13) and Washer (12).
4. Remove the slack adjuster and sleeve (11) from the splined end of the camshaft.
5. Remove the camshaft (7) from the torque plate by tapping the splined end of the camshaft with a soft mallet.
6. Remove the 'O' Ring (8) from cam end of the shaft.
7. If the Delrin Bushes require renewal, remove the oil seal (10) from the chamber bracket (20) and press the Delrin Bushes (9) out.

**f) Examination of the Parts**

Clean all the parts thoroughly in a suitable solvent (Kerosene or diesel).

Examine the camshaft for the journal diameters and if any damages on the 'S' Cam profile or on the splines are found replace with a new camshaft.

1. Clean the journal diameters on the torque plate and the chamber bracket.

2 Press in new Delrin Bushes (9) with a mandrel so that the bushes are not damaged.

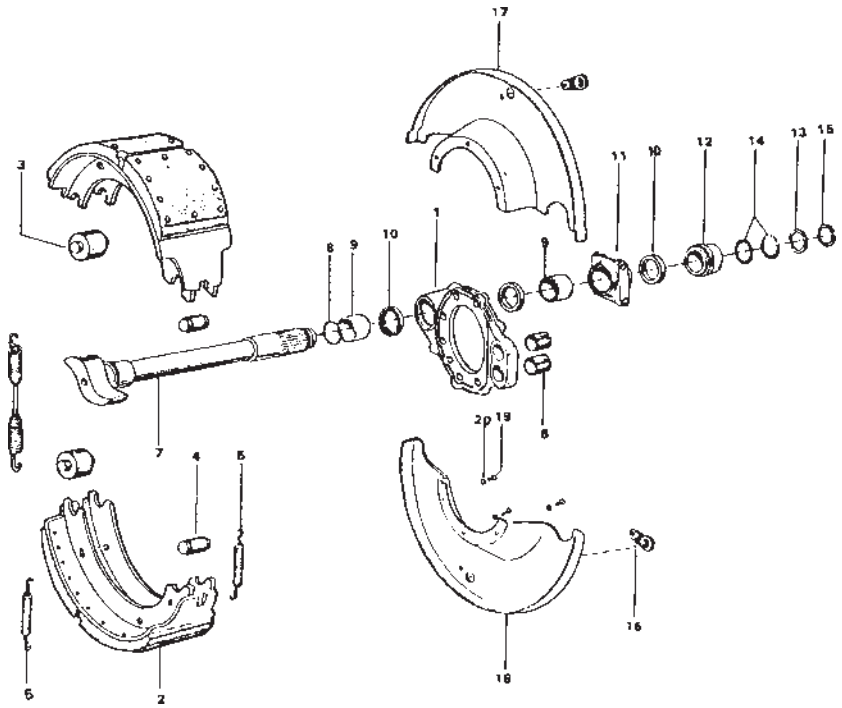
3. Press in a new oil seal (10) with a soft mandrel (taking care not to damage the seal) in such a way that the seal lip faces the slack adjuster, in position.
4. Smear recommended Grease on the inner surface of the Delrin Bushes.
5. Assemble the 'O' Ring (8) on to the torque plate bore at cam end.
6. Install the camshaft (7) from the front end of the torque plate.
7. Install sleeve (11) from the splined end of the camshaft.
8. Install the slack adjuster on the splined end of the camshaft.

   Care must be taken to locate the slack adjuster in position with respect to the direction of the cam movement and as well to see the adjusting screw and the grease nipple are accessible for servicing.
9. Insert the washer (12) followed by shims (13).
10. Fix circlip (14) with the help of a circlip plier and make sure that the circlip is well seated in the groove on the camshaft.
11. Check for the axial play of the camshaft. The shims should be just free to rotate. If necessary, add or remove shims to meet the requirement.

***Note :*** *S-Cam profile and the rollers should be dry. No lubricant should be applied to the rollers. But smear recommended grease on the fulcrum pin and roller seating of the shoe.*

12. Assemble the lined shoes as described earlier in 'Fitment of shoes'.
13. Actuate the brake by pulling out the slack adjuster by hand to an extent of about 30 mm and release.

    The shoes must return immediately without any delay.
14. Connect the operating linkage to the slack adjuster.
15. Turn the adjuster screw on the slack adjuster until the shoes are fully retracted.
16. Refit hub, drum and wheel.
17. Adjust brakes as explained under 'Brake Adjustment' and 'Road Test the vehicle'.



1. Torque Plate
2. Linered Shoe Assy.
3. Roller
4. Fulcrum Pin
5. Shoe Return Spring
6. Bush (Fulcrum Pin)
7. Camshaft
8. 'O' Ring
9. Bush
10. Oil Seal
11. Sleeve
12. Washer
13. Shim
14. Circlip
15. Grommet
16. Dust shield (Top)
17. Dust shield (Bottom)
18. Mounting Bolt
19. Spring washer
20. Chamber bracket assy.
21. Set screw
22. Spring washer

*Fig. 4 : Exploded view of S-Cam brake (Rear)*

### 2.1.3 Major Overhaul - Rear (Fig. 4)

**a) Removal**

Release the parking brake by lifting the hand control valve knob if it is in 'ON' condition.

1. Jack up the rear axle of the vehicle and remove the wheels.
2. Slacken off the adjusting screw of the slack adjuster until the shoes are fully retracted.
3. Remove the brake drum.
4. Remove the hub.
5. Remove the lined shoes (2) as explained earlier for front brakes.
6. Remove the circlip (15) fitted on the cam shaft at the slack adjuster side by using bent type outside circlip plier.
7. Take off the shims (14) and washers (13).
8. Disconnect and remove the slack adjuster from brake chamber push rod by removing the cotter pin.
9. Remove the sleeve (12).
10. Now, remove the camshaft (7) from the hub end by tapping it with a mallet.
11. Loosen and remove the two mounting bolts and take off the camshaft bracket (11).
12. Take out the 'O' ring (8) from the camshaft.
13. Remove the oil seals (10) from the torque plate (1) and camshaft bracket (11).
14. Clean all the parts thoroughly in a suitable solvent (kerosene or diesel).
15. Examine the camshaft for wear and damage at the 'S' cam journal diameters and at splines. If excessively worn or damaged, replace camshaft.
16. Check for the Delrin bushes pressed in the torque plate and camshaft bracket for condition and if he bushes are worn out or damaged, replace the bushes. While pressing the bushes, take care not to damage the bushes.

**b) Installation**

1. Press the new oil seal (10) on to the torque plate in such a way that the lip of the seal is towards the cam head. And press the oil seals (10) on to the camshaft bracket (11) (both sides) in such a way that the seal lips are facing towards the slack adjuster.
2. Lightly smear grease on the journals of the camshaft.
3. Assemble the camshaft bracket (11) on to the axle housing and tighten it.
4. Insert 'O' ring (8) followed by the camshaft (7) from the front end of the torque plate.
5. Install the sleeve (12) from the splined end of the camshaft.
6. Install the slack adjuster on to the splined end of the camshaft (7).

   Care must be taken to locate the slack adjuster in position, with respect to direction of cam movement and as well to see the adjusting screw and grease nipple are accessible for servicing.
7. Fit the washer (13) and shims (14) and fit circlip (15).
8. Rotate the camshaft (7) and check for free movement. If the camshaft does not rotate freely, check the alignment of the camshaft bracket and if necessary adjust the number of shims (4).
9. Assemble the lined shoes (2) as explained earlier, in front shoes.
10. Now, actuate the brake by pushing out the slack adjuster by hand to an extent of about 30mm and release.

    The shoes must return immediately without any delay.
11. Connect the operating linkage to the slack adjuster.
12. Turn the adjuster screw on the slack adjuster until the shoes are fully retracted.
13. Refit hub, drum and wheel.
14. Adjust brakes as explained under 'Brake Adjustment' and road test the vehicle.

**c) Fitment Instructions**

After mounting the brake before connecting the slack adjuster to air chamber push rod, slack adjuster to be pulled by hand in the direction of rotation by about an inch and make sure it returns freely.

**Shoe To Shoe Return Spring :** should be replaced at every lining change.

**Recommended Special Tools :**

| | |
|---|---|
| Removal and fitment of shoes | Shoe horn/longer screw driver |
| Fulcrum pin bush- | Special mandrel should be used for fitting the bushes into carrier to avoid spoilage of the bushes. |

## 2.2 S-CAM BRAKES (AUTOMOTIVE AXLES LTD)

The AAL "Q" series S-cam master brake allows you to change brakes shoes quickly without removing hubs. It is the basic time proven design providing this "Quick Change "serviceability benefit.

### 2.2.1 Major Overhaul

**a) Removal & Refitting Brake Shoes**

1. Remove the brake drum.
2. Back off the slack adjuster until the cam is in the start position. Disengage the retaining clips from the cam rollers. Press down on the bottom brake shoes and remove the lower cam roller. Next lift the top shoe and take out top cam roller.
3. Lift out the main shoe return spring which is now free from tension.
4. Swing the lower shoe back approximately $180^0$ to relieve the tension on the anchor end retaining springs. Remove the springs and slip the shoes off the anchor pins.
5. To install new linings, shoes and springs simply reverse this procedure. It is recommended to replace all three springs at each relining.

**b) Servicing Anchor Pins**

When changing AAL "Q" Series brake shoes there is usually no need to change the anchor pins. The shoes just slip off. However, if the pins worn out they can be easily replaced because they are held in place by the shoes. The stainless anchor pin bushing practically eliminates any spider wear or corrosion. Smear with grease bush bores & anchor pin small diameters while relining the brake shoes.

**c) Servicing Brake Linings**

Brake lining thickness must be the same on both the shoes of brake assembly and on each side of an Axle.

Always use genuine Tata Motors approved service replacement linings. High performance brake systems must be equipped with proper friction material and these requirements may vary from vehicle to vehicle.

Before relining, make sure that Brake Shoe contact faces are clean. Rivets of correct body diameter, head, size and shape length and material should be used. Gap between table and lining should not exceed 0.40 mm.

For vehicles operating in a corrosive environment coat the contacting areas of the anchor pins and shoe rollers with metallic based temperature resistant anti-seize compound.

Before relining, the shoes should be checked for,

1. Elongated rivet holes
2. Damaged weld
3. Wear of anchor pin slot to a width greater than 26.20 mm. (Fig. 5)
4. Stretching of the shoes between the anchor pin and roller edges greater than 344.50 mm. Discard shoes if any of the above defect.

Check spider (Fig. 6) for cracks and replace if necessary.

Replace seals at reassembly. Check anchor pins and bushings for excessive wear or looseness. If there is more than recommended play replace the bushings. If there is more than 0.4 mm play in the new bushing replace the anchor pin. Re-torque the spider mounting bolts.

**f) Servicing of Camshafts**

Inspect for flat spotting wear, corrosion or damage.

Check the cam surface, bearing journals and splines. Examine camshaft bracket for damage or bending. Check for camshaft bushing wear, replace if radial play exceeds recommended value.

Replace seals in bracket at reassembly.

Install spacing washers at reassembly to limit camshaft and play to recommended value.

Coat camshaft splines with a metallic based anti-seize compound and the bushings and cam journals with chassis grease.

Install new seals in both spider and bracket with the seal lip towards the slack adjuster end. (Fig. 6).

**g) Servicing of Dust Shields**

Examine dust shield for tightness, rust and distortion. The use of dust shields will extend lining life, minimize water fade, protect the brake component.

**h) Servicing of Slacking Adjusters**

Check to see that worm drive is free and working by rotating adjusting nut. Replace the slack adjuster if worm drive is faulty.

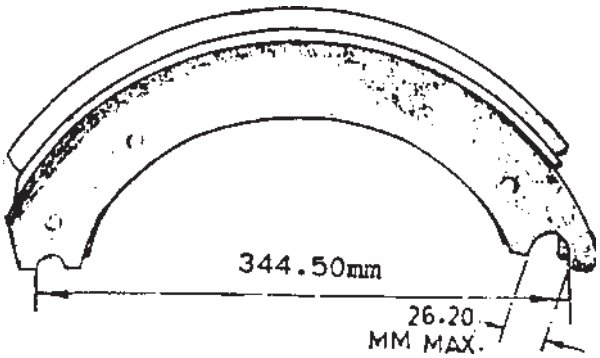



*Fig. 5 : Servicing Brake Lining*

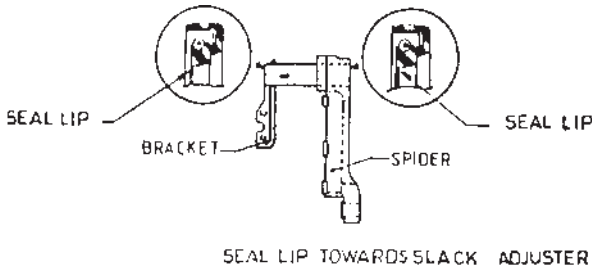



*Fig. 6 : Spider and Seal Lip*

When brake chamber push rod travel increases due to brake lining wear, to maximum values are recommended, brakes should be adjusted.

**i) Visual Inspection**

Both wheel ends of each axles and all four wheel ends of tandem axles should always be equipped with identical drums and linings.

Check entire air system for worn hoses and with full air pressure, leakage with brake released condition should not exceed as recommended.

**j) Road Test**

Always do the road test of the vehicle after brake reassembly, to ensure that the braking system as a whole is functioning properly.

Perform ten 50 kmph to 30 kmph snubs to seat the linings.

Perform ten stops from 30 kmph at 50% input air pressure.

Perform a full pressure stop from 30 kmph. Immediately after above stops check the drum temperatures. Any drums that are significantly cooler than the others indicates a lack of braking effort on those wheels.

**k) Inspection while relining the brake shoes**

1) Brake spider for distortion & loose mounting bolts.
2) Anchor pins & rollers for wear.
3) Brakes shoes for wear at anchor pin & roller slots
4) Cam shafts & rollers for wear
5) Shoe return spring & anchor springs for elongation.
6) Drums for cracks, deep scratches & other damages
7) Cam shaft seals.

**L) Fitment Instructions**

**Do's**

Replace the cam-head washer when it is worn out or distorted.

Grease seals of both the spider and the air chamber bracket should be installed with the seal lip facing the slack adjuster. Likewise the seals of the plummer block (rear brakes) should be installed with the lips facing outside.

**Dont's**

Do not use over-size brake linings since cam throw of cam head is sufficient enough to use the standard lining with the skimmed drums.

**2.3 Service Tips**

1. **In S-Cam brakes both the rollers and S- Cam must run dry.** This is important to have a good performance and also free rotation of the rollers on the cam.

   If the greasing is done, the rollers stick and do not rotate freely during the brake applications. Since the friction between the rollers and the 'S' Cam is necessary for the roller rotation, the **greasing of the rollers and the 'S' Cam head should not be done** when the vehicles come for any servicing.

   But only roller ends which sit into shoe web are to be greased lightly. Ref. Fig-7 for details.

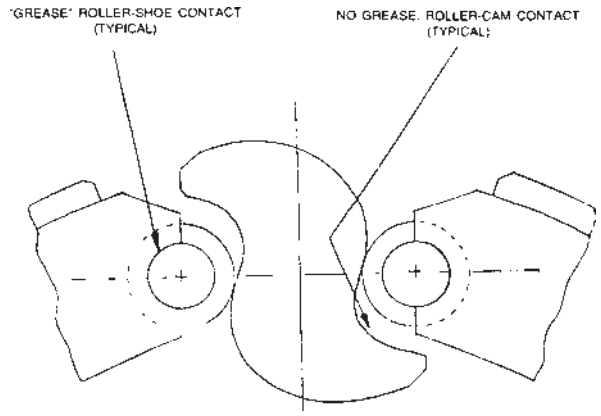



*Fig. 7 : Brake S-Cam and Rollers*

2. Same make of brake assemblies, brake linings and brake actuators should be used on the same axle.
3. When using repair size brake drums and linings, please ensure that drum diameters and brake lining sizes are same on opposite sides of the same axle.
4. Braking performance will drop down after brake chamber push rod travel of 45 mm in brakes applied condition. (Angle between push rod and centre line of slack adjuster will be less than 90.) Please do adjust service brakes before 45 mm travel. (Fig. 36.1)
5. Serviceable type on-line air filters are provided at each air tank for maintaining internal system clean with ease. Please clean filters as recommended. Frequent cleaning will ensure long life of brake components.
6. Brake drum diameters are recommended up to repair size II of 414 mm. Drums should not be used beyond 416 mm, as there will be no service braking or parking brake left, due to cam roll over. Before that, drums should be discarded.
7. Any extra air connection to auxiliaries like air horn should be taken from exhaust brake circuit only and not from hand brake circuit or service brake circuits.
8. An exhaust brake isolator switch is provided to isolate exhaust brake whenever required.
9. Graduated hand brake valve can be used along with isolator switch (exhaust brake) for simultaneous acceleration and partial braking of vehicle in certain situations like starting of vehicle on steep gradients.

## 3. Slack Adjuster &Automatic Brake Adjuster

### 3.1 Slack Adjuster

#### 3.1.1 Introduction

Slack Adjusters provide a quick, easy method of adjusting brakes to compensate for brake lining wear. Slack Adjusters were designed to conform to the development of heavy-duty, two shoe foundation brakes. Different Slack Adjuster types are adapted the various requirements of modern braking. All Slack Adjusters utilize the worm and gear principle.

All Slack Adjusters fit. with DIN splines 38 x 1.5 x 24 teeth (Fig. 9). Arms are provided in various lengths and of several types (offset, straight, for various installation requirements).

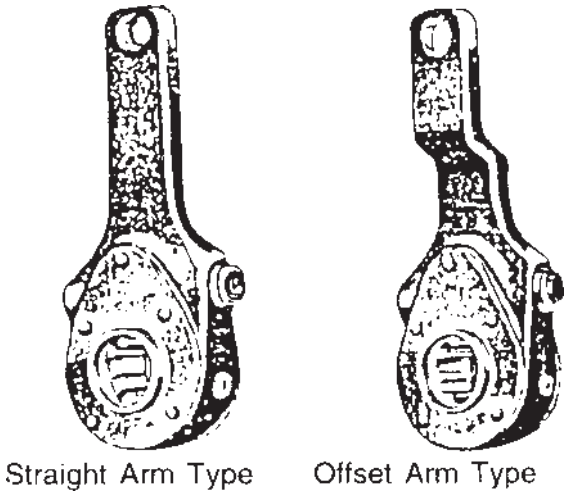



*Fig. 8.1 : Straight Arm & Offset Arm*

**a) Description**

The Slack Adjuster consists of a forged steel body which constitutes both the arm and spline housing in one piece. A worm gear with internal splines along with its driving worm mounted on its haft is housed in the body and the worm shaft runs tangentially to the worm gear and is plugged at one end and locked in position by a worm shaft lock at other end.

The worm and the worm shaft are press fit and run as a single unit. The locking of the worm shaft is achieved by the spring loaded lock, locking on the hexagonal head of the shaft. The lock itself is prevented from rotating by a pin fixed to the body and running along a slot on the shaft exterior of the lock. The whole unit is sealed by two-end cover plates rivetted to the body. The operating end of the arm contains a reamed hole with a sintered bronze bush pressed in, wherein the operating lever is coupled for actuation. The mating parts are lubricated with grease fed through a grease nipple.

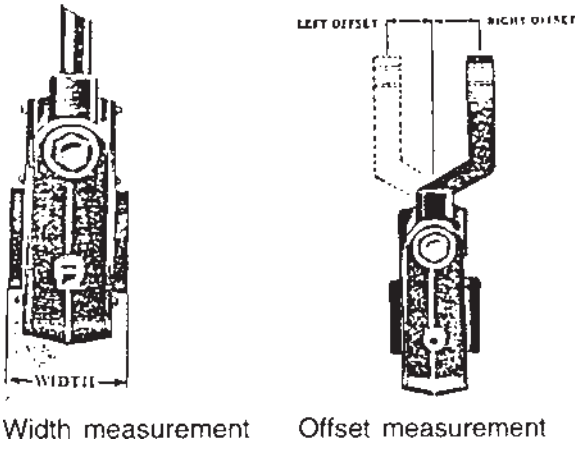



*Fig. 8.2 : Width & Offset Measurement*

**b) Operation**

Slack Adjusters perform a two-fold function : (1) they serve as a lever during normal braking operation

and (2) provide a quick and easy method of adjusting brakes.

**c) Braking**

In normal braking, the entire Slack Adjuster remains rigid as a unit and rotates bodily with the brake cam shaft as the brakes are applied or released. When the brakes are applied (a) air pressure actuates the brake chamber, (b) the brake chamber push rod rotates the Slack Adjuster, (c) the Slack adjuster rotates the cam shaft and cam, thereby spreading the brake shoes, applying the brakes. When brakes are released, (d) the air pressure in the brake chamber is released, (e) the brake chamber release spring and brake shoe return springs return the brake cam, cam shaft, Slack Adjuster and Brake Chamber push rod to the released position.

### 3.1.2 Adjustment (Fig. 10)

Brakes are adjusted by turning the adjusting screw of the Slack Adjuster with a common open end, box or socket wrench, after releasing the worm lock. Turning the adjusting screw rotates the worm gear. Turning the worm gear rotates the cam shaft and brake cam. The brake cam spreads the brake shoes and compensates for lining wear.

Brakes on a vehicle can be adjusted by merely turning the adjusting screw until the brake shoes are touching the brake drum with the brakes released. Back off the adjustment for sufficient brake lining clearance.

On vehicles with which mechanics are not familiar, it is advisable to jack up the wheel and make the adjustment as close as possible to the position where the brakes just begin to drag. Back off the adjustment to a position where the wheel will rotate.

After proper adjustment apply the brakes. The Slack Adjuster arm and brake chamber push rod should form and angle slightly greater than 90 degrees (Fig. 36.1). All Slack Adjusters on the vehicle should be at the same angle.

**a) Precaution To Be Taken While Adjusting Brake Drum To Lining Clearance**

For adjusting the brake lining to drum clearance, worm shaft lock (Fig. 10) has to be depressed fully and then the worm shaft has to be rotated using 14 mm ring/ double and spanner to get the required clearance. If the worm shaft lock is not depressed fully to clear the hexagon of the worm shaft, during adjustment the worm shaft lock will also tend to rotate along with

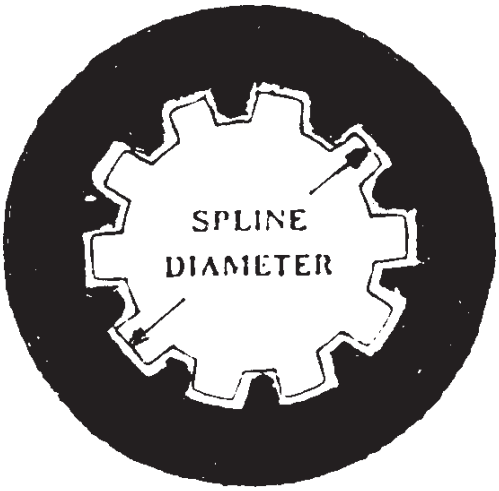



*Fig. 9 : Spline MEASUREMENT*

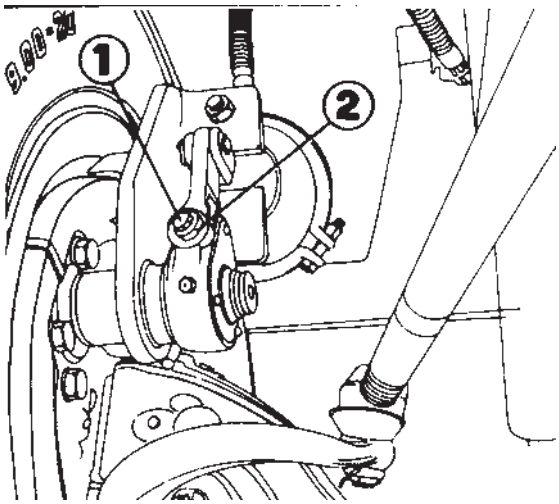



*Fig. 10 : Adjusting Brake with Slack Adjusters*
1. Adjuster Screw 2. Locking Sleeve

the worm shaft resulting in the shearing off of pin.

Hence the following procedures should be followed while adjusting brake lining to drum clearances to prevent the shearing off the pin.

1. To clean the worm shaft/worm shaft lock portion with suitable solvent (like kerosene) to remove dirt.
2. Depress the worm shaft lock fully using suitable 14 mm ring / double end spanner.
3. Rotate the worm shaft to effect the adjustment.

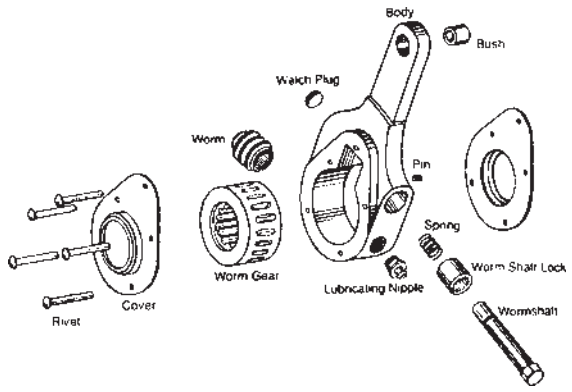



*Fig. 11 : Exploded view of Typical Slack Adjuster*

4. Release the lock after adjustment and ensure that the lock is properly located.

**3.1.3 Service Check**

**a) Operating Test**

Apply brakes and check to be sure Slack Adjusters rotate freely and without binding.

Release brakes and check to be sure slack Adjusters return to the release position freely without binding.

With brakes released, check to be sure the angle formed by the Slack Adjuster arm and brake chamber push rod is greater than 90 degrees. All Slack Adjusters should be set at this same angle.

With brakes applied, check to be sure the angle formed by the Slack Adjuster arm and brake chamber push rod is still slightly greater than 90 degrees. All Slack Adjusters should be set at this same angle.

**3.1.4 Installing**

Provide clearance so that the slack adjusters can be rotated to the maximum stroke of the brake chamber.

Locate the slack adjuster on the cam shaft so both the adjusting screw and grease fitting are accessible for servicing.

Refer to paras 3 and 4 under service check and make sure the proper service check and make sure that the proper adjustments are made to provide for these conditions when installing a slack adjuster.

When installing a slack adjuster consider the torque requirements of the slack adjuster. Each type slack adjuster has a maximum torque recommendation and this recommendation should not be exceeded.

When replacing one type of a slack adjuster with another type it is not only necessary to match the arm length, offset, spline diameter and width (Fig 8); it is also necessary to make certain that there is adequate clearance on the vehicle to use the replacement Slack Adjuster and that this replacement slack adjuster meets the necessary torque requirement.

**3.1.5 Dismantling** (Fig. 11)

Remove rivets holding covers and gear in place.

Remove welch plug.

Press out worm shaft from worm by pressing on the end of the worm shaft opposite the adjusting screw nut.

Remove worm shaft, worm shaft lock and worm lock spring.

Remove worm and gear from Slack Adjuster body.

**3.1.6 Cleaning & Inspection**

After Slack Adjuster is dismantled, clean all parts in cleaning solvent.

Carefully inspect body for cracks or distortion. Check play in yoke pin holes. If yoke pin is loose in hole, or if hole is out-of-round, press bushing out and press in replacement. Ream bushing after pressing in. Check inside surface of body, especially the surface where the worm gear rotates in the body. This surface must be smooth and free of any heavy nicks or scratches. Make sure the grease holes in the body are open and clear.

Inspect worm gear for broken teeth or damaged spline. Replace gear if either is found. After considerable service,

the worm gear may show wear on one section of teeth. Such gear is serviceable if installed with good teeth in contact with worm.

Check worm for bent, broken, or deeply score threads and replace if any of these conditions prevail.

Check the worm shaft lock for wear. It should be replaced if worn excessively. Inspect the worm shaft lock pin in the body, making sure it is rigidly installed. If loose, remove it and install replacement, prick punching it to body.

The bores of all worms, are serrated to assure a rigid assembly with worm shaft. Repeated removal and installation of a worm shaft in a serrated bore may make the shaft unfit for further use. Judgement must guide in most cases. It is recommended that a new worm shaft be installed when rebuilding a Slack Adjuster.

### 3.1.7 Reassembly

Place worm and gear in Slack Adjuster body.

Position and press the worm shaft, worm shaft lock and worm lock spring into the worm and Slack Adjuster body. Be careful to press the worm shaft into the body to the proper dimension (See dimension 'A' - Fig.12). Be sure to line up the recess in the worm shaft lock with the pin in the Slack Adjuster body before pressing into position.

Replace old welch plug with new one and install.

Install covers and rivets and rivet securely.

**a) Test and Adjustment of Rebuilt Slack Adjusters**

After rebuilding a Slack Adjuster, be sure to grease it with the proper lubricant. Refer to the section headed "Preventive Maintenance" for grease specifications.

Be sure all moving parts rotate freely and do not bind.

Test of a rebuilt Slack Adjuster can be performed on the vehicle.

Refer to section headed "Operation", "Adjusting" to make sure that the rebuilt Slack Adjuster performs those functions properly. Also, refer to the section

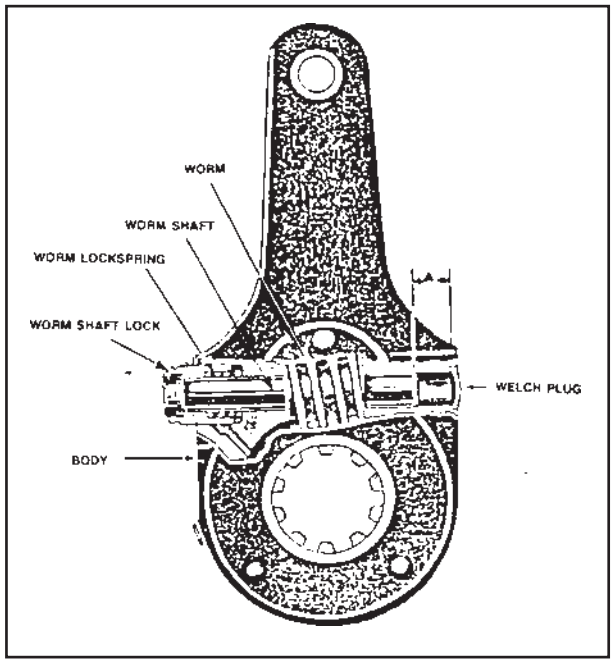
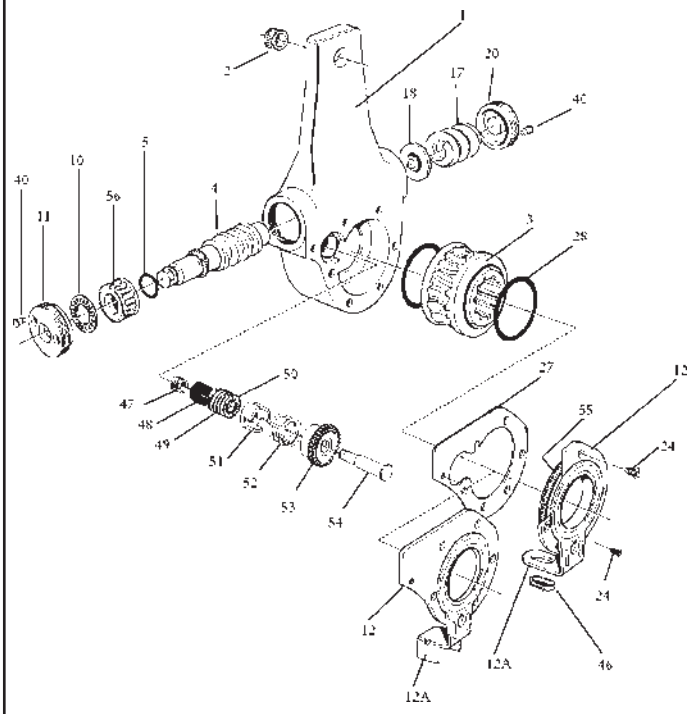



*Fig. 12 : Reassembling Worm Shaft into Body*



| | | | |
|---|---|---|---|
| 1. | Housing | 28. | O-Ring |
| 2. | Bushing | 40. | Rivet |
| 3. | Worm Wheel | 46. | Plastic Insert |
| 4. | Worm Shaft | 47. | Compression Spring |
| 5. | O-ring | 48. | Spring Support |
| 10. | Needle Bearing | 49. | Adjusting Screw |
| 11. | Front Cover | 50. | Toothed Plate |
| 12. | Control Unit Assembly | 51. | Companion Flange |
| 12a. | Control Arm | 52. | Gear Wheel Spring |
| 17. | Coil Spring | 53. | Gear Wheel |
| 18. | Thrust Washer | 54. | Regulator Shaft |
| 20. | Rear Cover | 55. | Control Disc |
| 24. | Torx Screw | 56. | Clutch Wheel |
| 27. | Gasket | | |

*Fig. 13.1 : Exploded view of Automatic Brake Adjuster (Haldex)*

headed "Service Check" to make sure the rebuilt Slack Adjuster performs those functions properly.

### 3.2 SELF-SETTING AUTOMATIC BRAKE ADJUSTER (S-ABA)

**3.2.1 Description** (Fig. 13.1)

Housing (1) is cast in modular iron and tenifer treated to give a low coefficient of friction and high wear resistance. The housing is available in different variations with a choice of lever length, offset and inclination.

Busing (2) is made of hardened steel and can be supplied in different dimensions.

Worm wheel (3) & Worm Shaft (4) transmits force from housing (1) to the S-cam shaft. The tooth profile of the gear is asymmetrical and both parts are made of specially treated grade steel.

O-Rings (5) & (28) which are made of nitrile rubber, protect the mechanical parts from salt, water and dirt.

Regulator Wheel assembly (47-54) maintains the predetermined clearance between the lining and the brake drum.

Control unit (12) supplies the motion required for compensatory action of the adjuster. The unit mainly consists of control disc (55), control arm (12A). The control arm and the disc are rigidly joined to each other and can rotate freely as unit in the cover.

Gasket (27) fits between control unit (12) and housing (1).

Needle bearing (10), Thrust washer (18) and Screw covers (11 & 20) take up the thrust from coil spring (17).

Coil spring (17) holds worm shaft (4) in contact with clutch wheel (56).

Rivets (40) lock screw covers (11 & 20) in desired position and allow easy disassembly.

In addition to having all the function malities of maual slack adjuster, the automatic slack adjuster also adjusts

brake automatically for lining wear.

Control arm mounting bracket is provided to give stationary reference point for automatic adjuster.

### 3.2.2 Operating Checks

a Push Rod Travel: Check that free travel (lining to drum contact) does not exceed one third of the total stroke and ensure adjuster returns to 'full off' position. (Last point is important for correct adjuster operation).

Adjusters with single bent control arms incorporate renewable insert bushes. Check insert bush of wear and change if necessary. The peg retaining bolt should also be checked and changed if worn. Abnormal wear in these parts will increase push rod travel.

b Anchor point Installation: Ensure installation is secure and that control arm anchor bolt is tight. If not, retighten fastners.

c Adjuster Function:

- Check with Torque Meter.

De-adjustment torque: Place a torque wrench on 12mm adjusting hexagon and turn torque wrench 1/8 turn anti-clockwise to check that internal clutches do not slip at a torque of less than 1.8 mkg. If clutches slip at a lower torque, adjuster must be replaced.

Repeat this opearation three times with the same adjuster. If either of the clutches slip at a lesser torque the adjuster must be replaced.

- Manual Check if torque meter is not available.

Adjuster function can also be tested by de-adjusting brake at least one full turn on adjusting hexagon to give excess lining/drum clearance.

Apply and release brake and observe that adjusting hexagon rotates CLOCKWISE at the end of every return stroke. If rotation is zero, adjuster must be replaced immediately, for inspection.

Leaving spanner on adjusting hexagon will accentuate rotation. If adjuster function satisfactory, readjust brake

***NOTE :*** *When turning hexagon anti-clockwise, much more effort is required than when turning clockwise and the action of the serrated clutch should be distinctly heard. This is also an indication of satisfactory function.*

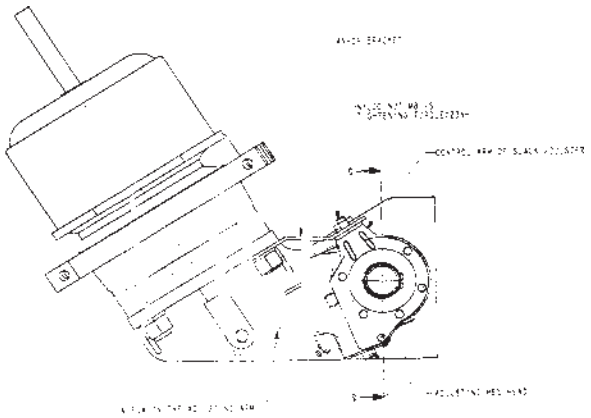


*Fig. 13.2 : Control arm mounting*

- Check that the piston stroke has not considerbly changed from the normal one every 36,000 km.

### 3.2.3 Adjuster Replacement

The adjuster must be changed once its de-adjustment torque falls below 18 Nm. (13 lb.ft.)

***Warning:*** *Do not repeatedly adjust a Haldex Brake Adjuster to compensate for excessive lining / drum clearance or overstroking. If continual manual adjustment is necessary, then either:*

a) Adjuster is worn/malfunctioning.

b) Fault is outside parameters of adjuster and requires further investigation.

### 3.2.4 Installation Procedure

1. Block wheels to prevent vehicle from rolling.
2. Check the pushrod is fully retracted. Apply (Min 6 $kg/cm^2$) air to release Spring Brake / Turn off mechanically to release the Spring Brake.
3. Clean & Apply Anti seize / Grease on 'S'cam shaft splines.
4. Check there is no excessive play or wear in camshaft/ bushes (recommended maximum play 0.5 mm), clevis pin/bushes and control arm anchorage attachments.
5. Install Anchor Bracket loosely at suitable area (Don't tighten anchor bracket)
6. Install the Brake Adjuster on to the 'S'cam shaft with the adjuster hexagon pointing away from the Brake

Chamber.

7. Rotate the Adjuster Hexagon nut clockwise until the Brake chamber clevis hole line up with the Slack adjuster arm hole.
8. Install the clevis pin /cotter pin.
9. Add shims /spacer according to maintain (0.5-2mm) Axial play & lock with circlip. Space washer with dia 60 mm or more should be installed against control lever.
10. Move the control arm to align with the anchor bracket slot & tighten all the anchor bracket fasteners.
11. Rotate the adjuster hexagon nut clockwise until brake lining contacts the brake drum. Then back off the adjuster hexagon by turning anti clockwise $270^0$ i.e. ¾ of a turn.
12. A minimum of 1.8 mkg torque is required to over come the internal Clutch, a ratcheting sound will occur.

### 3.2.5 Brake Shoe Reline

Do not use impact guns, as internal clutches will be damaged.

- Using a 12mm hexagonal wrench, rotate adjusting hexagon in an anti-clockwise direction to return 'S' camshaft to 'Off' position.
- Realine shoes, lubricate pivots, S-cam, etc. and re-assemble. Check that 'S' camshaft rotates freely and returns to 'Off' position.
- When resetting shoe/drum clearance, hexagon to be used in the normal manner. Bring linings into contact with drum and back off brakes by approx. 1 turn. Brakes will adjust to the pre-set running clearance over a number of brake applications.

### 3.2.6 Fault Finding

***Note :*** *Free pushrod travel is nominally 1/3 of the total brake chamber stroke.*

a) Excessive Pushrod Travel

- Check pushrod is returning to fully 'Off' position and that camshaft is not sticking
- Check there is no excessive play or wear in camshaft/ bushes (recommended maximum play 0.5 mm), clevis pin/bushes and control arm anchorage attachments.

***Note:*** *Some adjuster installations have renewable plastic control arm bushes.*

- Check adjuster operation.

b) Brake Bind or insufficient Push Rod Travel

- Check camshaft is not sticking , brake shoe anchor pins are not seized or shoe return springs broken.
- Where spring brake chambers are fitted, check there is sufficient air pressure available to keep parking brake in the 'OFF' position. (Minimum 6.0 bar.)

### 3.2.6 Lubrication

The automatic brake adjuster should be lubricated in conjunction with the lubrication prescribed for the vehicle chassis. A lithiumbased chassis grease should be used.

Long term greased adjuster (LTG) I. e. units without grease nipples do not require any periodical lubrication.

- Clevis pins should be lubricated at servicing intervals.

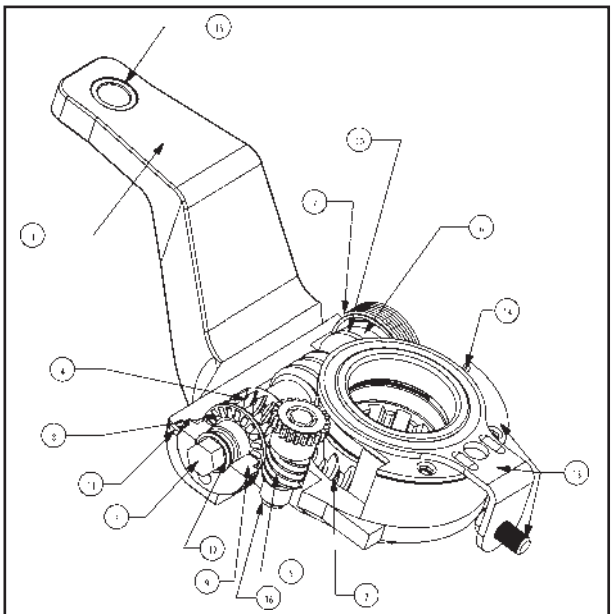



*Fig. 13.3 : Automatic Brake Adjuster (MEI)*

- A light oil spray is recommended around camshaft splines; to reduce risk of corrosion and seizure of adjuster onto camshaft and in particular, where there is circlip retention of adjuster.

## 4. PNEUMATIC SYSTEM

### 4.1 AIR DRYER WITH UNLOADER VALVE AND TYRE INFLATOR

**a) Function**

The function of the Air Dryer with unloader valve and tyre inflator is to dry and clean the compressed air delivered by the compressor and to control the system pressure. It also removes air system contaminates in solid, liquid and vapour form before they enter the brake system. The unit also provides facility for inflating tyre tube when necessary.

**b) Description**

The Air Dryer consists of an aluminum body which houses the components of unloader valve and tyre inflator. Molecular sieve desicant is contained in a sealed cartridge which secured to the body through a heavy coil spring and a steel housing.

**4.1.1 Service Check**

**Inspection**

1. Check the air lines for tightness of compressor mounting bolts.
2. Ensure the air lines is in good condition.
3. Check the tightness of cylinder head mounting bolts of the compressor.

**a) Operating Tests**

1. Drain the reservoir and check for presence of moisture / water collection in the reservoir. Presence of moisture is indication of requirement of changing the desiccant cartridge.
2. Drain the reservoir and then start the engine. Charge the system until the "Cuts out" and record the reading of dash-board gauge pressure. Ensure that the pressure gauge on the dash-board gives correct reading before commencing the test. If the pressure setting differs, loosen the lock nut and adjust the adjusting screw. Repeat the test till the correct pressure setting is achieved and then tighten the lock nut. For the purpose of resetting, it may be required to deplete the reservoir by applying the brakes a few times.

**b) Leakage Tests**

1. Charge the system to just below the "Cut out" pressure and stop the engine. Apply soap solution on the entire unit to check for air leakage. Leakage from any part of the valve or from the air line connections is not permissible.
2. Start the engine and charge the system until "cut out". Stop the engine and check for air leak through exhaust passage of base cover to detect non return valve leakage.

**4.1.2 Removal**

1. Block the wheels to prevent movement of the vehicle during working.
2. Brush away dirt/dust from the air line connection and the unit.
3. Loosen the pipe clamps and disconnect the pipe lines from the unit.
5. Close open ends of the pipes to prevent dirt/dust entering the air lines.
6. Unscrew the mounting bolts and nuts and remove the unit.

**4.1.3 Installations**

1. Locate the Unit on the bracket and fix the three mounting screws and secure the unit.
2. Connect the inlet and delivery pipe lines.
3. Carryout 'Operating/Leakage tests' as given under 'Service check'.

**4.1.4 Dismantling (Fig.14)**

Tools required for servicing

Philip head screw driver, a good circlip pliers, nose pliers and standard tools and spanners.

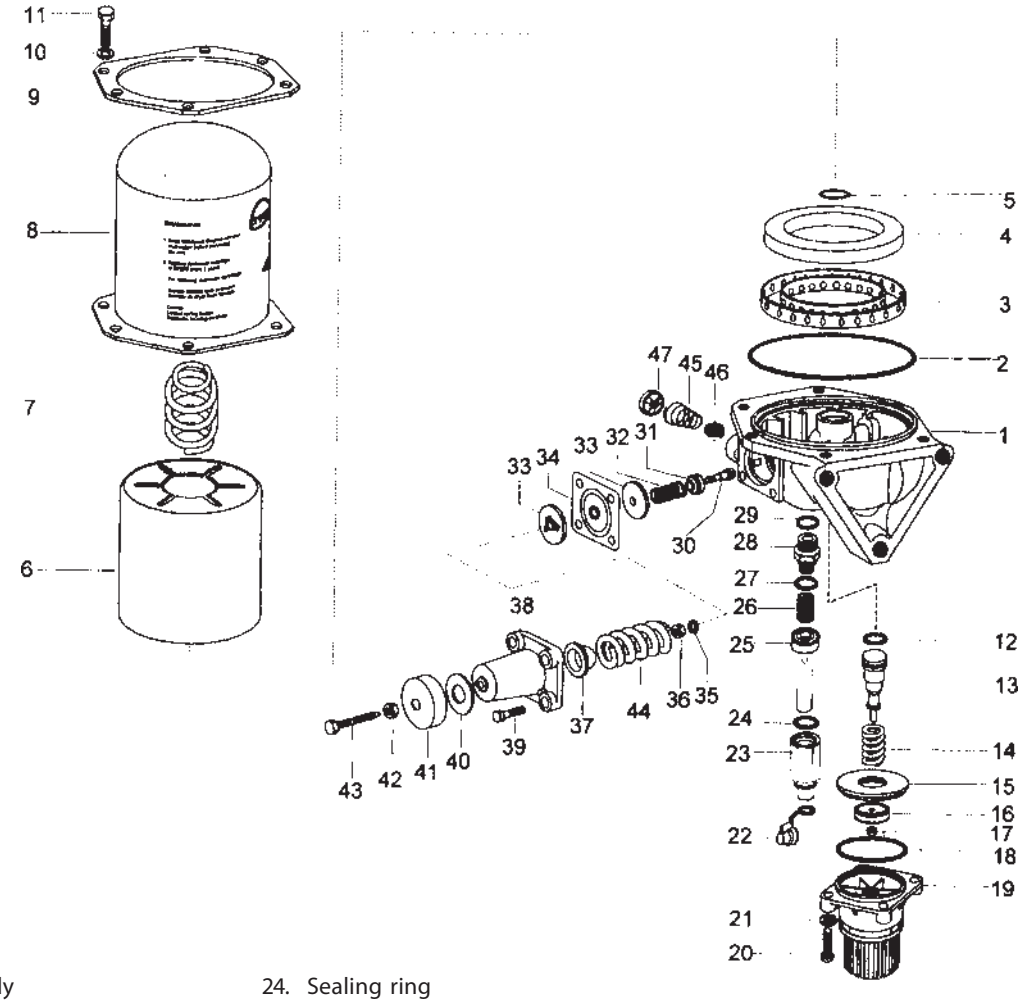
1 Clean the exterior of the Air dryer thoroughly.

2 Hold the Air Dryer assembly in a vice with suitable vice clamp and loosen and remove the 6 screws (11) securing the housing to the body. (Care must be taken to hold the housing while removing the screws since the housing is held against a heavily loaded spring)

3 Remove the housing (8), the stiffener plate (9), the spring (7) and the disccant cartridge (6).

4 Remove the filter (4), the filter retainer (3), the sealing ring (5) and sealing ring (2) from the valve body (1)

5 Loosen the lock nut (42) and remove the adjustment




1. Body
2. Sealing ring
3. Filter retainer
4. Filter
5. Sealing ring
6. Desiccant cartridge
7. Spring
8. Housing
9. Stiffener plate
10. Steel washer
11. Hex.Screw.
12. Sealing ring
13. Unloader plunger
14. Compression spring
15. Valve seat
16. Valve
17. Hex. nyloc nut
18. Sealing ring
19. Silencer
20. Pan head screw
21. Steel washer
22. Dust cap
23. Adaptor
24. Sealing ring
25. Tyre inflator plunger
26. Valve
27. Sealing washer
28. Spring retainer
29. Tyre inflator spring
30. Governor plunger
31. Valve
32. Spring
33. Follower
34. Diaphragm
35. Spring Washer
36. Hex. nut
37. Spring guide
38. Top cover
39. Hex.screw
40. Exhaust flap
41. Cup
42. Hex.Nut
43. Adjustment Nut
44. Compression Spring
45. Conical Spring
46. Non return Valve
47. Valve Stop & Spring guide



*Fig. 14 : Air Dryer with Unloader valve & Tyre Inflator*

screw (43) cup (41) and exhaust flap (40).

6 Unscrew the four screws (39) securing the top cover to the body. Remove the spring (44), the spring guide (37) and the top cover (38)

7 Remove the diaphragm sub assembly.

8 Hold the governor plunger (30) by inserting a suitable pin in the hole and loosen the lock nut (36) and remove the washer (35), the followers (33), the diaphragm (34), spring (32), and valve (31) from the diaphragm sub assembly.

9 Unscrew the valve stop and spring retainer (47) and remove the spring (45) and the non-return valve (46).

10 Unscrew the 4 Philip head screws (20) securing the silencer to the body and remove the silencer sub assembly.

11 Remove the sealing ring (18)

12 Withdraw the Unloader plunger sub assembly by holding the nyloc nut (17) with a flat nose pliers.

13 Remove the dust cap (22) from the tyre inflator adapter (23)

14 Loosen and remove the tyre inflator adapter (23), sealing ring (24), plunger (25) with the valve (26), the washer (27), spring retainer (28) and the spring (29).

15 Remove the valve (26) from the plunger (25)

16 Loosen the nyloc nut and remove the valve (16), valve seat (15), spring (14)

17 Remove the sealing ring (12) from the plunger (13).

**4.1.5 Cleaning and Inspection**

1 Clean all the components with a cleaning solvent and blow-dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.

2 Thoroughly clean the valves body and make sure that the air passages cross-holes are not blocked.

3 Check the valve body for thread damages, nick marks / damages on the valve seats, excessive wear / score marks on the plunger bore.

4 Check the springs for distortion, and/or permanent distortion.

SCRAP ALL THE OLD PARTS WHICH ARE FOUND UNSERVICEABLE.

**4.1.6 Reassembly**

1 Use recommended Repair kit to replace the parts scrapped during dismantling and in addition replace all parts which were found unserviceable / defective during cleaning and inspection.

2 Lubricate all the sliding parts with silicone grease. This grease is supplied along with the Repair kit.

3 Assemble the conical spring (45) to the non return valve (46) and position the valve in the valve body. Secure the valve in position by screwing in the valve stop and spring retainer (47) in the delivery port.

4 Install new sealing ring (25) on the tyre inflator plunger (25).

5 Locate the spring (29), valve (26) and tyre and tyre inflator plunger in the valve body and secure in position by tightening the adapter (23) with sealing washer (27) to a torque of 45 Nm.

6 Fix the dust cap (22) on the tyre inflator adapter.

7 Install new sealing ring (12) on the Unloader plunger (13)

8 Locate the valve seat (15) and valve (16) on the Unloader plunger by tightening the nyloc nut (17) to a torque of 2 Nm.

9 Locate the Unloader plunger sub assembly in to the body.

10 Locate the sealing ring (18) on the silencer body.

11 Place the silencer assembly (19) over the body. Apply Loctite 242 or equivalent on the 4 Philips head screw (20) threads and secure the silencer with spring washers (21).

12 Place the valve (31), the spring (32), bottom follower (33), diaphragm (34), the top follower (33) in the governor plunger (30) and secure by tightening the nut (36) with spring washer (35) to a torque of 6 Nm. Ensure proper orientation of diaphragm during assembly.

13 Place the diaphragm on the body by guiding the governor plunger into the bore.

14 Place the graduating spring (44), spring guide (37) and top cover (38) on the diaphragm assembly and secure the top cover by tightening the 4 screws (39) to a torque of 9 Nm.

15 Place the exhaust flap (40) and cup (41) on the top cover and screw in the adjusting screw (43) with the lock nut (42).

16 Assemble the sealing ring (5) for the desccant cartridge on the centre of the body.

17 Assemble the filter (4) onto the filter retainer (3).

18 Assemble the larger sealing ring (2) on the spigot of

the body.

19 Place the desiccant cartridge (6) over the body and locate the spring (7) over the desiccant cartridge.

20 Locate the housing (8) and the stiffener plate (9) and secure with the Six hexagon screws (11) and steel washer (10) to a torque of 25 Nm.

### 4.2 SYSTEM PROTECTION VALVE (Fig. 15)

#### a) Function

The function of system protection valve is to charge Four lines from a common compressor and prevent back flow of compressed air from any line. In the event of failure of any one of the lines, this valve helps to maintain the other lines intact to their operating pressure.

#### b) Description

The System protection valve consists of a valve body, a diaphragm assembly, Six spring loaded hemispherical valves, graduating spring and top cover. The body has one inlet port connecting the delivery of the compressor and Four delivery ports. Two ports lablled 21 and 22 are connected to two independent reservoirs feeding air pressure to the dual brake valve. Port labelled 23 is connected to the hand brake circuit and port 24 is connected to auxiliary circuits like exhaust brake.

The body provides valve seats for the Four elements. Each element has a spring loaded hemispherical valve. a diaphragm assembly locates the valves.The top cover locates the graduting springs and secure the diaphragm assemby through Five hexagonal head screws. A dust cover is provided to prevent dust entry into the elements.

#### 4.2.1 Service Check

#### a) Operating Tests

Deplete the air pressure completely from all the lines.

Connect a test gauge in the inlet line of the system protection valve (preferably in the sensing tank drain port).

Connect test gauges one in each of the delivery lines of the system protection valve.

With any one of the service lines open, start the engine and build up air pressure, to check the opening pressure of that element. The stabilised pressure showing in the inlet gauge is the opening pressure of that element.

If the system pressure is not charged to the correct pressure setting, the valve element should be removed, serviced and adjusted to give the correct pressure setting.

For setting the specified pressure, screw in all the adjusting screws to higher pressure and unscrew to get the required pressure setting. For pressure setting service element run the compressor at idling speed of the engine.

Repeat this procedure for all other three elements and attend to them if necessary.

Note : For service lines the gauges provided on the dash-board may be used.

**Closing Pressure of Auxiliary Element**

For checking the closing pressure of an element in the auxiliary line, charge the system fully and release the pressure slowly by opening that line to atmosphere. Pressure retained in the inlet test gauge is the closing pressure of that element.

**Closing Pressure of Service Element**

For checking the closing pressure of an element in the service line, charge the system fully and release the pressure by opening that line to atmosphere. The pressure drops in the test gauge connected to the inlet at a faster rate to a pressure and further keeps on dropping slowly. The pressure dropped suddenly to a value is the closing pressure of that element.

#### b) Leak Tests

Charge the system to unloader valve cut out pressure and stop the engine.

Apply soap solution on the joint and gaiters and cheek for air leakage.

If air leak noticed in the joint, check valve body mating faces for nick/score marks and damage and replace the valve bodies, if necessary.

If the body faces are free from the above defects, replace the joint and follow sequential tightening as given under reassembly.

If air leak noticed in the gaiters, check for score/nick marks and damage on the valve body bores and plungers in addition to the flashes on the 'O' rings and replace the plunger, valve body or the 'O' ring, if necessary.

**Non Return Valve Leak**

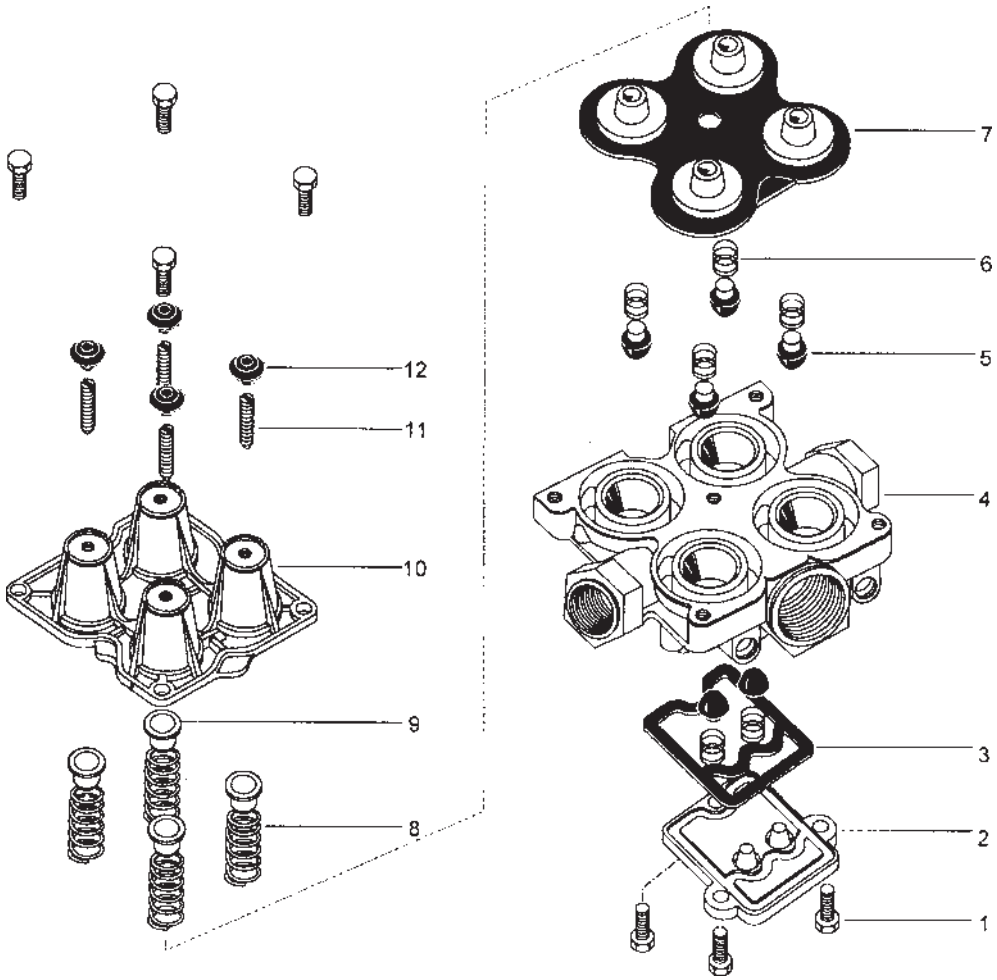
Connect test gauges in the delivery of the service and auxiliary lines and charge the system fully.

Deplete any one of the service reservoirs by disconnecting that line.

No pressure drop is permissible in the other test gauges of the service line and auxiliary lines.

Pressure drop in any of the test gauge indicates nonreturn valve leak in that line.

Connect that service line and repeat the above procedure by disconnecting the other lines one by one to detect non-return valve leak in other lines.




1. Set screw
2. Base cover
3. Gasket
4. Body
5. Valve
6. Spring
7. Diaphragm assembly
8. Compression spring
9. Spring guide
10. Top cover
11. Pressure setting screw
12. Dust cover



*Fig. 15 : System protection Valve ( Diaphragm type).*

Note : Prior to conducting air leakage tests, ensure that the entire system is free from air leak. With the system fully charged, if system protection valve gives rise to hissing noise, it leaves an indication that there exists external air leak which has to be attended first before conducting leak tests.

Remove all the test gauges.

**4.2.2 Removal**

1. Block the wheels to prevent the movement of the vehicle during working.
2. Brush away dust/dirt from the air line connections and the system protection valve.
3. Deplete the air pressure in all the lines.
4. Identify the pipes with its appropriate parts and disconnect the pipes.
5. Close the open ends of the pipes to prevent dust/ dirt entering the air lines.
6. Loosen and remove the mounting nuts and remove the valve from the bracket.

**4.2.3 Replacing**

- Fix the short end of the long adaptor with an aluminum washer to the inlet port of the valve.
- Screw in the lock nut and an aluminum washer on the long end of the adaptor and screw in the adaptor to the sensing tank boss and secure tightly.
- (Locate the valve on the mounting bracket and secure tightly where applicable).
- Identify the ports and connect its respective pipes.
- given under "Service Check".

**4.2.4 Dismantling**

- Tools required for servicing.
- Spanners 10, 11, 13 A/F, a 2.5 mm Allen key. No other special tool is required.
- Loosen and remove the lock nut from the long adaptor and remove the adaptor and the washer from the valve port.
- Remove the four dust covers.
- Loosen and remove the five hexagonal screws securing the top cover to the body.
- Remove the spring, the spring guides, the diaphragm assembly and the four valves.
- Loosen and remove the three screws securing the base cover to the body.
- Remove the gasket and the two valves.
- Scrap all the parts which are serviced in the repair kit.

**4.2.5 Cleaning And Inspection**

1 Clean all the components with a cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.

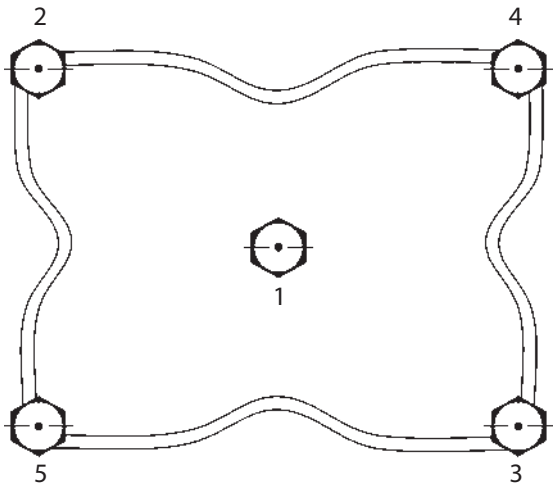



*Fig. 16 : System Protection Valve Sequential Tightening*

2 Thoroughly clean the body and check the valve seats for damage, nick marks. check the threads for damage.

3 Check the springs for distortion, and permanent set.

Scrap all the old parts which are found unserviceable

**4.2.6 Re-assembly**

1 Use recommended Repair kit to replace the parts scrapped during dismantling and in addition replace all parts which were found unserviceable / defective during cleaning and inspection.

2 Locate the springs on the hemispherical valves and locate the valve assembly on the seat in the valve body.

3 Locate the diaphragm assembly on the valve in proper orientation.

4 Locate the pressure setting springs on the diaphragm

5 Locate the spring guides on the springs.

6 Locate the top cover and secure with five hexagonal screws. Tighten the screws evenly in sequence as shown in the figure 16.

7 Assemble the four pressure setting screws on the top cover.

8 Assemble the dust covers. Use a small drift of 2 mm dia and insert the cover fully to ensure that it is properly seated.

***Note :*** *Use the longer graduating spring for the service elements and the shorter ones for auxiliaries.*

**4.3 DRYING AND DISTRIBUTION UNIT (DDU)**
(Combined unit of Air Dryer, System Protection Valve, Unloader Valve, Tyre Inflator)

**Function**

Drying and distribution unit (DDU) combines the function of the Air dryer with unloader valve, purge tank (fitted with the air dryer) and the Quadruple System Protection Valve (QSPV).

The main functions of DDU are:

- Air Drying – Removes moisture completely from the compressed air
- Unloading – Regulates system pressure by exhausting the compressor delivery air to atmosphere when system pressure is reached and allows recharging of the system when the system pressure reduces.
- Safety Valve – In case of any malfunctioning of the unloader, protects the compressor and system by blowing off the excess pressure. This device is integral with the unloader mechanism.
- Quadruple System Protection Valve (QSPV) – This function is integrated into the DDU, which protects the healthy circuits of the air brake system, in case of failure in one of the circuits. The non-return valves in this portion prevent back flow of stored compressed air upstream
- Tyre inflator – This device helps in tapping air from the DDU for inflation of vehicle tyres
- Purge tank – This tank which is integral with the DDU stores dry air for regeneration of desiccant bed

**Specifications**

| | |
|---|---|
| Length | 322 mm |
| Width (max) | 209 mm |
| Weight | 8.5 kg |
| Working medium | Air |
| Thermal range of operation | -25$^0$C to +80$^0$c |
| Short term resistance to heat | 100$^0$C |
| Maximum allowable air inlet temperature | 600$^0$c |
| Normal working pressure | 8 bar |
| Maximum permissible pressure | 10 bar |
| Blow off pressure | 12 $\pm$ 2 bar |
| Maximum air flow rate | 400 Liters / minute |

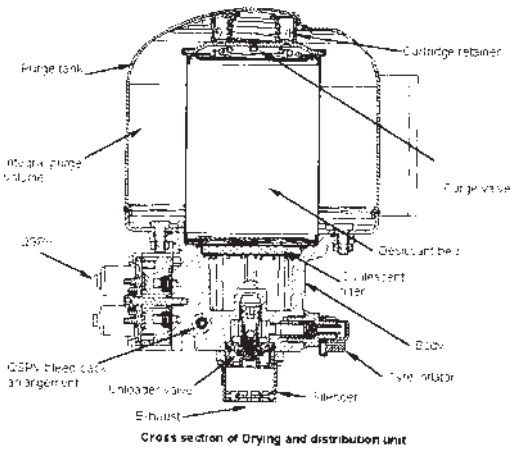


Figure-5

*Fig. 17 : Drying & Distribution*

**Connections of ports**

| | |
|---|---|
| Inlet Port 1 | Delivery from compressor. |
| Port 21 | Reservoir (Rear axle braking circuit reservoir.) |
| Port 22 | Reservoir (Front axle braking circuit reservoir.) |
| Port 23 | Delivery for hand brake circuit. |
| Port 24 | Delivery for auxiliary circuit like exhaust brake. |
| Port 4 (Optional) | Control port (for compressors with cylinder head unloading device) |

**Operation**

DDU consists of an aluminium body on which the purge tank, integral unloader valve, integral QSPV and the tyre inflator are mounted.The exhaust is fitted with a silencer. Intemaily, air path consists ofa coalescent fiiter, which removes the oil and other contaminants from the compressed air and a desiccant bed, which removes the moisture from the air.

During Charging, the compressor pumps air into the service reservoirs . The water moleeules in the air get adsorbed on microscopic pores on the surface of the desiccant beads . A portion of the dried air is stored in the purge volume contained in the sheet metal purge tank . During untoading cycle, the Unloader exhausts the compressor delivery air to the atmosphere.

**Drying And Distribution Unit (DDU)**




1 Purge tank sub assembly
2 Spring
3 Cartridge retainer
4 Purge valve
5 Desiccant cartridge
6 Filter
7 Filter retainer
8 Sealing ring
9 Sealing ring
10 Valve body
11 '0' ring
12 Unloader plunger
13 Spring
14 Valve seal
15 'O' ring
16 Spherical valve
17 Screw
18 Silencer assembly
19 Cover
20 Gasket - QSPV
21 Body - QSPV
22 'O' ring
23 Valve
24 Spring - QSPV
25 Diaphragm - QSPV
26 Spring
27 Spring guide
28 Top Cover QSPV
29 Bolt - QSPV
30 Adjusting screw
31 Lip seal
32 Cover
33 Allen bolt
34 Spacer
35 '0' ring
36 Spring
37 Valve - pressure test connector
38 'O' ring
39 Body
40 Cap
41 Gasket - ULVTI
42 Boot
43 Governor plunger
44 Bonded valve
45 Spring - ULVTI
46 Follower
47 Diaphragm - ULVTI
48 Nut
49 Spring - ULVTI
50 Cap
51 Screw holder
52 Top cover - ULVTI
53 Bolt
54 Cap
55 Adjustment screw
56 Valve seat
57 'O' ring
58 Spherical valve
59 Spring guide
60 Nut

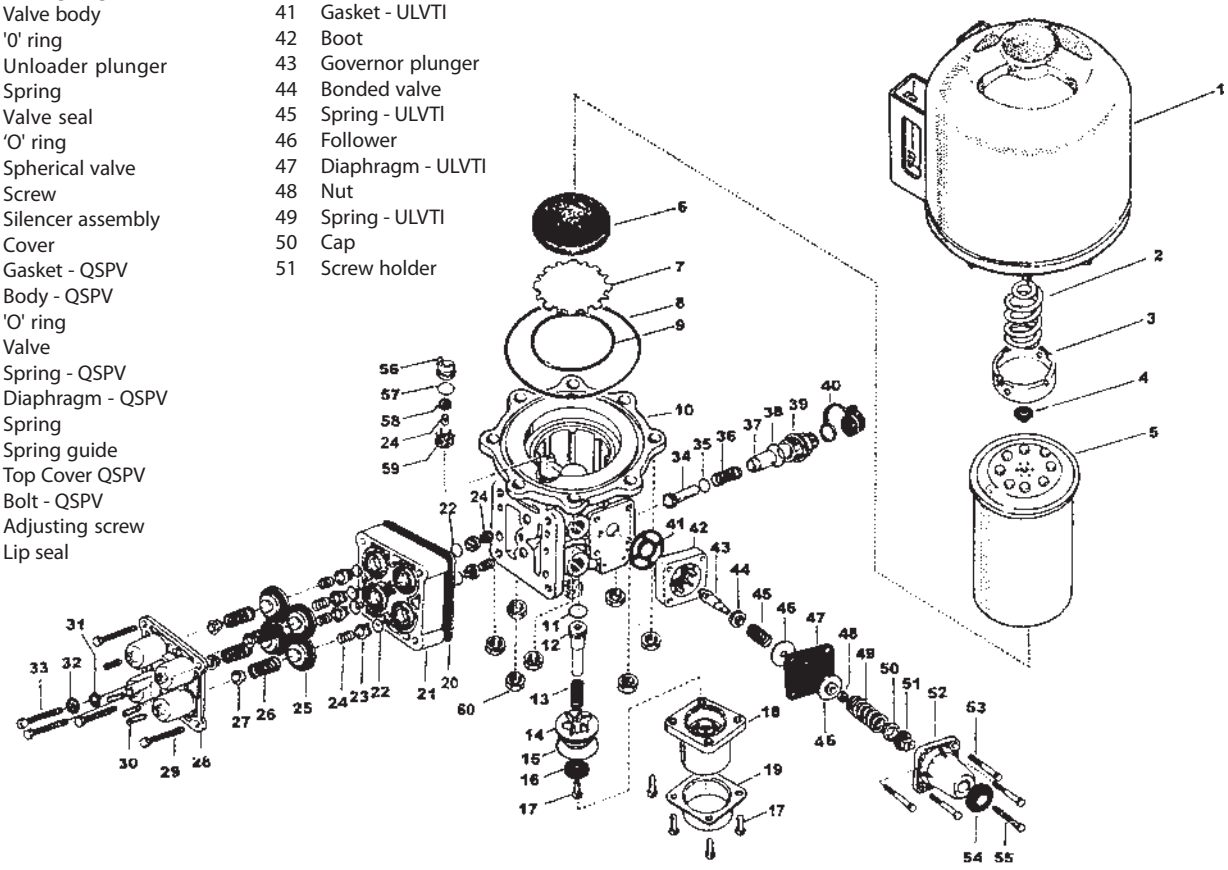


*Fig. 18 : Drying And Distribution Unit (DDU)*

Non return valve present in the DDU body and QSPV body does not allow any back flow from service reservoirs, Because of pressure difference between the air pressure stored in the purge volume and below desiccant bed, the pressurized dry air from the purge volume expands and flows back through a small orifice in the purge valve over the desiccant bed.This expansion and flow of dried air in the reverse direction collects the moisture adsorbed by the desiccant during the charging cycle, regenerating the desiccant. The moisture collected by the desiccant, condensed water, oil and other contaminants are also exhausted to atmosphere in each unloading cycle.

**Replacement Of Desiccant Cartridge**

The desiccant generally functions satisfactorily in the field up to 3 years, after which it may have to be replaced . The residual oil vapours car~ied over beyond the pre-filter, contaminates the desiccant over a period of time and lowers its air drying efficiency.Therefore if the oil carry over of the compressor is high, more frequent replacement of the desiccant is warranted.

When the desiccant is renewed, the coalescent filter and the rubber components in the unloader, QSPV and tyre inflator portions also should be replaced using recommended repair kit.

**Service Check**

**a) Inspection**

- Check the airlines / DDU mounting bolts for tightness.
- Ensure that the air Inlet line is in good condition.

**b) Operating Test**

- Drain the Reservoir and check for presence of moisture / water collection in the reservoir. Presence of rwisture is indication of requirement of changing the desiccant cartridge
- Drain the Reservoir and start the engine. Charge the system until the unit euts out. Record the pressure reading of the dash board gauge. Ensure the correctness of the gauge before commenci~g the test. If the pressure setting is different to the recommended value adjust the pressure setting screw.
- Repeat the test until the correct pressure setting is achieved . For the purpose of setting the pressure, it may be required to deplete the reservoir by applying brakes a few times.

**c) Leakage Stage**

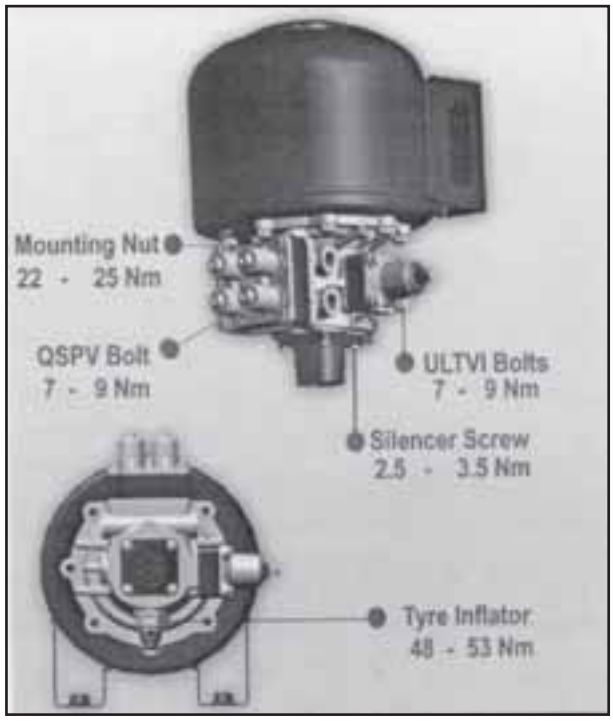
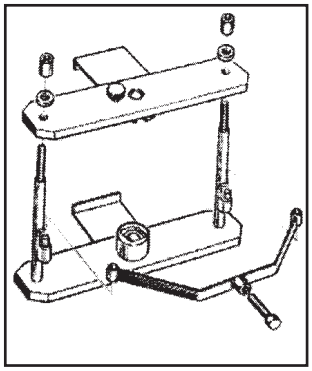



*Fig. 19 : Tightening Torque*

- Charge the system to just below the 'Cut-out' pressure and stop the engine.Apply soap solution on the entire unit to check for air leakage. Air leak of 25mm soap bubble is permissible. Exces-sive air leak, if noticed, the assembly needs to be attended,
- Ensure that the airline connections are free from air leak.

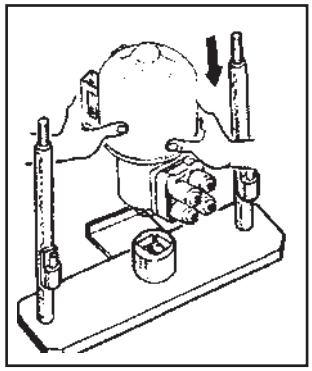
**Removing**

**DISMANTLING**



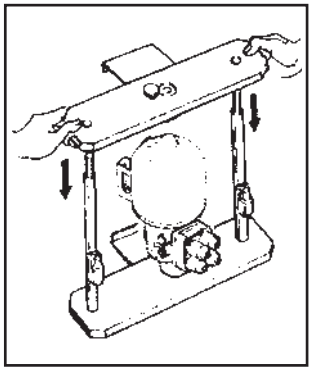
*Step : 1*

1 Make ready the fixture by removing the top plate & side plate.



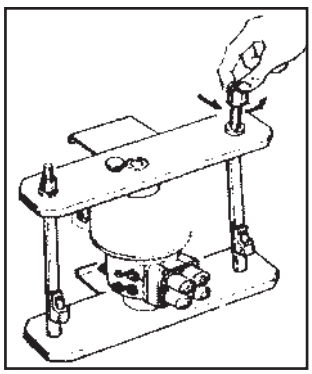
*Step : 2*

2 Position the DDU as shown.



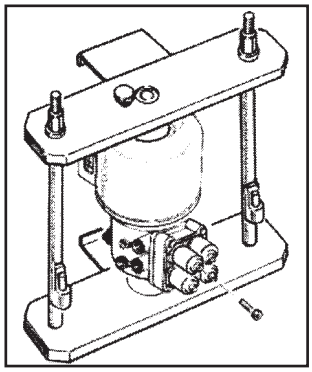
*Step : 3*

3 Put the top cover above the DDU as shown.



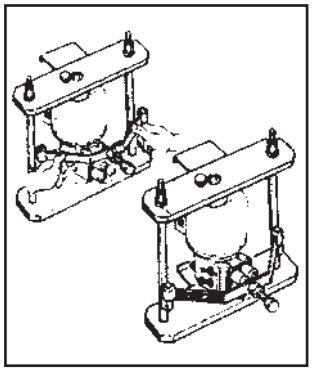
*Step : 4*

4 Fasten the top cover nuts - 2 off.



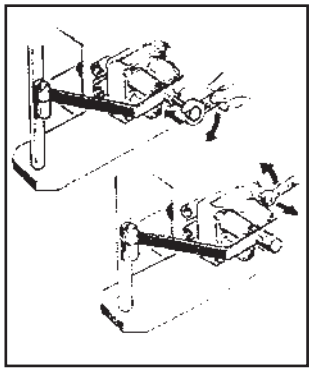
*Step : 5*

5 Remove Quadruple System protection Valve centre screw.



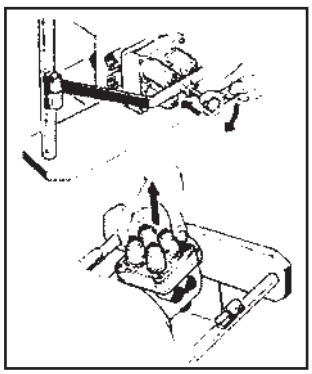
*Step : 6*

6 Assemble the side plate in the fixture.



*Step : 7*

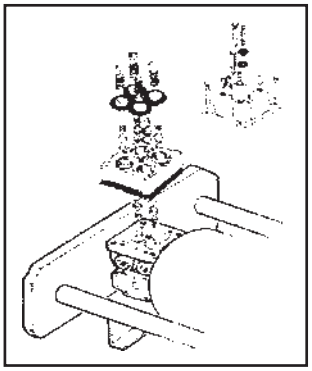
7 Tighten the screw in the side plate and loosen the QSPV screws - 4 off.



*Step : 8*

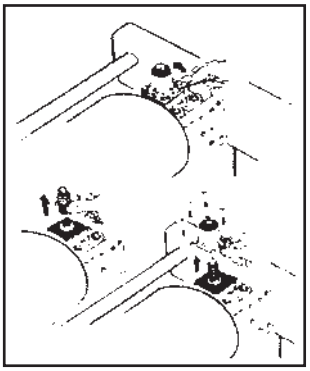
8 Loosen the side plate screw and dismantle the QSPV as shown.

**DISMANTLING**



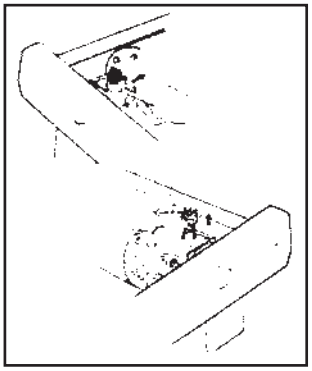
*Step : 9*

9 Loosen the side plate screw and dismantle the QSPV as shown.



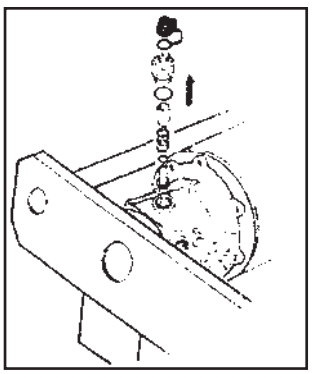
*Step : 10*

10 Loosen the governor valve assembly screws - 4 off and dismantle the governor valve as shown.



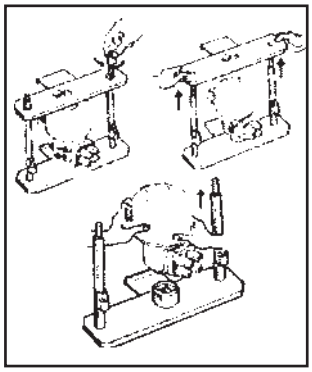
*Step : 11*

11 Loosen the governor fine inflator assembly dismantle if present.



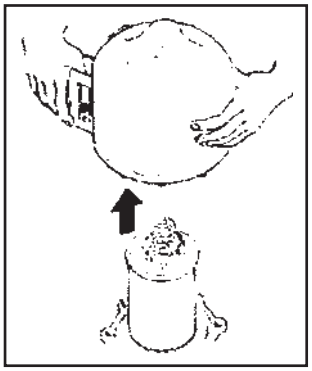
*Step : 12*

12 Loosen the governor fine inflator assembly dismantle if present.



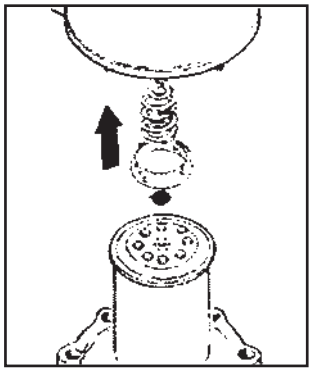
*Step : 13*

13 Loosen & Remove the purge tank mounting nuts, remove the top plate & dismantle the purge tank.



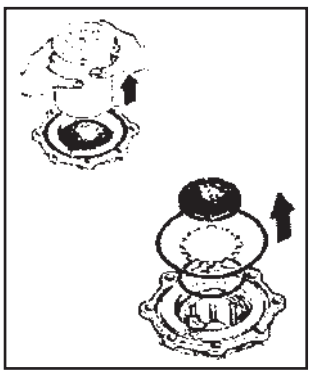
*Step : 14*

14 Remove the purge tank & retainer etc.



*Step : 15*

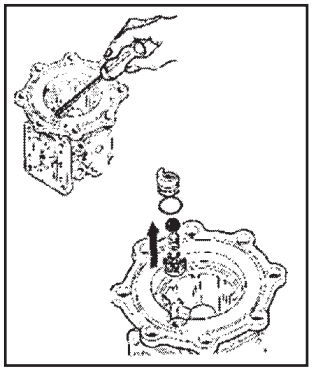
15 Remove the purge tank & retainer etc.



*Step : 16*

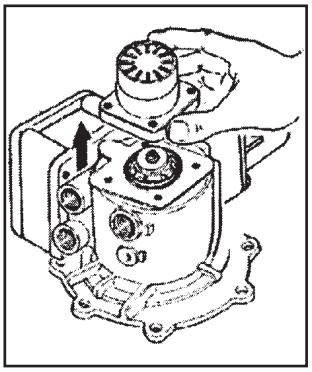
16 Lift the cartridge from the valve body and remove the items as shown.

**DISMANTLING**



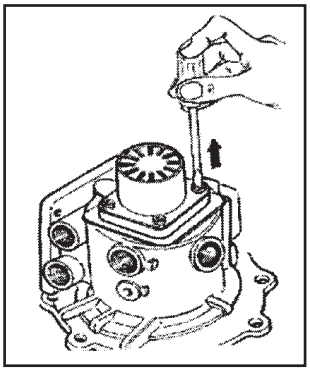
*Step : 17*

17 Remove the non-return valve (NRV) from valve body as shown.



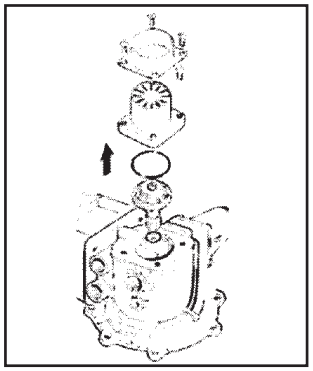
*Step : 19*

19 Remove the silencer.



*Step : 18*

18 Loosen the silencer screws.



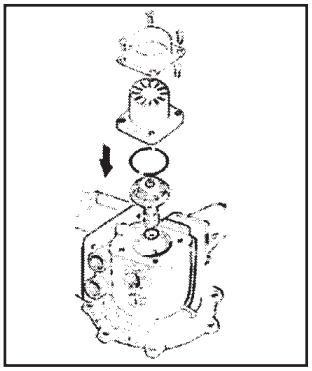
*Step : 20*

20 Dismantle the unloaded plunger assembly as shown.

**INSPECTION**

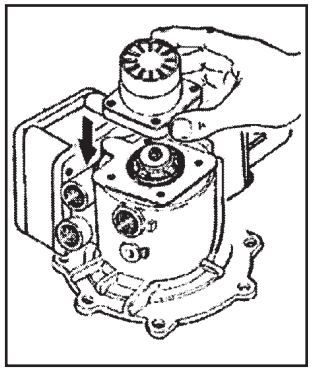
- Clean all the metallic parts using cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.
- Thoroughly clean the valve body and make sure that the air passes cross- holes are free from blockage.
- Check the valve body for damage on the port faces / threads, nick / score marks /damages on valve seats, excessive wear / score mark on the unloader plunger bore and the governor plunger bore.
- Check the springs for distortion, rust formation and permanent set. Scrap all the old parts, which are found unserviceable.
- Once cleaning and inspection is completed assembling procedures starts and note that the reverse steps of dismantling are assembling steps of the product.

**ASSEMBLING**



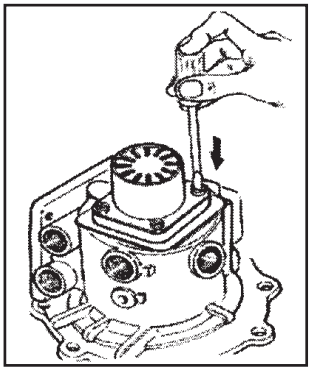
*Step : 1*

1 Assemble the unloader plunger assembly and silences.



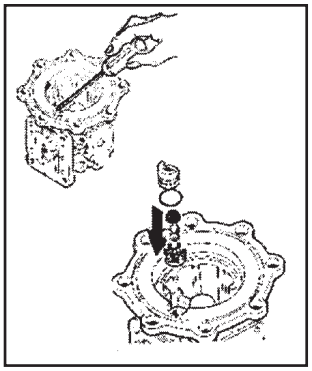
*Step : 2*

2 Fasten the silencer with valve body.



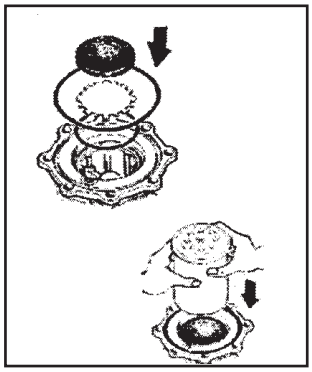
*Step : 3*

3 Fasten the silencer with valve body.



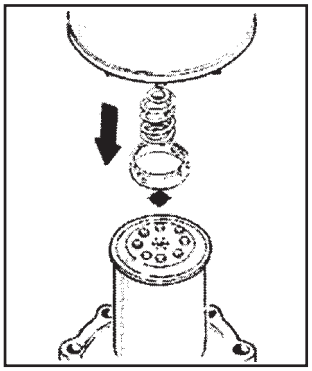
*Step : 4*

4 Assemble the NRV with valve body as shown.



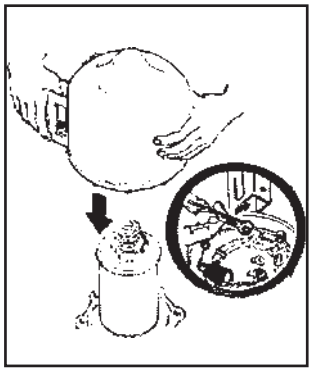
*Step : 5*

5 Assemble the filter elements in the valve body and place the cartridge as shown.



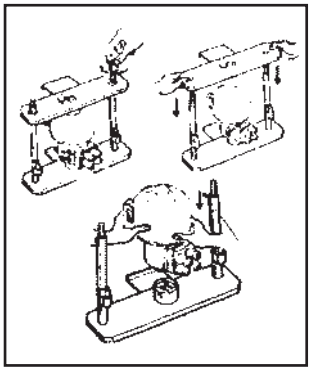
*Step : 6*

6 Place purge valve, retainer and spring over the cartridge.



*Step : 7*

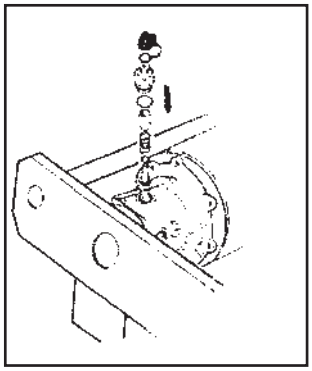
7 Assemble the purge tank over the cartridge and place them in the fixture.



*Step : 8*

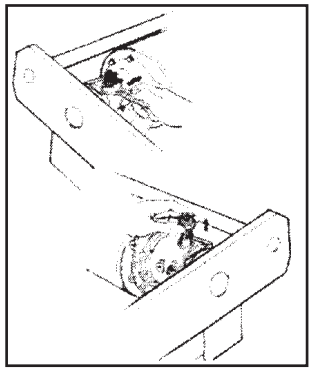
8 put the fixture top plate & tighten. Fasten the purge tank mounting bolts.

**ASSEMBLING**



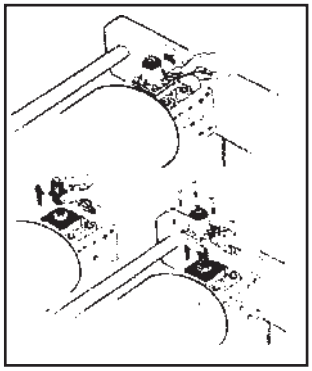
*Step : 9*

9 Assemble the fine inflator assembly as shown if present.



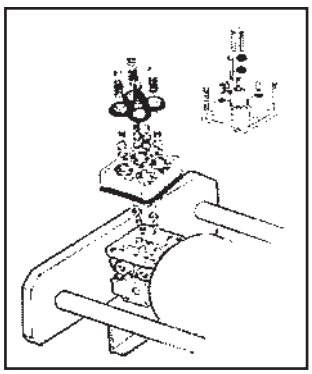
*Step : 10*

10 Assemble the fine inflator assembly as shown if present.



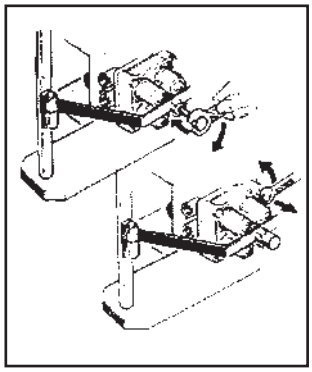
*Step : 11*

11 Assemble the governor valve as shown.



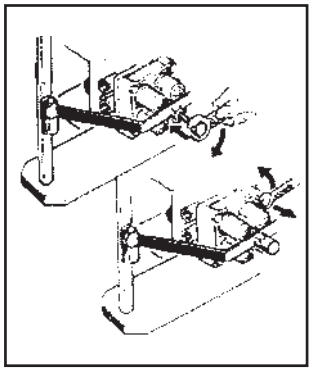
*Step : 12*

12 Carefully assemble QSPV in to the valve body.



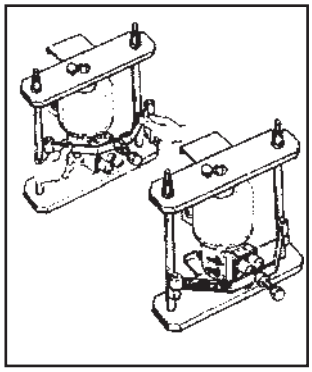
*Step : 13*

13 Put the fixture side plate & tighten the screw.



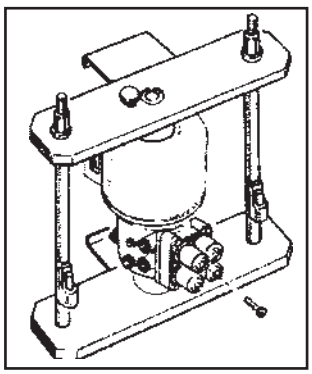
*Step : 14*

14 Fasten the QSPV screws.



*Step : 15*

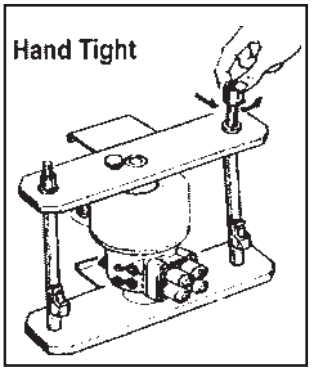
15 Remove the fixture side plate.



*Step : 16*

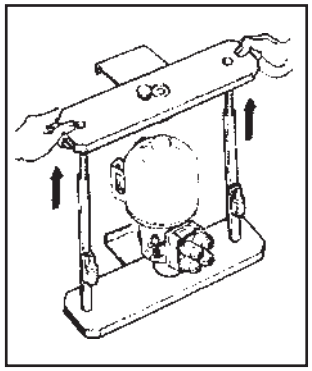
16 Assembly QSPV centre screw.

**ASSEMBLING**



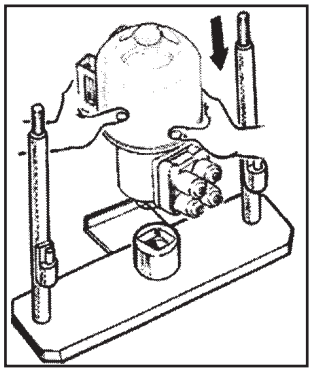

*Step : 17*

17 Loosen the fixture top plate.



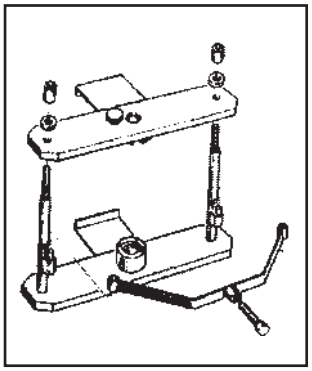
*Step : 18*

18 Remove the fixture top plate.



*Step : 19*

19 Remove the DDU assembled.



*Step : 20*

20 Remove fixture top & plates for safe storage.

- Block the wheels to prevent movement of the vehicle during working.
- Disconnect the pipe ines and close the open ends of the pipes to prevent dust / dirt entry.
- Identify the pipe connections.
- Remove the mounting bolts of the DDU.

***Note :***

*When working on or around air brake system & components the following precautions should be observed in the interest of SAFETY.*

*Always Block Vehicles.*

*Stop engine when working under a vehicle.*

*Keep hands away from chamber push rods and slack adjusters., they may apply as system pressure drops.*

*Never connect or disconnect a horse or line containing pressure., It may whip.*

*Never remove a component or pipe plug unless you are certain all system pressure has been depleted.*

*Never exceed recommended pressure and always wear safety.*

*Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful spring and injury can result if not properly disassembled.*

*Use only proper tools and observe all precautions to use of those tools.*

### 4.4 DUAL BRAKE VALVE (Fig. 20)

**a) Function**

Dual brake valve is used to gradually charge and exhaust the brake actuators and also to control the trailer brake systems through trailer control valve in a Dual Brake System

**b) Description**

The Dual Brake Valve mainly consists of an upper body and a lower body in which the pistons and the spring loaded valves are housed. A venting guide assembly is located in the bottom side of the lower body. The spring-loaded piston houses a rubber spring, a spring seat and a stem and located in upper body. The upper and the lower bodies provide inlet /delivery ports of primary, secondary and gauges/switches ports connections. The upper and lower body are secured together by 4 screws.

#### 4.4.1 Service Checks

**a) Operating Test**

- Check and ensure that the pipe connections and joint are free from air leakage when the brake is in applied condition.
- Connect test gauges in the delivery of the primary / secondary lines of the brake valve and check delivery pressure with the brake pedal fully depressed. The delivery pressure registered in the test gauges should be approximately the same as primary / secondary dashboard gauge pressures.
- Depress the brake pedal in several positions between fully released and fully applied positions and check the delivery pressures registered by the test gauges which should vary in accordance with the brake pedal position.

**b) Leakage Test**

- **Off Leak**

  Charge the system fully and check for air leak in pipeline joints. Check leak at exhaust in brake valve by applying soap solution.

- **On Leak**

  Depress the brake pedal fully and check for air leak in the exhaust of the brake valve. By holding the brake pedal fully depressed, check the delivery pipe joints for air leakage by applying soap solution.

  Air leak of 25mm soap bubble in 5 seconds is permissible. If excessive air leak noticed, disconnect either primary or secondary and again check air leak. Air leak noticed in either of the line connected, leaves indication to check and attend to the Primary / Secondary portion of the valve.

#### 4.4.2 Removing

- Block the wheels to prevent movement of the vehicle during working.
- Deplete air pressure from the system.
- Brush away dirt / dust from the air pipe connections
- Disconnect pipelines after identifying the pipe connection to avoid wrong connection while replacing the unit on the vehicle.
- Close the open ends of the pipes to prevent dust/ dirt entry.
- Disconnect the electrical connections of Low pressure Indicator switches / Stop light switches, if provided.
- Loosen and remove the mounting nuts and remove the valve.

#### 4.4.3 Replacing

- Mount the brake valve in its location and secure it tightly.
- Connect the pipelines; Follow the identification of the pipelines to avoid wrong connection.
- Connect the electrical terminals to the low-pressure indicator switches / Stop light switches, if provided.
- Charge the system and check for warning from Low-pressure indicator switches when the system pressure is below the pressure setting of the switch.
- Apply the service brake and check for stop light switch glowing.
- Carry out ' Operating / Leakage tests' as given under 'Service Check'.

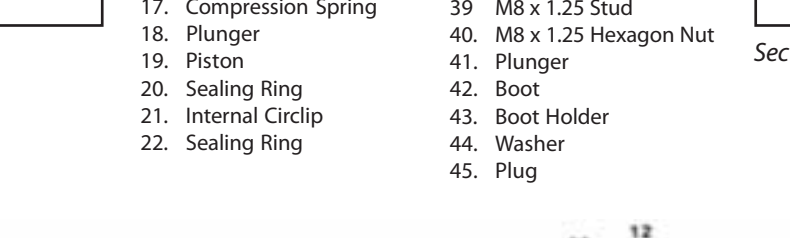
#### 4.4.4 Dismantling

- Clean the exterior of the valve.
- Loosen and remove the Stop light switches and Low-pressure indicator switches, if provided.
- Mark the position of upper and lower bodies to avoid wrong position of ports during reassembly.
- Remove the bottom cover and the filter
- Loosen and remove the 4 screws, which secure the upper, lower and detach the bodies and secondary piston sub-assembly.
- **Secondary piston sub-assembly**

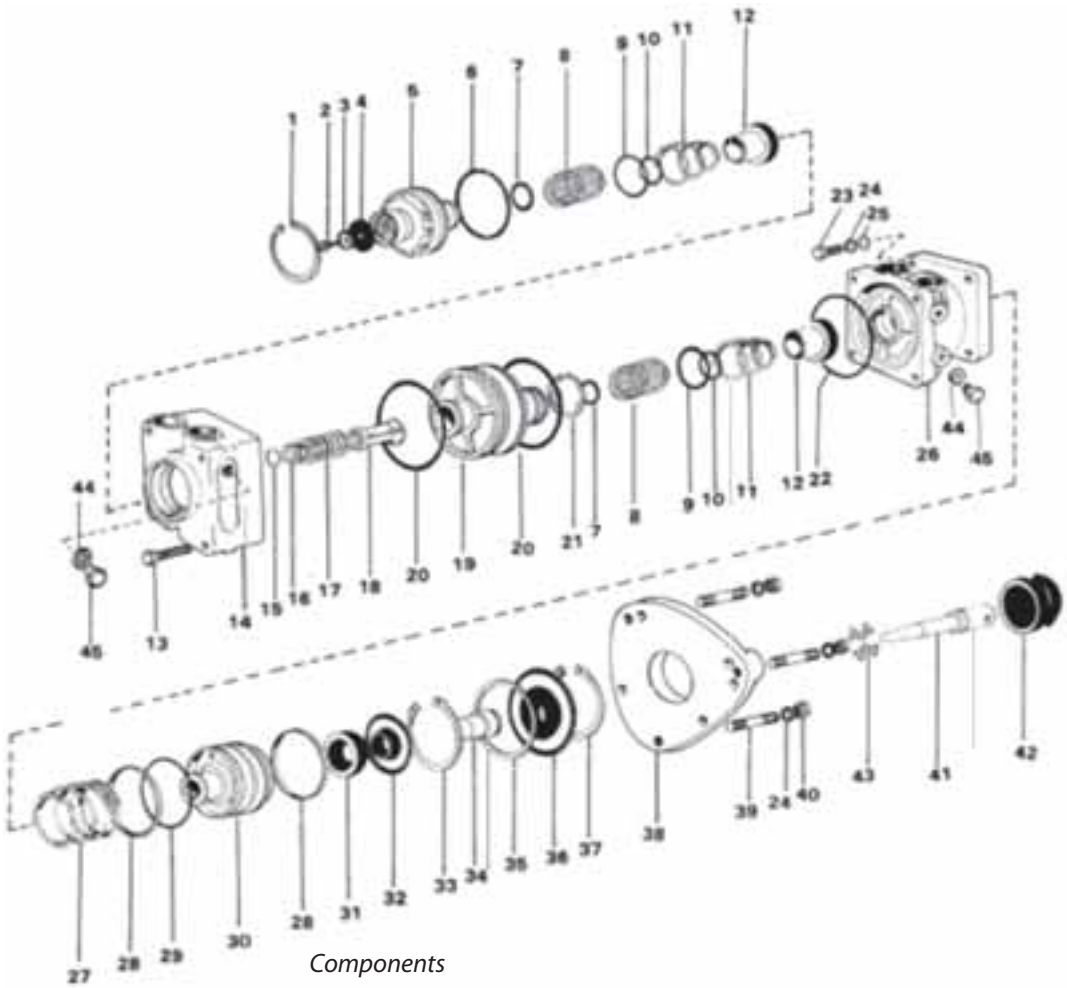


*Assembly*

1. Internal Circlip
2. Self Tapping Screw
3. Cap
4. Washer
5. Venting Guide
6. Sealing Ring
7. Sealing Ring
8. Integral Filter
9. Sealing Ring
10. Sealing Ring
11. Spring
12. Valve
13. Hexagon Head Bolt
14. Lower Body
15. Snap Ring
16. Spring Seat
17. Compression Spring
18. Plunger
19. Piston
20. Sealing Ring
21. Internal Circlip
22. Sealing Ring
23. M8 x 1.25 Hexahead Screw
24. Metric Spring Washer
25. Steel Washer
26. Upper Body
27. Spring
28. Guide Ring
29. Sealing Ring
30. Piston
31. Rubber Spring
32. Spring Seat
33. Internal Circlip
34. Stem
35. Spacer
36. Boot
37. Internal Circlip
38. Adptor Plate
39 M8 x 1.25 Stud
40. M8 x 1.25 Hexagon Nut
41. Plunger
42. Boot
43. Boot Holder
44. Washer
45. Plug



*Sectional View*



*Components*

**Dual Brake Valve**

Remove the snap ring from its groove and extract the spring seat, spring and plunger.

- **Lower body sub- assembly**

  Remove the circlip and detach venting guide, spring, integral filter and valve.

- **Upper body Sub-assembly**

  Remove the bottom circlip and detach the spring, integral filter and valve.

  Remove the upper circlip and detach the boot, spacer and stem.

  Detach the upper primary piston sub-assembly.

- **Primary piston Sub-assembly**

  Remove the circlip and detach the spring seat and rubber spring.

- Remove the sealing rings and guide rings from the primary pistons.

### 4.4.5 Cleaning And Inspection

- Clean the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.
- Ensure that metering holes are free from blockage in upper / lower bodies and secondary piston.
- Inspect the bore in the upper body and lower body for score marks / excessive wear, valve seat for damage / nick marks, port thread for damage.
- Check the springs and circlips for corrosion, distortion, and permanent set.
- Clean the filter and the mesh with compressed air. Ensure that the components are clean before assembly.

***Note :*** *Scrap all the old parts, Which are found unserviceable.*

### 4.4.6 Reassembly

- Use recommended Repair kit to replace the old parts scrapped during dismantling and also replace the parts found to be unserviceable during inspection.
- Lubricate the pistons, bores of upper and lower bodies, integral filters, sealing ring with **silicon grease**. This grease is supplied in the repair kit.
- Install the new sealing rings on the pistons, venting guide and integral filter and smear with grease.
- Install guide rings on the primary piston and smear with grease.
- **Secondary piston sub-assembly**

  Locate the plunger, spring and spring seat into the piston bore and secure by the snap ring. Ensure that the snap ring is seated in the groove properly.

- **Lower body sub-assembly**

  Place the valve, spring, and integral filter and with sealing ring on venting guide, position and guide the venting guide gently in the valve body bottom bore. Secure the venting guide in the valve body with circlip. Ensure that the circlip is located in the groove properly. Place the mesh in the bottom cover and snap fit to groove in the lower body.

- **Upper body sub-assembly**

  Position and place the valve, spring, filter in the bottom side of the body and secure with circlip. Ensure that the circlip is located in the groove properly.

- **Primary piston sub-assembly**

  Place and position the rubber spring, spring seat and stem in the primary piston. Press the stem assemble the circlip. Ensure that the circlip is located in the groove properly.

***Note :*** *Avoid grease / oil contact with rubber spring.*

- Insert the primary piston in the topside of the upper body. Place the spacer, boot along with stem and secure with circlip. Ensure that the circlip is located in the groove properly.
- Locate the sealing ring in the bottom groove of the upper body and secure upper and lower bodies together by the 4 screws by tightening to a torque of 10Nm. Ensure that the marking on valve bodies is in line.
- Assemble the Low pressure Indicator switches in the auxiliary ports of inlets and Stop light switches in the auxiliary ports of deliveries along with sealing washer.

***Note :*** *(Common for All Pneumatic Components)*

*When working on or around air brake systems and components the following precautions should be observed in the interest of* ***Safety****.*

- *Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.*
- *Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.*
- *Never exceed recommended pressure and always wear safety glasses when working.*
- *Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of*

*those tools.*

- *Use only genuine replacement parts and components.*
- *Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.*

**4.5 Graduated Hand Control Valve** (Fig. 21)

**a) Function**

The purpose of this valve is to gradually charge and exhaust air from spring brake chamber for releasing/ applying the parking or emergency brakes in a truck or a tractor.

**b) Description**

The valve mainly comprises of an inlet exhaust valve, a cam, a cam follower. These are housed in a valve body and a top cover. The cam is actuated by a lever with a knob. The position of the lever is locked by means of a sleeve which gets located in a corresponding slot in the top cover. The top cover is provided with a gaiter to prevent dust entry into the valve. A dial is provided to the valve to indicate the 'ON' &"OFF" positions of brakes.

**4.5.1 Service Check**

**a) Operating Tests**

Move the lever to the brakes 'OFF' position and charge the system to cutout pressure and stop the engine. Move the lever to brakes 'ON' position gradually. The air should start exhausting from about 10 degrees movement of the lever from 'OFF' position. Further movement will start to apply the spring brakes. Move completely towards brakes'ON' position and check for full effectiveness of spring brakes. The air in the hand brake line should be exhaustedfully within 10 degrees from 'ON' position.

Move the lever from 'ON' to 'OFF' position and observe a sound of air passing through to the spring brakes releasing it. In the final locking position of the lever with spring brakes`OFF'full inlet pressure must be available at the delivery.

**b) Leakage Tests**

With the lever in brakes 'ON' position, charge the system fully. Check for air leakage through the exhaust banjo. No air leak is permissible.

Air leak, if noticed indicates faulty inlet/exhaust valve or damage on valve seat in valve body.

With the lever in brakes 'OFF' position, charge the system fully and check for air leakage through exhaust banjo. No air leak is permissible.

Air leak if noticed, indicates faulty inlet/exhaust valve, damage on the valve seat or the plunger of 'O' rings.

**4.5.2 Removal**

1 Block the wheels to prevent movement of the vehicle during working.

2 Brush away dust/dirt from the air line connections and the system protection valve.

3 Deplete the air pressure in all the lines.

4 Disconnect the inlet / delivery pipe lines and close the open ends of the pipes to prevent dust / dirt entry.

5 Mark the valve orientation with respect to its mounting.

6 Remove the mounting screws and the dial. Remove the valve from the mounting bracket.

**4.5.3 Installation**

1. Fit the adaptors and low pressure indicator switch along with aluminium washers.
2. Identify the marking and locate the valve on the mounting bracket. Place the dial on the bracket and secure the valve tightly by screws and spring washers. Ensure that the dial is located properly.
3. Connect the pipe lines to its respective ports.
4. Connect the electrical terminals of the low pressure indicator switch.
5. Charge the air pressure and carryout 'operating/ air leakage tests'as given under 'Service check'.

**4.5.4 Dismantling**

Tools required for servicing

Spanners 10, 11, 13 A/F, a 2.5 mm drift punch, a small ball peen hammer. No special tool is required.

1 Mark the position of the top cover assembly with respect to the valve body.

2 Unscrew and remove the knob (27) from the lever.

3 Remove the spring (26) and the sleeve (25) and the gaiter (23), the dial (22).

4 Push out the tension pin (19) from the pivot pin (18) using a flat drift punch. Ensure that the tension pin is not bell mouthed due to excessive force or use of wrong tool.

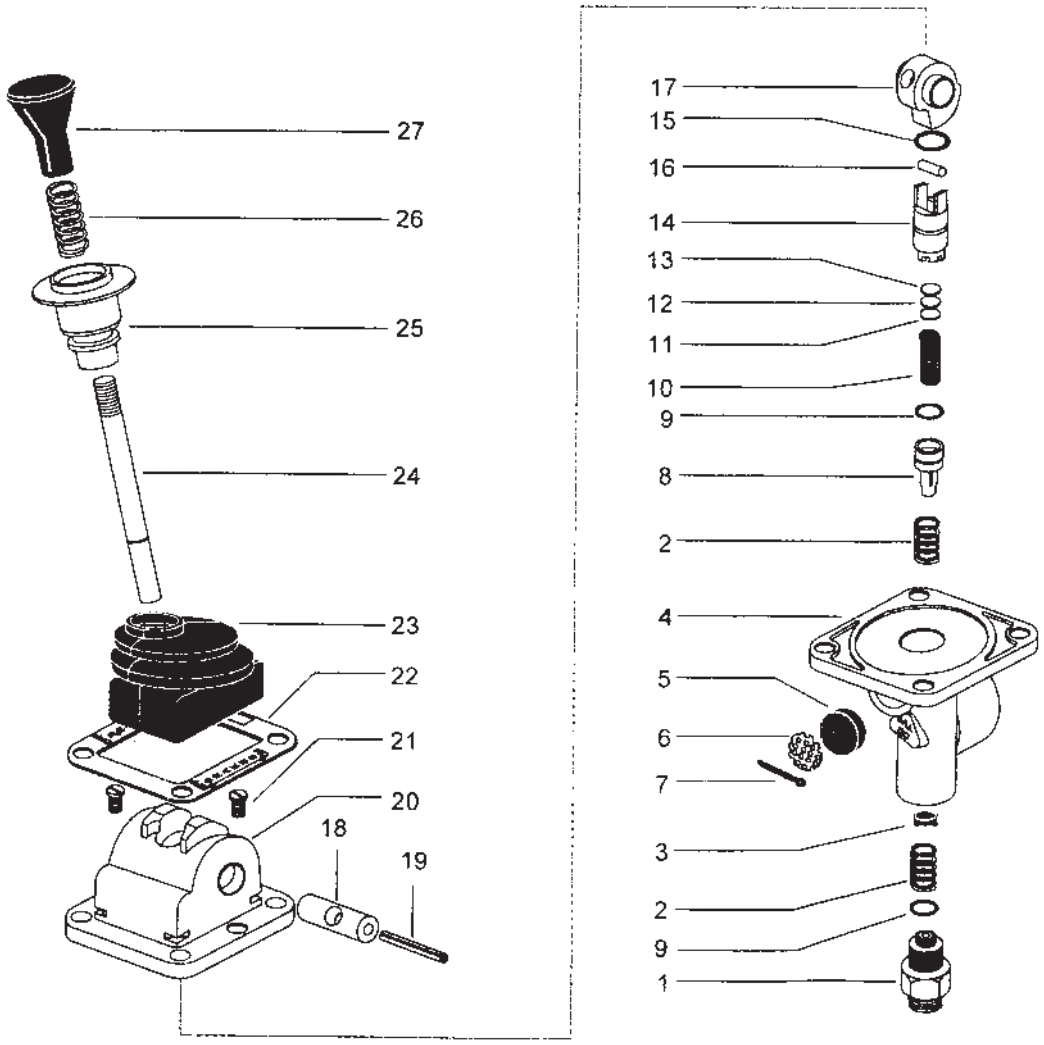
5 Remove the lever (24)

6 Push out the pivot pin (18) from top cover (20)

7 Unscrew the 2 slotted countersunk head screws (21) and remove the top cover (20).

8 Remove the cam (17), roller (16), cam follower (14), shims (11, 12, 13), spring (10), plunger (8) and springs (2) from the valve body (4)

9 Remove the sealing rings (15 & 9) from the cam follower (14) and plunger (8) respectively.






1. Inlet adaptor
2. Spring
3. Valve
4. Valve body
5. Filter
6. Strainer plate
7. Split pin
8. Plunger
9. Sealing ring
10. Spring
11. Shim
12. Shim
13. Shim
14. Cam follower
15. Sealing ring
16. Roller
17. Cam
18. Pivot
19. Tension spring
20. Top cover
21. Slotted C' sunk head screw
22. Dial
23. Gaiter
24. Lever
25. Sleeve
26. Spring
27. Knob

*Fig. 21 - Graduated Hand Control Valve*

10 Remove the split pin (7) , strainer plate (6), filter (5) from the body.

11 Loosen and remove the inlet adaptor (1), sealing ring (9), spring (2) and valve (3).

12 Scrap all the parts which are serviced in the repair kit.

#### 4.5.5 Cleaning and inspection

Clean all the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.

Check the valve body, cover, inlet adaptor and plunger for excessive wear, nick/score marks, cracks and damages.

Check the cam and cam follower for excessive wear at the mating surfaces.

Cheek the springs for distortion, corrosion and permanent set.

Check the cover and the sleeve for excessive wear on its mating surfaces.

Check the cover for excessive wear on pivot pin bore and play of pivot pin in its bore.

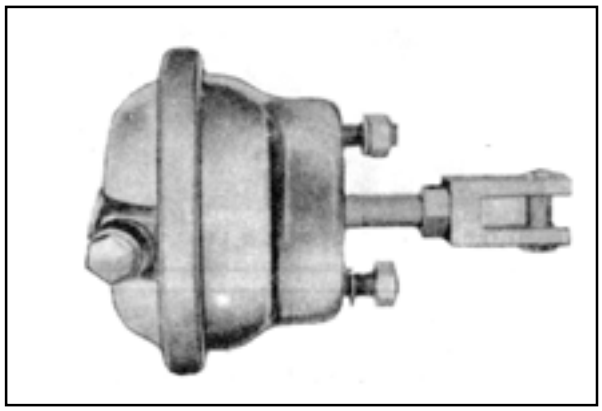
Scrap all the old parts found to be unserviceable.

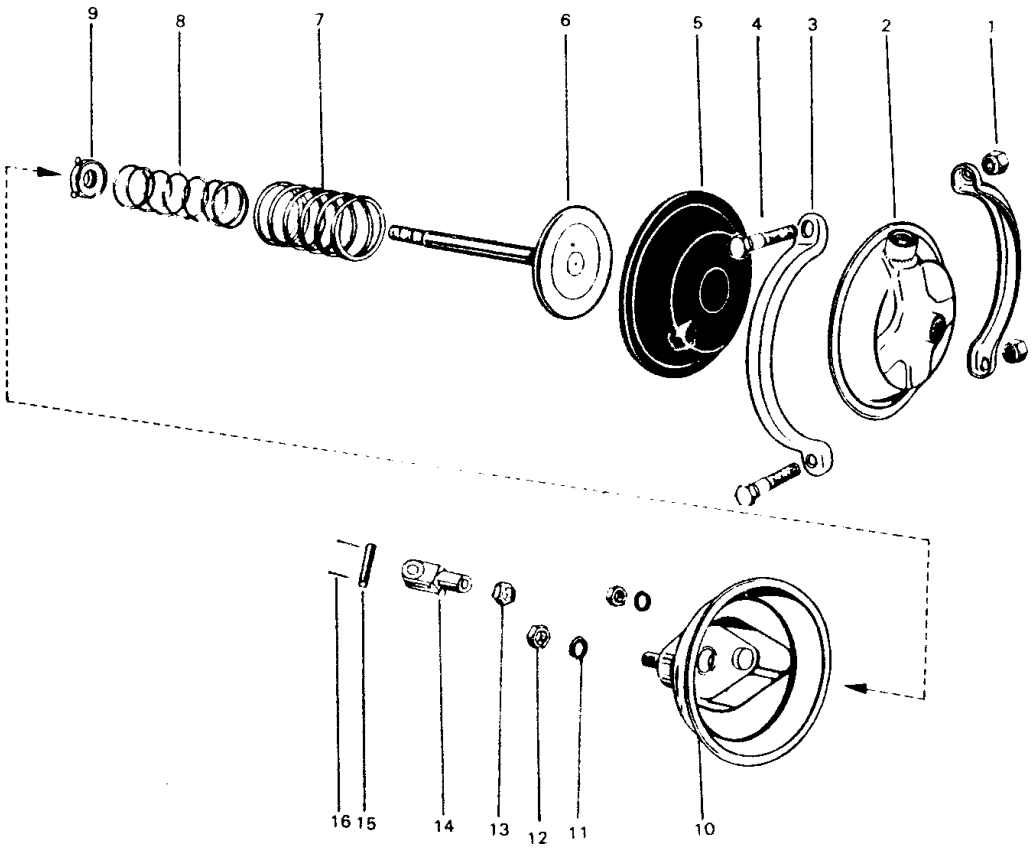
#### 4.5.6 Reassembly

- Use recommended repair kit to replace the parts scrapped during dismantling and in addition replace all parts which were found unserviceable / defective during cleaning and inspection.
- Lubricate all the sliding parts and their mating surfaces with Bharat MP2 grease which is supplied in the repair kit.
- Assemble 'O' rings (9 & 15) on the plunger (8), cam follower (14) and the inlet adaptor (1).
- Locate the spring (2), valve (3) on the inlet adaptor and screw into the inlet port of the valve body (4).
- Locate the spring (2) and plunger (8) in the valve body bore.
- Place the spring (10) on the plunger, shims (11, 12, 13) on the spring and insert the cam follower.

**Top cover sub assembly**

- Locate the cam (17) in the top cover (20), align the holes and insert the pivot pin (18)
- Locate the lever (24) in the pivot pin (18), align the hole in the pivot pin with the corresponding hole in the lever and press the tension pin (19) into the pivot pin holes.
- Locate the roller (16) on the cam follower
- With the lever (24) in the brakes 'ON' position, identify the marking and locate the top cover sub-assembly on the plunger.
- Press in the top cover and secure the cover with the body by the two slotted c'sunk head screws (21).
- Assemble the gaiter (23) on the sleeve, slide the sleeve into the lever and assemble the other end of the gaiter on its groove in the top cover (20).
- Locate the spring (26) on the sleeve and smear a few drops of loctite 242 or its equivalent on the thread of the lever (24).
- Screw in the knob 27) on the lever (24)
- Locate the filter (5) and strainer plate (6) on the exhaust passage of the body and secure by the split pin (7) and fold its ends fully.






1. Nut
2. Pressure Plate Assembly
3. Clamp Ring
4. Hex. Screw
5. Diaphragm
6. Push Rod Assembly
7. Spring
8. Seal Spring
9. Wiper Pad
10. Non Pressure Plate Assembly
11. Spring Washer
12. Nut
13. Lock Nut
14. Fork
15. Pin
16. Split Pin

*Fig. 22 : Brake Chamber, Front, Type 24*

### 4.6 Brake Chamber, Front, Type-24 (Fig. 22)

**a) Function**

Brake Chambers convert the energy of compressed air into the mechanical force and motion necessary to operate the brakes.

**b) Description**

The Brake Chamber consists of a Non-Pressure Plate Assembly, a Pressure Plate Assembly, a diaphragm in between them which are secured together by a Clamp Ring Assembly. Also a Spring loaded Push Rod Assembly rests against the Diaphragm. Two mounting studs are also welded on to the Non-Pressure Plate to secure the unit on mounting bracket.

An identification tag incorporating the Part No. and Batch No. is provided in the Clamp Ring Bolt.

#### 4.6.1 Operation (Fig. 23)

**a) Brakes Applied**

When the brake valve is operated, air pressure enters the brake chamber behind the diaphragm and the push rod rotates the slack adjuster, the slack adjuster rotates the cam shaft and cam thereby spreading the brake shoes, thus applying the brakes.

**b) Brakes Released**

When the brake application is released, air pressure in the brake chamber is released, the brake chamber release spring and brake shoe return springs return the brake cam, camshaft, slack adjuster and brake chamber push rod to the released position.

#### 4.6.2 Service Check

**a) Operating Test**

Apply Brakes and observe that push rods move out promptly without binding.

Release Brakes and observe that Push Rods return to release position promptly without binding.

Check Push Rod travel to ensure minimum movement without the Brakes dragging.

**b) Leakage Tests**

Actuate the Brake Chamber by applying Air Pressure and check for leak at the Clamp Ring joint. No leak is permissible.

#### 4.6.3 Removal and Installation

**a) Removal**

Prevent the vehicle from moving by means of blocks placed behind the wheels.

Brush away and clean dirt from the unit and air line connection.

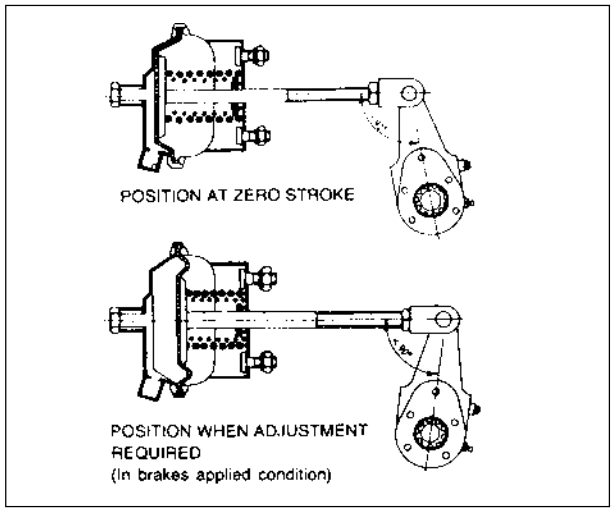



*Fig. 23*

Disconnect air line connection from the unit.

Keep the open end of pipe plugged with adhesive ape to prevent dirt entry.

Loosen and remove the Mounting Bolts and remove the Brake Chamber.

**b) Installation**

Position the Brake Chamber on its mounting and fit the Spring Washers and Nuts; securely tighten the units.

Remove the plug of the pipe line and reconnect to the Brake Chamber.

Ensure that the brakes are correctly adjusted and that the linkage does not bind.

#### 4.6.4 Dismantling

Loosen and remove the clamp Ring Bolt and Nut.

Tap gently and open out the Clamp Ring.

Remove the Pressure Plate Assembly, Diaphragm, Non-Pressure Plate Assembly, Push Rod and Push Rod Return Spring.

Clean all the metallic parts thoroughly using cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.

Check the pressure Plate/Non Pressure Plate for thread damage, Spring for corrosion/distortion.

Discard all unserviceable parts and Diaphragm.

#### 4.6.5 Reassembly

Position the return Spring and Non-Pressure Plate in the Push Rod Assembly.

Place on flat surface and force down the Non- Pressure Plate until it rests on the flat surface.

Hold the Push Rod tight by a vice grip plier.

Position the Diaphragm on the Pressure Plate and place the Non-Pressure Plate on it.

Locate the Clamp Ring on Pressure/Non-Pressure Plate Assemblies and tighten the Clamp Ring Bolt and Nut.

Release the vice grip plier from the push rod.

Carry out the operation/leakage tests as given under service check.

### 4.7 Spring Brake Actuator, Rear, Type 24/24 (Fig.24)

#### a) Function

To produce braking forces at the foundation brakes. It serves the function of Service, Secondary and Parking brakes.

#### b) Description

This assembly is a combination of diaphragm brake chamber and spring actuator with mechanical rear wind off arrangement. While the diaphragm is for actuating service brakes and spring loaded piston is for secondary/ parking brake actuation, the mechanical wind off arrangement is for releasing the spring brake in case of emergency viz., to release spring brakes temporarily should occasion arise where the vehicle has to be moved after a failure in the brake system.

#### 4.7.1 Service Check

#### a) Inspection

Check the tightness of the mounting nuts. (Tightening Torque 10-13 mkg).

Ensure that the wind off bolt is in fully tightened condition.

#### b) Operating Tests

Check free movement of Push Rod without binding while applying/releasing the brakes. Check and ensure that the pipe connections and joints are free from leakage when service brake is applied.

Check and ensure that the pipe connections and joints are free from leakage when spring brake in released condition.

#### 4.7.2 Removal

1. Block the wheels and operate the hand brake valve to 'Brakes off condition'.
2. Rotate the wind off bolt in anticlockwise direction such that wind off bolt comes out fully and remove the Pin connecting the fork to the Slack Adjuster.
3. Operate the hand brake valve to 'Brakes on' condition and completely rain the system air pressure.
4. Disconnect air lines after marking suitable identification of port position with reference to the vehicle installation for easy reinstallation.
5. Loosen and remove the mounting nuts (24 A/F) and remove the Spring Brake Actuator.
6. Close the open ports to prevent entry of dirt.
7. Measure the distance between the Fork pin hole and mounting face.

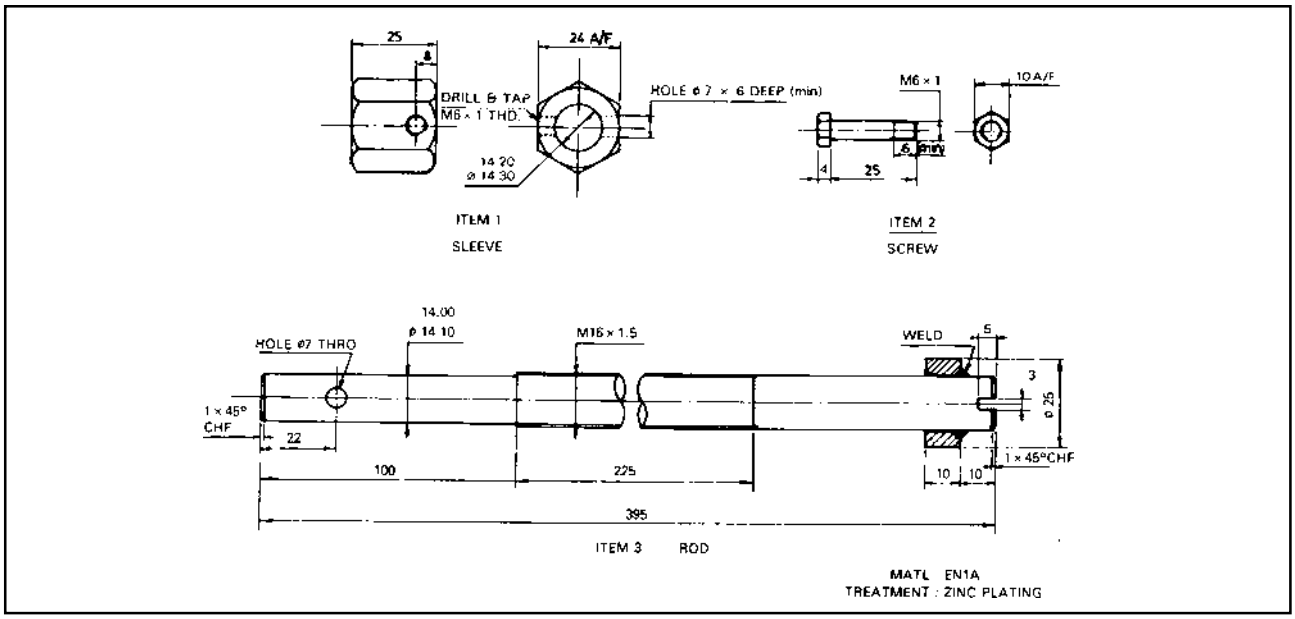



*Fig. 24 Special tools*

### 4.7.3 Dismantling

A Heavy coil spring is housed in the spring brake actuator and extreme care should be taken in servicing this actuator.

1. Clean the exterior of the assembly and remove the fork/lock nut (24 A/F) from and push rod.
2. Remove the nylon tube after removing the clips.
3. Loosen and remove the clamp ring nuts (14 A/F), bolts and dismantle the clamp rings, non-pressure plate, Springs diaphragm , push rod and seal.
4. Loosen and remove the stem plug (36 A/F) with sealing Ring from the piston.
5. Remove the knurl pin from the hexagonal sleeve (wind off nut) by using 6 mm dia flat punch rod and remove the sleeve from the wind off bolt (Rotate wind off bolt to bring the Hex. sleeve out of end cover face - If not done during removal).

   If compressed air supply facility is available

   Apply air pressure of 7.4 kg/cm' to Spring Brake Chamber port (12) using suitable pipe connections. Remove the knurl pin, hex sleeve and the Wind Off Bolt and follow the procedure laid down in Instruction 9 and 10. Release air pressure from Spring Brake Actuator and dismantle the assembly as per Instruction 11, 12 and 13 (i.e. Procedure laid down in 6, 7 and 8 need not be carried out.)
6. Fit special toot sleeve (Refer Fig. 24 item No. 1) on the wind off bolt and insert M6 Screw (Item No. 2) through the cross holes on sleeve and wind off bolt and tighten (Refer Fig. 25 for illustration).
7. Rotate the special tool sleeve (24 A/F) using a Ring Spanner in clockwise direction until the Sleeve touches the end cover boss face.
8. Remove the special tool sleeve after unscrewing M6 Screw and remove the wind off bolt from the piston.
9. Insert the Rod (part of special tool) (item No. 3 Fig. 24) through the Piston and screw in to the end cover boss.
10. Fix the special tool sleeve on the rod as given in instruction 6 and rotate the special tool sleeve until rod starts to compress the spring.
11. Unscrew eight M8 nuts (13 A/F) and remove the cylinder and gasket from the end cover.
12. Rotate the special tool sleeve until the spring load is fully released and remove the special tool sleeve and rod to dismantle the piston, spring and end cover.

l3. Remove all bearings (nylon), '0' Ring and seal from piston and cylinder.

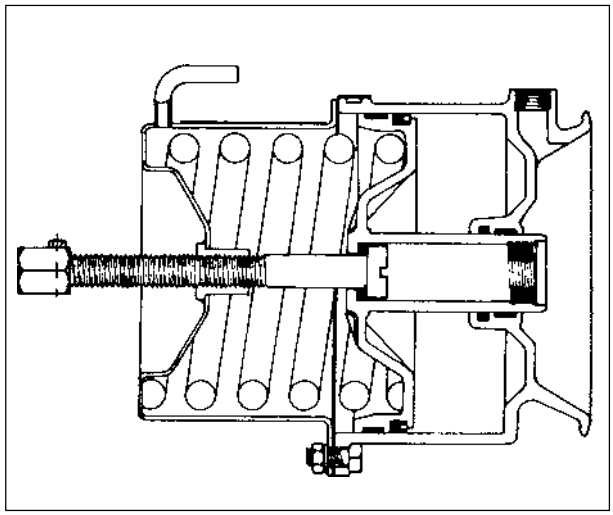


*Fig. 25 Dismantling with Special & Screw*

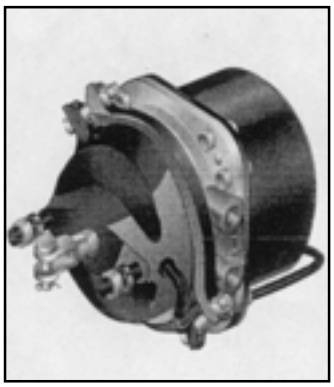
### 4.7.4 Cleaning and Inspection

Clean all metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.

Inspect all parts for excessive wear and deterioration. Check cylinder bore, flange and ram piston for any score mark/crack/damage.

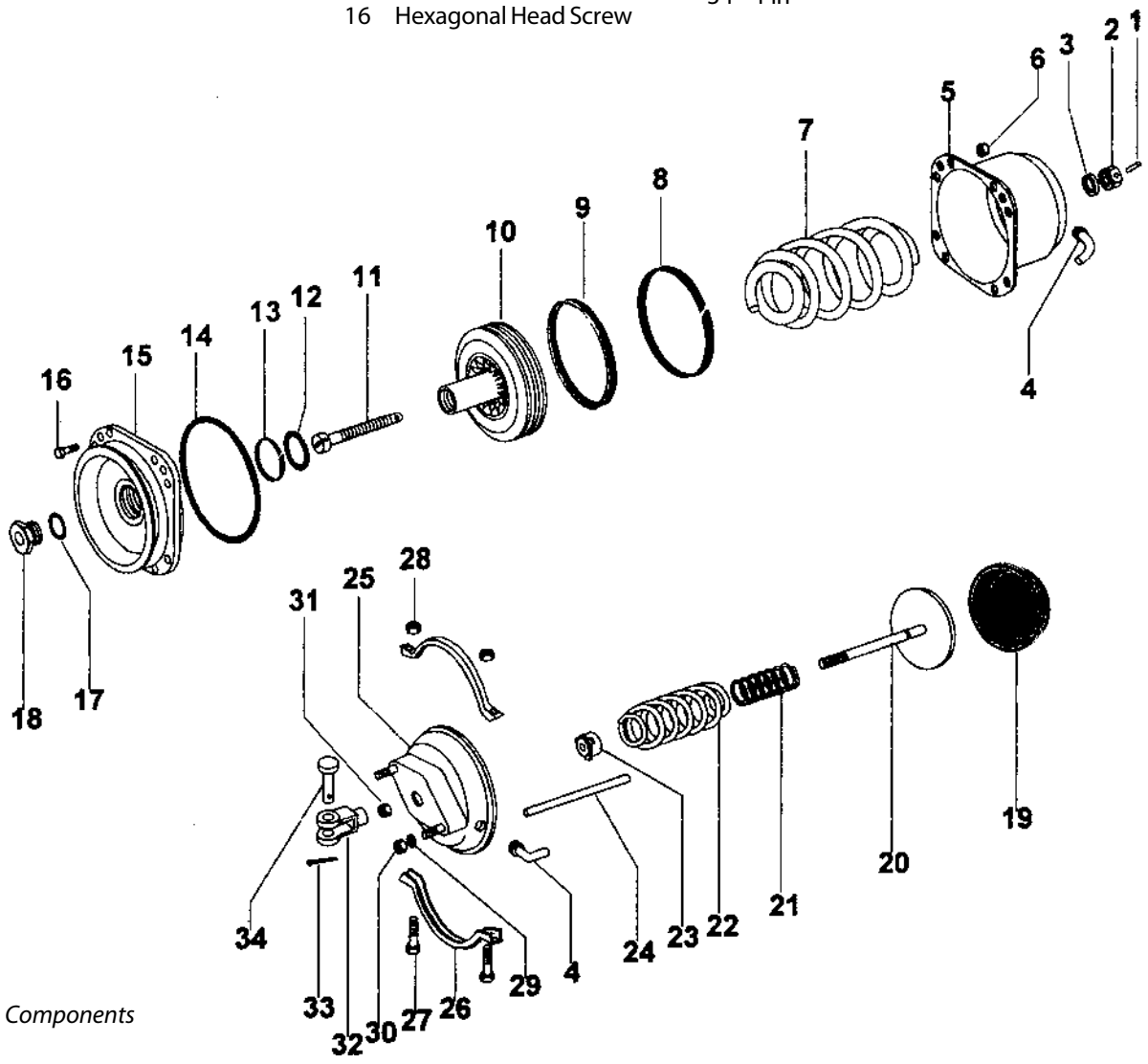
Check the springs for distortion, corrosion and permanent set.

Scrap all the old parts which are unserviceable



*Assembly*

1 Knurl Pin
2 Slotted Nut
3 Sealing Washer
4 Elbow
5 Cylinder Assy.
6 Hexagonal Nut
7 Heavy Coil Spring
8 Bearing (RAM)
9 Seal (RAM)
10 RAM Assy.
11 Wind of rod
12 'O' Ring
13 Bearing
14 Sealing Ring
15 Flange
16 Hexagonal Head Screw
17 'O' Ring
18 Stem Plug
19 Diaphragm
20 Push Rod Assy.
21 Seal Spring
22 Spring
23 Seal
24 Tube
25 Non Pressure Assy.
26 Clamp Ring
27 Clamp Ring Bolt
28 Clamp Ring Nut
29 Spring Washer
30 Hexagonal Nut
31 Lock Nut
32 Fork
33 Split Pin
34 Pin




*Components*

*Fig. 26 : Spring Brake Actuator, Rear, Type 24/24*

**4.7.5 Reassembly** (Fig. 27)

1. Use recommended Repair Kit to replace the old parts. Replace all parts found to be worn out/ defective during inspection by new parts.
2. Lubricate all moving parts and '0' Rings with MP2 grease.
3. Fit the seal (ensuring the correct position of the lip) and bearing on the respective grooves of the piston.
4. Place the main Spring inside the end cover and keep the Piston over the spring. (Lightly coat grease over the entire spring before assembly).
5. Insert the special tool rod with nylon washer into the piston and assemble the special tool sleeve with M6 screw on to the other end of the rod (Ref. Fig. No. 27.1).
6. Rotate the special tool sleeve to compress the spring until the piston touches the face of the end cover.
7. Fit 'O' Ring and bearing in the respective grooves of the cylinder.
8. Position the flange on the cylinder ensuring proper orientation of the ports and alignment of 8 holes.
9. Locate the stiffener plate and tighten the eight M8 screws and tighten to a torque of 25-35 Nm.
10. Rotate the special tool sleeve to release the spring load and remove the special sleeve from the rod.
11. Remove the rod & nylon washer from the piston and insert the wind off rod.
12. Assemble the special tool sleeve with M6 screw on the wind off bolt and rotate in anticlockwise direction such that wind off bolt fully come out.

    If Compressed air Supply Facility is Available - Apply air pressure to Spring Brake port and screw in the Wind Off Bolt with nylon washer. Fit the Hex Sleeve (wind off nut) with aluminium washer and press the Spring Dowel on the Sleeve. Follow the procedure laid down in Instruction 14, 15, 16, 17, 18 and 19 (i.e. Procedure laid down in 13 and 14 need not be carried out.)
13. Remove the special tool sleeve, insert aluminum washer and assemble the hexagonal slave on the wind off rod by on the sleeve and the wind off rod.
14. Assemble the stem plug sealing ring on the piston and tighten to torque of 30 Nm.
15. Locate the diaphragm on the flange.
16. Locate the push rod assembly over the diaphragm.
17. Locate the spring on the push rod.
18. Locate the dust seal on the seal retaining spring.
19. Locate the non pressure plate guiding its hole on the dust seal.
20. Assemble the clamp ring and check for proper orientation during positioning and tighten the clamp ring nut to a torque of 15 to 18 Nm.
21. Fix the rubber elbows on the cylinder and the non pressure plate.
22. Apply 'PVC' solvent cement' at both ends of the tube and insert the tube into the elbows to a length of 17mm.
23. Assemble the lock nut and fork on the push rod.
24. Set the distance between the for pin hole centre and the mounting face to the valve as measured during removing. (Distance in brakes released position is 72 mm.)
25. Tighten the lock nut.
26. Release the wind off rod and finally when the sleeve touches the cylinder tighten to a torque of 20 Nm.
27. Fit the adaptors in the Service port (11) and the Spring brake port (12) with sealing washers. Tighten the adaptor in port 11 to a torque of 29-34 Nm. and the adaptor in port 12 to a torque of 20-25 Nm.
28. Fit the assembly on the vehicle and tighten the mounting nuts to a torque of 10 to 13 mkg.
29. Connect the pipes and fit the pin on the fork with Slack Adjuster and lock.
30. Adjust the brakes and check for pipe joints leak before put into service.

**4.7.6 Test Procedure**

a) Connect spring brake Actuator port (12) with air lines through a 'ON-OFF' valve.

b) Apply air pressure to Spring Brake Actuator port and check for release of piston push rod. Operate the 'ON-OFF' Valve few times and check for free movement of piston/push rod. Operate the valve to 'ON' position and check for leak through breather holes on non-pressure plate, body and port 11 to check leak through piston stem.

c) Connect the pipe to service port (11) through a separate 'ON-OFF' valve and apply pressure to spring brake port to keep the heavy coil spring in compressed condition. Operate 'ON-OFF' valve of service brake few times and check for free movement of push rod.

d) Operate the valve connected to Service Brake to 'ON' position and check for leak through diaphragm and clamp ring joints.

The above procedures are to be adopted after fitment on the vehicle if not tested earlier.

**4.7.7 Replacing Diaphragm On Vehicle** (Fig. 28)

Whenever replacement of diaphragm in Spring Brake Actuator is required during regular maintenance of Brake System, it is possible to replace it without removing the Spring Brake Actuator from the Vehicle, as per the procedure given below :

1. Apply Hand Brake.
2. Wind off the Spring Brake Actuator to release the Spring Brake mechanically.
3. Release the worm shaft lock and rotate the wormshaft on the Slack Adjuster so as to pull the spring brake push rod out (This is to eliminate push rod return spring force acting over the Diaphragm). (Ref. Fig. 28)
4. Loosen both running nuts of Service and Spring brake port pipe tines (Do not remove the pipe from the Adaptor).

   (Hold the adaptor with suitable spanner while loosening the running nut).
5. Unscrew the Clamp ring bolts and nuts and remove the clamp ring.
6. Remove the Diaphragm and place the new Diaphragm in position. (Use only Diaphragm with Centre Pad).
7. Fix the Clamp ring ensuring correct engagement of Clamp ring all over.
8. Tighten Clamp ring bolts and nuts to a torque of 1.0 to 1.3 mkg.
9. Tighten both pipe line running nots.

***Important***

- *Adjust The Brake To Ensure Correct Lining Clearance.*
- *Tighten Wind off nut to apply spring brake.*
- *Release the Hand brake with wheels blocked suitably.*
- *Check and ensure leak free joint on spring Brake Pipe line joints.*
- *Check and ensure leak free joint around diaphragm and pipe tine joint with the service brake in applied condition.*
- *This Procedure is only for Replacing Diaphragm.*
- *For Overhauling of Spring Brake Actuator, it is Necessary to Remove the Assembly from the Vehicle.*

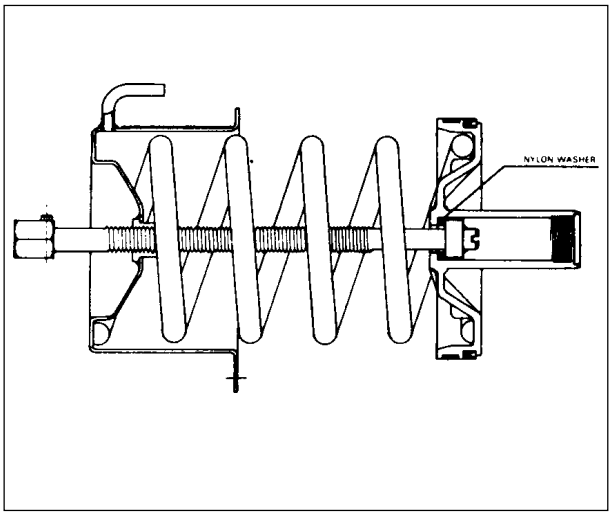



*Fig. 27.1 : Main Spring, end cover and piston*

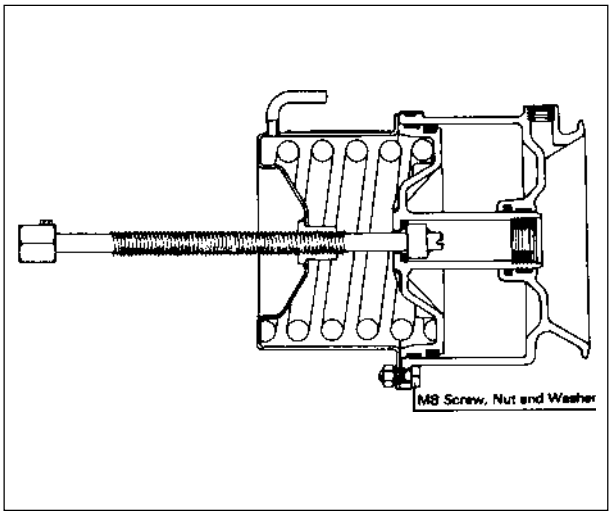



*Fig. 27.2 : End Cover on Cylinder*

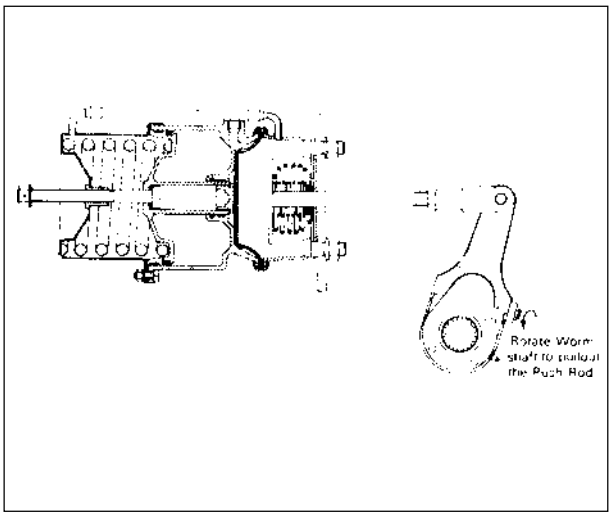


*Fig. 28 : Replacing Diaphragm*

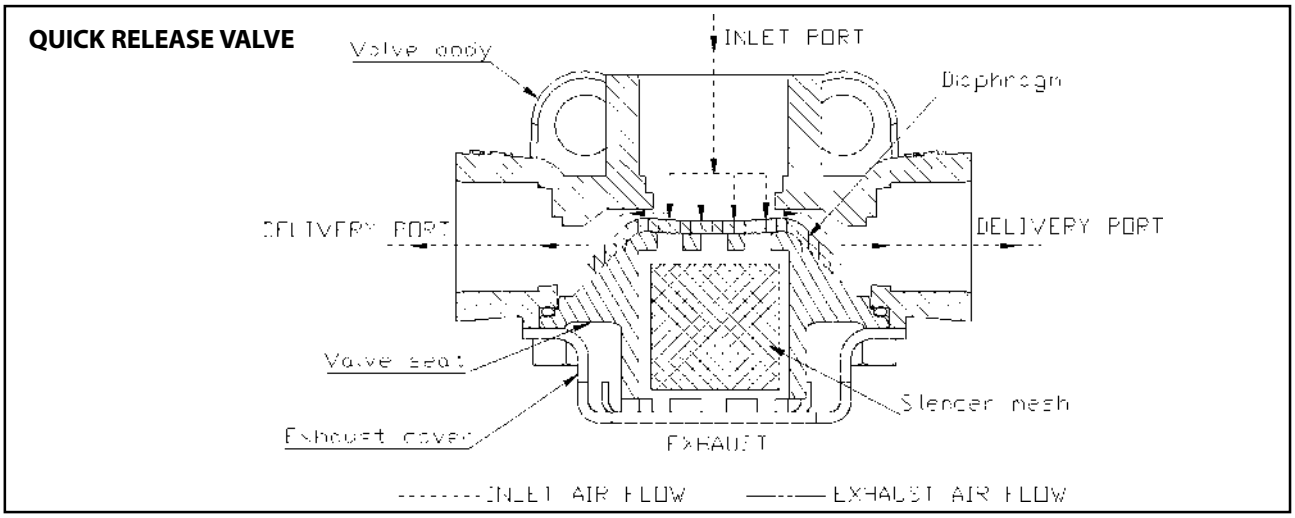



*Fig. 29*

### 4.8 Quick Release Valve

**Function**

The Quick Release Valve ensures faster exhaust of air pressure from the brake chambers / spring brake actuators.

**Description**

The Quick Release Valve is mounted close to the brake chambers / spring brake actuators. When brake is applied, the exhaust passage on valve seat is closed by the diaphragm and air pressure is admitted to the brake chambers / spring brake actuators to which the unit is connected. When the brake is released, exhaust passage is opened and air pressure from the brake chambers / spring brake actuators is exhausted to atmosphere through the valve instead of exhausting through the brake valve.

**Service Checks**

a) Operating and leakage tests.

- Apply and release the brakes several times and check for prompt response of the brake chambers during application and release.
- Fully apply the brakes and hold the application and observe for leakage through the exhaust by applying soap solution. Air leak of 25mm soap bubble in 5 seconds is permissible.

**Removing**

- Block the wheels to prevent movement of the vehicle during working.
- Disconnect air pipes and close the open ends of the pipes to prevent dust/dirt entry.
- Remove the Unit.

**Replacing**

- Locate the Unit and connect the pipelines after removing the closure plugs from the pipe ends. Carry out checks as indicated under'Operating and Leakage tests'.

**Dismantling**

- Clean the exterior of the Valve thoroughly.
- Unscrew the four screws (10 A/F) securing the Exhaust cover to the body.
- Remove the valve seat, sealing ring and the diaphragm.

**Cleaning And Inspection**

- Clean all the components with a cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.
- Check the body for damage to the threads.

**Scrap all the old parts which are found unserviceable.**

**Reassembly**

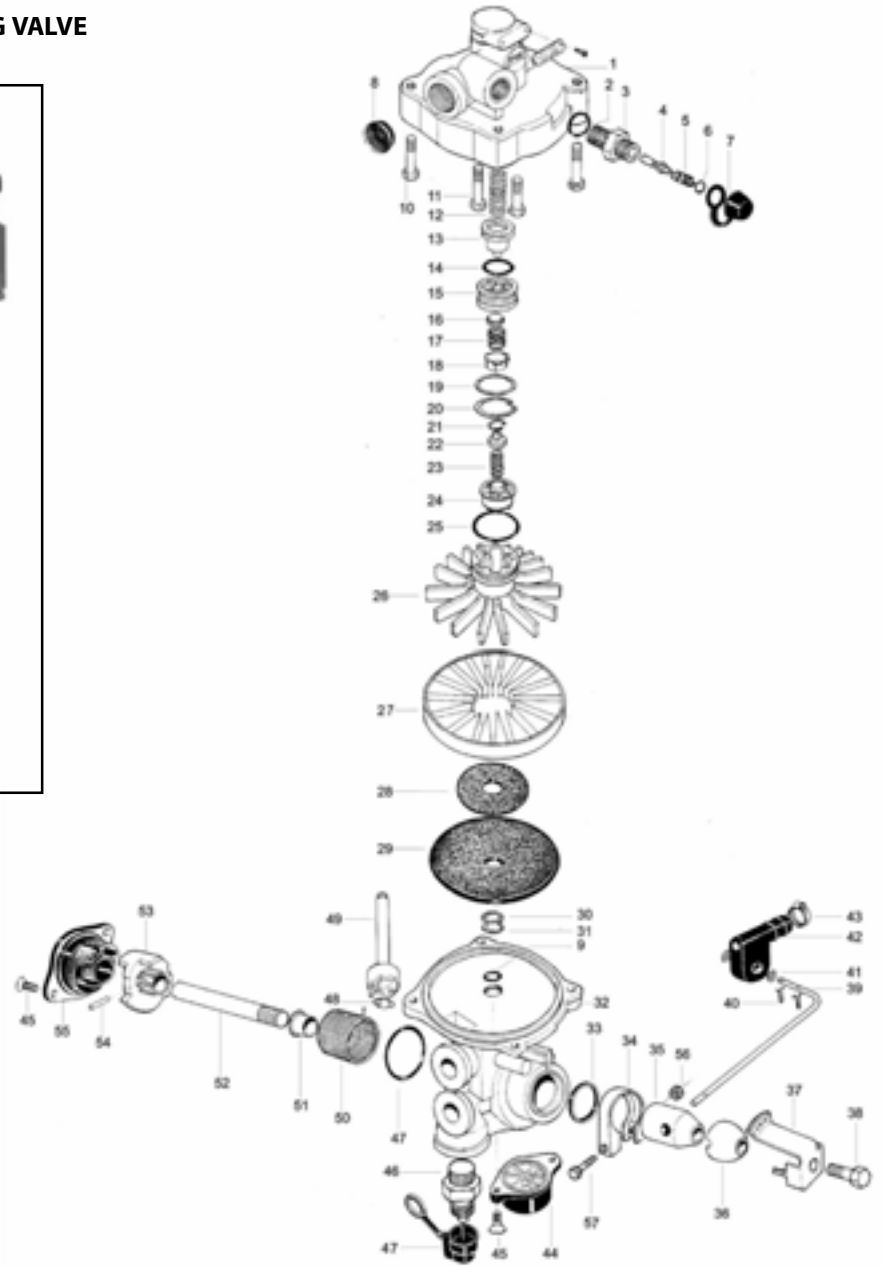
- Locate the diaphragm, the sealing ring, and the valve seat in the body.
- Position the exhaust cover and secure with the 4 hexagonal screws by tightening to a torque of 7-6 Nm.

**AUTOMATIC LOAD SENSING VALVE**



*Assembly*

*Components*



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Upper body | 16 | Bonded valve | 31 | Diaphragm retainer | 44 | Silencer sub - assy |
| 2 | Sealing ring | 17 | Valve housing spring | 32 | Lower body | 45 | Screw |
| 3 | Body | 18 | Spring retainer | 33 | Dust seal | 46 | Pressure test connector |
| 4 | Valve | 19 | Sealing ring | 34 | Clamp ring | 47 | O - ring |
| 5 | Spring | 20 | Internal circlip | 35 | Collet | 48 | Cam roller |
| 6 | Sealing ring | 21 | Internal circlip | 36 | Cap | 49 | Tappet |
| 7 | Dust cap | 22 | Bonded valve | 37 | Angle indicator | 50 | Torsion spring |
| 8 | Strainer | 23 | Moving fin spring | 38 | Hex. head screw | 51 | Split bush |
| 9 | Sealing ring | 24 | Moving fin spring stopper | | lever assembly | 52 | Cam shaft |
| 10 | Bolt | 25 | Sealing ring | 39 | Lever | 53 | Cam |
| 11 | Hex head screw | 26 | Moving fin | 40 | Split pin | 54 | Grooved dowel pin |
| 12 | Spring | 27 | Stationary fin | 41 | Steel washer | 55 | Cam retainer |
| 13 | Valve | 28 | Diaphragm disc | 42 | Link - automatic | 56 | Sun lock nut |
| 14 | Sealing ring | 29 | Diaphragm | | Load sensing valve | 57 | Pan head screw |
| 15 | Valve housing | 30 | Seal | 43 | Worm drive hose clamp | | |

*Fig.30*

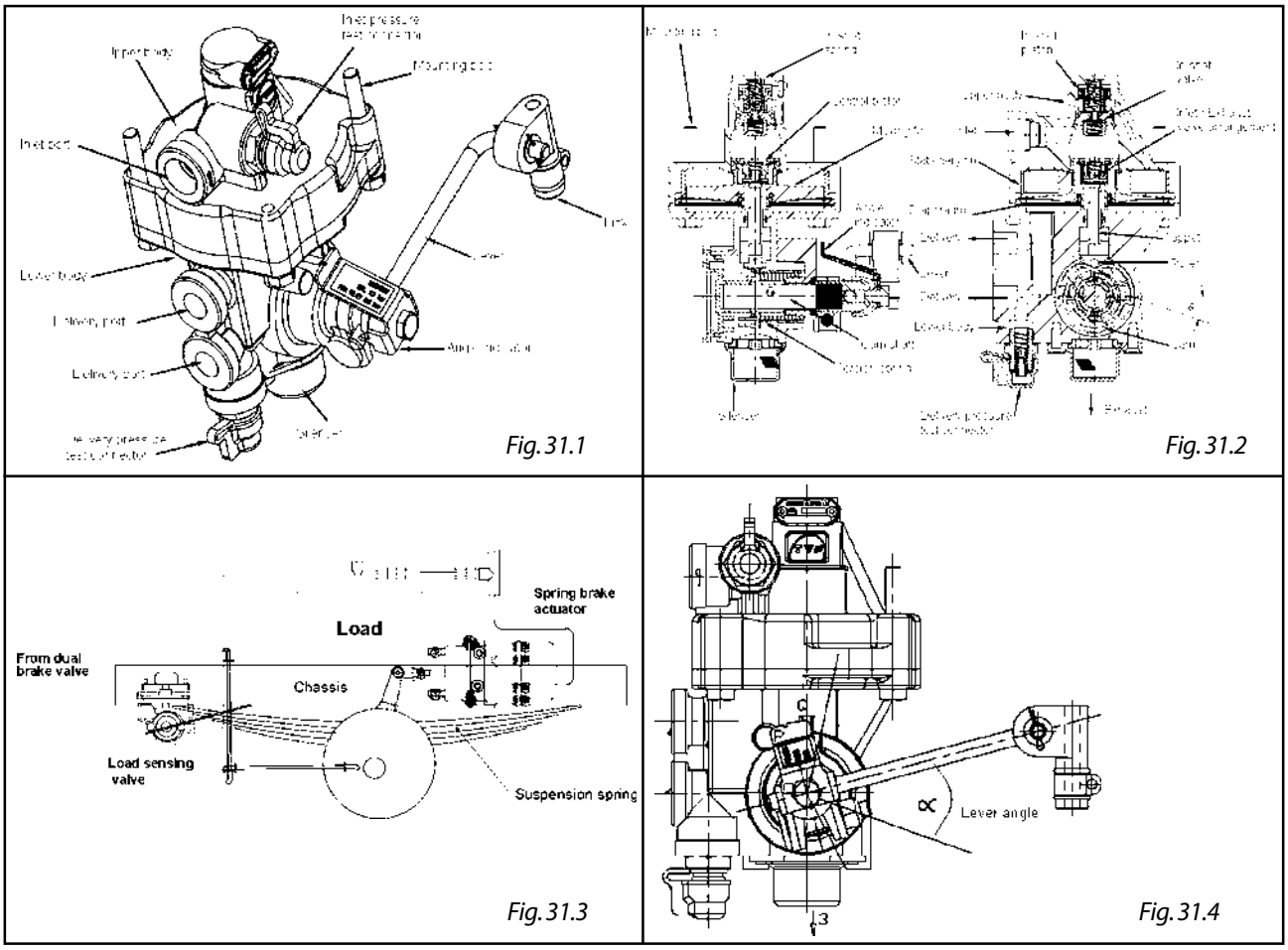



Fig.31.1 Fig.31.2 Fig.31.3 Fig.31.4

*Fig.31*

**4.9 Automatic Load Sensing Valve** (Fig. 30)

**Function**

The Automatic Load Sensing Valve (ALSV) has been designed to regulate the braking force on a particular axle in proportion to the load on that axle, and is controlled by the variations in the spring deflection of mechanical suspension systems. In ALSV, the regulation of delivery pressure takes place automatically in response to the change in the load on the axles of the vehicle.

**Description**

Fig. 31.1 shows the SCL ALSV and Fig. 31.2 shows the cross section of the valve. The unit consists of upper and lower body, which are bolted together encasing a control piston, an inlet / exhaust valve arrangement and a flexible diaphragm. The piston is integral with an arrangement called moving fin which is free to move vertically. The inner edge of the diaphragm is attached to the lower end of the moving fin. The moving fin, when moving in the vertical direction, meshes with an arrangement called stationary fin. Depending on the extent of meshing between stationary and moving fin, the contact area of diaphragm with the moving fin varies .Thus, the delivered pressure, which depends on the effective area of the diaphragm, is determined by the vertical position of the moving fin. The position of the piston is controlled by the inlet / exhaust valve arrangement. The position of the inlet / exhaust valve arrangement in turn is determined by a tappet. The cam- follower and tappet arrangement is controlled by a lever, which is connected to the axle through a linkage arrangement. The relative motion between the axle and the chassis is determined by the vehicle suspension and the axle load.

**Operation**

The ALSV is mounted on the vehicle chassis Fig. 31.3 and the operating lever is connected to the axle through a simple linkage. When the vehicle is empty, the distance between the axle and the ALSV is greatest and the lever end is in its lower most position. As the vehicle is loaded, Fig.31.4 the distance between axle and chassis decreases, and the lever end moves upwards causing the cam to rotate which in turn moves the tappet to a position corresponding to the vehicle load.

When a brake application is made, air at brake line pressure is fed through inlet port into the upper chamber forcing the moving fin with piston downwards, which closes delivery from exhaust and connects inlet to delivery. The air now flows into the chamber below diaphragm and flows out through delivery ports to brake actuators. At the same time, air flows into chamber above diaphragm through the opened in-shot valve and acts on the upper side of the diaphragm. Thus pressures above and below the diaphragm are equalized. This pressure control provides un-modulated output at low inlet pressure. If the inlet pressure increases further, the in-shot piston is pressed further against the in-shot spring load and in-shot valve closes. There will not be any further increase in pressure above the diaphragm.

As the moving fin with piston moves down, the diaphragm begins to move away from the stationary fin, pushed away by the fanned out portion of the moving fin. This alters the effective area of the diaphragm supported by the moving fin with piston, until the force under the diaphragm, which depends on the pressure and the effective area, equals that acting on the top of the moving fin piston and the inlet valve closes. Balance is therefore achieved with a lower delivery pressure than that applied at the inlet port, keeping the valve assembly in the "lapped" condition with the inlet and exhaust closed. The applied pressure is thus regulated in proportion to vehicle spring deflection.

As the effective area of the diaphragm depends on the position of the moving fin attached to the piston, which in turn depends on the position of cam attached to lever, the output pressure to the brake actuators will be increased or decreased according to the load on the axle.

When the brake is released, the pressure in the ALSV supply line (between the Dual Brake Valve and ALSV) falls and will result in loss of balance of air forces on the moving fin piston. This results in unseating of the valve from the tappet, allowing air below the diaphragm to exhaust to atmosphere through the hollow tappet and out of the exhaust. A silencer is provided to reduce the noise due to exhaust.

**Installation In Vehicle**

The assembly should be in vertical orientation, with exhaust silencer facing down.

The lever angle of ALSV should be set as per the theoretical prediction for unladen condition (An angle indicator with a graduation range 0 to 45° is provided for this purpose).

**Dismantling**

1. Clean the exterior of the body thoroughly.
2. Mark the position of the bodies to facilitate reassembly.
3. Remove the screw (38), angle indicator (37) and cap (36).
4. Remove the lever (39).
5. Remove screw (57), clamp ring (34) and dust seal (33).
6. Remove the silencer sub-assy (44).
7. Remove cam retainer (55) by unscrewing (45) using mallet.
8. Remove the camshaft assembly (52,53,54).
9. Pull out split bush (51) and torsion spring (50).
10. Remove Take out the o-ring (47).
11. Pull out cam roller and tappet (48,49).
12. Unscrew bolts (10 & 11) and remove upper body from lower body.
13. Remove sealing ring (9).
14. Remove the circlip (31) and washer (30) from upper body.
15. Pull out the diaphragm (29).
16. Pull out the stationary fin (27).
17. Remove o-ring (25) from moving fin (26).
18. Remove circlip (21), remove spring stopper (24),
19. Remove spring (23).
20. Pull out bonded valve (22).
21. Remove circlip (20).
22. Apply very light air pressure through the pin hole at upper body to remove valve housing assembly (15,16,17,18,19).
23. Press the cap (18) and manually rotate to remove it.
24. Remove spring (17) and bonded valve (16).
25. To remove valve (13) apply very light air pressure through the centre hole.
26. Remove sealing ring (14).
27. Remove spring (12).

**Cleaning And Inspection**

1. Clean all the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.
2. Thoroughly clean all the bodies and make sure that the air passages are free from blockage.
3. Check for any crack / damage in the bodies, damage on port faces / thread, nick / score marks / damages on the valve seats, excessive wear / score marks / damage on the pistons.
4. Check the springs for distortion, rust formation and permanent set.
5. Scrap all old parts which are found to be unserviceable.



**Re Assembly**

1. Hold the bonded valve (16) as shown place it on valve housing (15).
2. Place the spring (17) over the valve (16), place the spring retainer (18), press it downwards and manually turn to lock.
3. Apply recommended grease on sealing ring (19) and assemble it.
4. Locate the upper body (1) in fixture. Apply recommended grease on valve bore. Place spring (12) in the bore.
5. Assemble sealing ring (14) on valve (13). Place the assembly over spring (12). Ensure that the larger diameter of the valve (13) is facing the spring (12).
6. Place valve housing assembly (15,16,17,18,19) on the bore keeping the larger diameter of the assembly at the bottom. Press the total assembly vertically downwards. Lock the assembly using circlip (20).
7. Assemble the sealing ring (25) with moving fin (26). Assemble moving fin (26) and stationary fin (27).



8. Apply grease on the both side of the diaphragm disc (28). Assemble diaphragm (29) and diaphragm disc (28). Place the diaphragm assembly (29,28) on stationary fin (27).
9. Place the seal (30) and fix it with circlip (31). Check for proper seating of the circlip on the groove.
10. Hold the bonded valve (24) as shown and place it on the valve seat of moving fin (26).
11. Assemble spring (23) and moving spring fin stopper (24).
12. Assemble circlip (21) using circlip plier.
13. Assemble fin assembly into the upper body. Ensure proper seating of diaphragm into the upper body.



14. Assemble camshaft (52), cam (53) and grooved dowel pin (54). Apply loctite 648 before assembling cam and camshaft.
15. Assemble dust seal (33) on the lower body (32).
16. Apply grease on the sealing ring bore on the lower body. Press the sealing ring (9) inside the bore. Ensure orientation as shown.
17. Assemble tappet (49) through the bored hole of the lower body. Apply grease on the outer diameter of the tappet and on tappet roller (48).
18. Assemble o-ring (47) on the cam retainer (55).
19. Place the torsion spring (50) in such a way that the coil end catches the slot in the lower body.
20. Insert the split bush (51) over camshaft. Assemble the camshaft assembly along with the split bush. Push the tappet forward and rotate the camshaft approx 440o to align.
21. Assemble cam retainer sub assembly and tighten the screws (45).
22. Place lower body sub assembly on upper body sub assembly. Use the marks during dismantling for correct orientation.

23. Tighten the screws (10,11). Tightening torque should be 22.5±2.5 Nm.
24. Insert the collet (35) into the clamp ring (34).
25. Insert pan head screw (57) into the clamp ring. Ensure the square profiles in screw and clamp ring matches. Hand tight lock nut (56) with the screw.
26. Assemble clamp ring assembly over the projected portion of the camshaft. Tighten the lock nut. Tightening torque should be 11.5±1.5 Nm.
27. Pick the lever (39) and insert it through the hole provided in the collet.
28. Pick and place cap (36), angle indicator (37) and hexagonal head screw (38). Tighten the screw. Tightening torque should be 22.5±2.5 Nm.
29. Place the silencer assembly (44), tighten the screws (45).

***Precaution** : Do not use any sharp tool. Use circlip pliers to remove and install circlips.*

**Adjustment** (Fig. 32)

In unladen vehicle (with or without load body) Loosen screw 'B'. Rotate link 'A' by sliding rubber connector over link 'C' such that Point 'P' on dial 'D' coincides with point 'Q'. Tighten the screw 'B'. Adjustment of LCRV should be done as per valve setting data given on the sticker, located near windshield washer water reservoir.

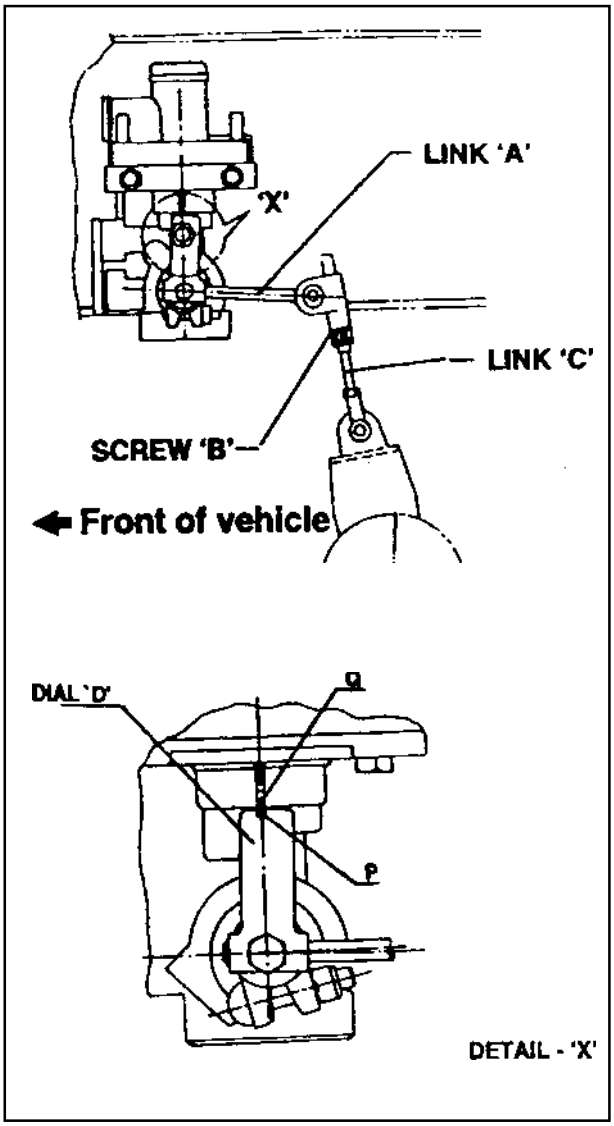
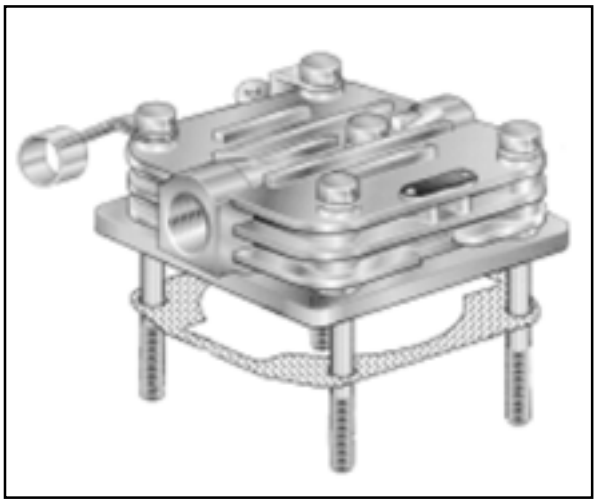



*Fig. 32*



**CYLINDER HEAD ASSEMBLY - 94 MM DIA**

1. bolt
2. Washer
3. Bolt
4. Cylinder Head
5. Joint
6. Rivet
7. Delivery Reed
8. Valve Plate
9. Inlet Reed
10. Joint
11. Clip
12. Clip

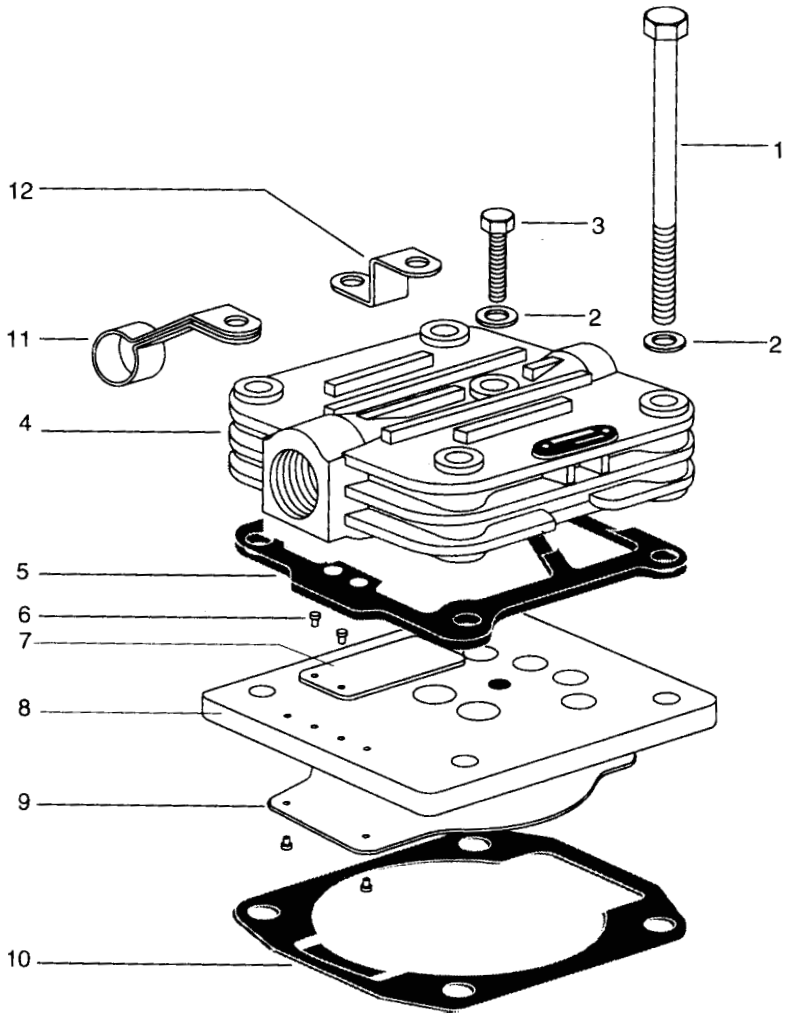



*Fig. 33*

**4.10 CYLINDER HEAD ASSEMBLY -** (94 mm Dia) Fig. 33

**Service Checks**

- Check for tightness of compressor mounting bolts.
- Ensure that the air inlet line is in good condition.

**Removing**

- Block the wheels to prevent movement of the vehicle during working.
- Disconnect air pipes and close the open ends of the pipes to prevent dust/dirt entry.
- Remove the head mounting bolts and detach the head from compressor.

**Dismantling**

Tools required for servicing.

Spanners 10 A/f, 11, 13 A/f, no other special tools required.

- Clean the exterior of the assembly thoroughly
- Mark the position of the cylinder head in relation to the cylinder block before dismantling.
- Loosen and remove the nut securing the cylinder head to the valve plate (10 A/F)
- Mark the inlet and delivery side on the valve plate.
- Push out the locating pins/rivets retaining the inlet reed, from the valve plate using a suitable drift. Remove the inlet reed.
- Repeat for removing the delivery reed.

**Cleaning And Inspection**

- Clean all the components with a cleaning solvent and blow-dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.
- Thoroughly clean the cylinder head, scrape carbon (with care to ensure that no scratches or deep score are made during scrapping), dirt and particles of old joints from all surfaces.
- Clean the inlet and delivery reeds if they are not damaged.

*Scrap all the old parts which are found unserviceable*

**Reassembly**

- Locate the delivery reed valve in the valve plate and fix/flair it with the locating pins/rivets. Locating pins are to be pressed by hand and are not to be riveted. If it is a rivet, flair it. Ensure that the reed is located in the same side as identified during dismantling.
- Reverse the valve plate and locate the inlet reed and fix it with the two locating pins/rivets.
- Place the delivery reed joint on the top side of the valve plate. Ensure that the joint does not overlap the reed.

  Locate the inlet reed joint. Assemble the cylinder head with the reed plate on to the cylinder block.

**4.11 SINGLE CYLINDER COMPRESSOR** (Fig. 34)

**(SC-160 High Speed Air Cooled)**

**Function**

The compressor delivers air and builds up pressure in the Air Reservoir. The compressed air is used for vehicle braking and other static systems.

**Description**

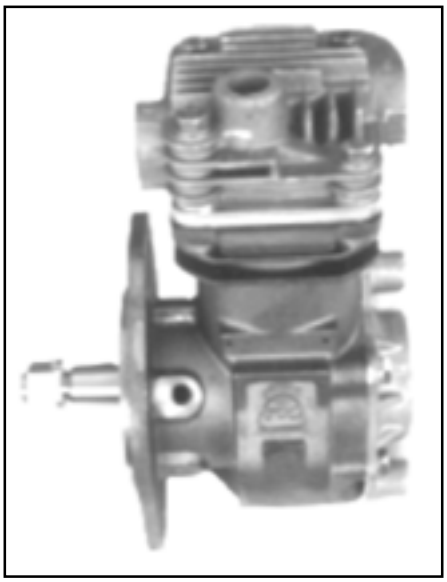
This is s single cylinder, reciprocating type compressor suitable for flange mounting and a through drive for the power steering pump. The compressor has a bore of 80 mm dia. , stroke of 32 mm and displacement of 160 cc.

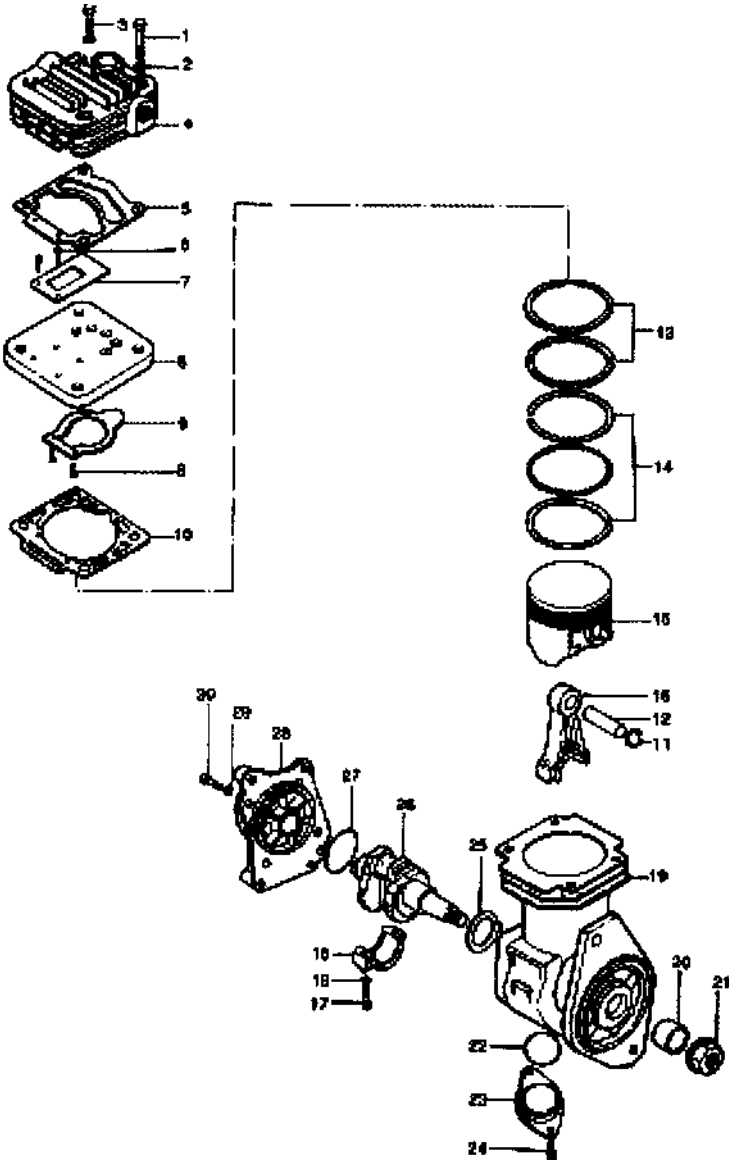
**Service Checks**

- Check for tightness of compressor mounting bolts.
- Ensure that the air inlet line is in good condition.
- Check for tightness of cylinder head mounting bolts of the compressor.
- Operating Tests.

Run the engine and build up air pressure in the system up to the cut out pressure. If the time taken to build up cut out pressure is excessive to the recommended time then check for system leakage in the air lines including the pipes and pipe joints. If this leak is not excessive then it denotes that the loss of efficiency of compressor is due to wear. Another sign of wear is excessive oil passing to the reservoir. If either condition is noticed during inspection then the compressor is due for overhaul.

**Single Cylinder Compressor**





1. Set Screw
2. Steel Washer
3. Hex Headscrew & bolts
4. Cylinder Head
5. Delivery Joint
6. Valve Assembly
7. Rivet
8. Delivery reed
9. Valve plate
10. Inlet reed
11. Inlet joint
12. Gudgeon pin
13. Compression ring
14. Oil control ring
15. Piston
16. Connecting rod
17. Connecting rod bolt
18. Washer
19. Cylinder Block
20. Wrapped Bush
21. Crankshaft nut
22. 'O' Ring
23. Sump Cover
24. Hex. Head Screw
25. Thrust Washer
26. Crankshaft
27. Sealing Ring
28. End Cover
29. Washer
30. Set Screw

*Fig. 34*

**Removing**

- Block the wheels to prevent movement of the vehicle during working.
- Disconnect air and oil pipes and close the open ends of the pipes to prevent dust/dirt entry.
- Remove the mounting bolts and detach the compressor from its mountings.( On vehicles with power steering pump remove the compressor with the pump and then dismantle the pump from the compressor.)
- Loosen the nut and remove the drive gear and from the crankshaft.

**Replacing**

- Locate the drive gear on the mounting side of the crankshaft.
- Locate the washer on the crankshaft and tighten the nut uniformly to a torque of 175 Nm.
- Locate the 'O' ring in the mounting face of the cylinder block in its groove.
- On vehicles with power steering pump install the pump on the compressor end cover.
- Install the compressor (compressor) with pump in case of vehicles with power steering pump) on its engine mounting face and secure tightly.
- Connect the oil and air pipes.
- Carry out the operating tests as given under "Service check."

**Dismantling**

Tools required for servicing.

Spanners 10, 11, 13 A/F, a 6 mm Allen key and a puller for removing the drive gear. No other special tool is required

- Clean the exterior of the compressor thoroughly.
- Mark the position of the cylinder head in relation to the cylinder block before dismantling.
- Unscrew the four screws securing the cylinder head to the crank case and remove the cylinder head assembly.
- Loosen and remove the screw securing the cylinder head to the valve plate.
- Mark the inlet and delivery side on the valve plate.
- Push out the locating pins/rivets retaining the inlet reed, from the valve plate using a suitable drift. Remove the inlet reed.
- Repeat for removing the delivery reed.
- Loosen and remove the four screws securing the base plate to the crank case. Remove the base cover plate.
- Turn the crankshaft to the bottom dead centre position and loosen the connecting rod bolts and remove the cap.
- Withdraw the piston assembly through the top of the crank case.
- Remove the piston rings from the piston. Remove one of the circlips retaining the gudgeon pin and push the gudgeon pin until it comes out of the piston remove the connecting rod.
- Loosen the end cover screws (Allen Cap screws) and remove the end cover, crank shaft and the thrust washer.

**Cleaning And Inspection**

- Clean all the components with a cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.
- Thoroughly clean the cylinder head, scrape carbon (with care to ensure that no scratches or deep score are made during scraping), dirt and particles of old joints from all surfaces.
- Clean the oil holes in the crank shaft using a piece of wire if necessary, and flush with cleaning solvent and blow dry with compressed air. Ensure that the oil hole is free from blockage.
- Clean the inlet and delivery reeds if they are not damaged.
- Clean the oil passage in the end cover and blow dry with compressed air. Ensure that the oil hole is free from blockage. Check the bush
- bearing in the end cover for wear, score marks and / or damage. Replace bush bearing if these defects are found.

- Check the cylinder bore for presence of honing marks all over the bore. Also check for any deep score marks. Check the bore diameter for ovality and taper at three different locations both in the diameter and the length. If the value of the taper plus twice the ovality is more than 0.05 mm then the cylinder is to be rebored to the next over size. If it is less than 0.05 mm then the standard piston with new standard rings are to be used.
- Finished bore sizes after reboring and honing are given below.
- Standard bore 66.701± 0.013
- 1st oversize 66.945 to 66.960
- 2nd Oversize 67.195 to 67.200
- If the bore is worn out beyond the 2nd oversize limit then the crank case is to be replaced.
- Check the bush bore for wear, score marks, and / or damage. Replace bush bearing if these defects are found.
- Check the fit of the piston rings in the groove. The clearance should be within 0.052/0.020 mm.
- Check the piston for score marks, cracks, damages and renew if any of these defects are noticed. Check the gudgeon pin fit on the piston and connecting rod. The clearance between the pin and connecting rod small end bore should be within 0.011/0.033 mm.
- Check the connecting rod for cracks, and damage. Check the bearings for score marks and damage. Replace connecting rod and bearings if any of these defects are noticed. The clearance between the connecting rod big end bearings and the crank pin journal must be between 0.013 and 0.031 mm.
- Check the crank shaft journal and pin diameter for finish.( since the crank shaft is hardened and ground wear is not expected.)
- Check the cylinder head for damage at the ports. Replace if the port threads are damaged. Check the reed valves for damage or distortion. Replace if damaged or distorted. Check the reed plate for damages and score marks. Replace if damaged or heavily scored.
- Replace all joints supplied in the relevant repair kit.

*Scrap all the old parts which are found unserviceable.*

**Reassembly**

**Crank shaft and End cover.**

Use recommended Repair kit to replace the parts scrapped during dismantling and in addition replace all parts which were found

- unserviceable / defective during cleaning and inspection. Lubricate all moving parts with clean engine oil to prevent possible damage when the engine is started and until oil supply is established.
- Locate the thrust washer in the cylinder block at the stepped bore. The thrust washer is to be installed such that the slots on the thrust washer are visible outside as installed.
- Insert the crank shaft in the cylinder block after smearing a little engine oil on bush and crank shaft journals.
- Assemble the 'O' ring in the end cover in the groove. Assemble the end cover in the cylinder block .
- Insert the Allen cap screws and check for free rotation of crank shaft.
- Tighten the Allen cap screws uniformly to a torque of 22 Nm. Apply Loctite 243 or its equivalent to the threads before tightening.

**Piston Assembly**

- Locate the connecting rod small end in the piston and insert the gudgeon pin. Fit the circlip and ensure that the circlip is properly located in the groove in the piston.
- Fit new rings on the piston and ensure that the side marked 'TOP' are upper most and the ring gaps are set at 120 degrees to each other.
- Position the crank shaft at the bottom dead centre. Lubricate the cylinder bore and the piston, the connecting rod big end with clean engine oil. Pass the piston assembly through the top of the cylinder bore using a piston ring guide and ensure that the connecting rod big end is located properly on the crank shaft journal. Assemble the cap.
- Position the connecting rod bolts and tighten to a torque of 7-9 Nm. Apply Loctite 243 or its equivalent to the threads before tightening.

- Check for free rotation of the crank shaft.
- Place the base cover o-ring and the base cover in position and locate the base cover screws. Tighten uniformly to a torque of 20-25 Nm.

**Cylinder head and reed valves**

- Locate the delivery reed valve in the valve plate and fix/flair it with the locating pins/rivets. Ensure that the reed is located in the same side as identified during dismantling.
- Reverse the valve plate and locate the inlet reed and fix/flair it with the two locating pins/rivets.
- Assemble two dummy studs on the two corners of the cylinder block.
- Place the delivery on the top side of the valve plate. Ensure that the joint does not overlap the reed. Then place the thicker joint
- Locate the cylinder head on the valve plate.
- Assemble the cylinder head with the reed plate on to the cylinder block guiding it through the dummy stud
- Secure the cylinder head on cylinder block with mounting bolt and tighten it to the recommended torque.
- Check for free rotation of crank shaft.

*Do not apply oil, grease, shellac, or any other sealing compound other than those recommended to the joints. Avoid reuse of joints once removed.*

## 5. HAND BRAKE SYSTEM

### 5.1 Hand Brake Arrangement

Hand Brake is integral with spring brake actuator on rear axle. Spring brake chamber piston ram acts directly on push rod assembly of brake chamber. Conventional rear parking brake linkages are dispensed with. For details refer "Spring brake actuators".

### 5.2 Hand Brake Adjustment

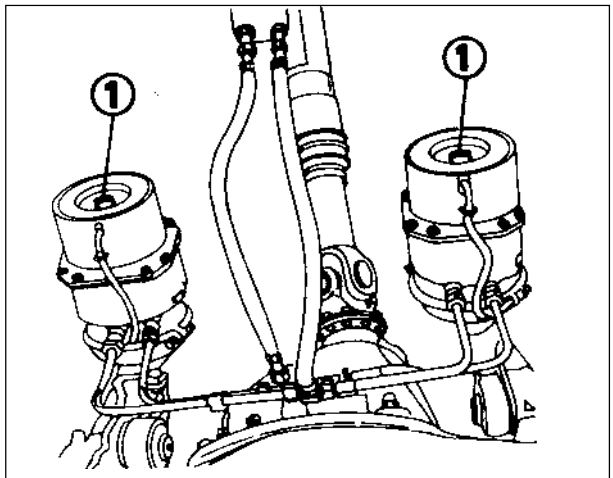
No separate adjustment is required. The same service brake adjustment holds good for hand brake also.

### 5.3 Releasing Hand Brake (Fig. .35)

If there is air leak in hand brake circuit, parking brake gets applied automatically. Air leakage in any other circuit (front, rear and exhaust brake) does not affect parking brake due to the action of system protection valve.

A mechanical 'wind off' screw (M16 x 1.5) is provided at the top of spring brake actuator to release automatically applied hand brake due to any reason. To release, rotate wind off screw up with a spanner against the tension of spring (inside spring brake chamber) till brakes are completely released.

The wind off screw has to be turned down into original position, soon after mechanical wind off requirement is over and before vehicle is put on the road again.




1. Mechanical wind off Screw

Fig. 35 Releasing Hand Brake

## 6. Adjustment of Brakes Controls

### 6.1 Adjustment of Services Brakes/Slack Adjusters (Fig. 36.1 & 36.2)

In order to ensure efficient operation, all four brakes must be kept properly adjusted. Excessive travel of the rake chamber push rod indicates the need for brake adjustment, i.e., if the angle between the brake chamber push rod and the centre line of slack adjuster is less than 90 in the brakes applied condition, the brakes should be adjusted (Fig. 36.1).

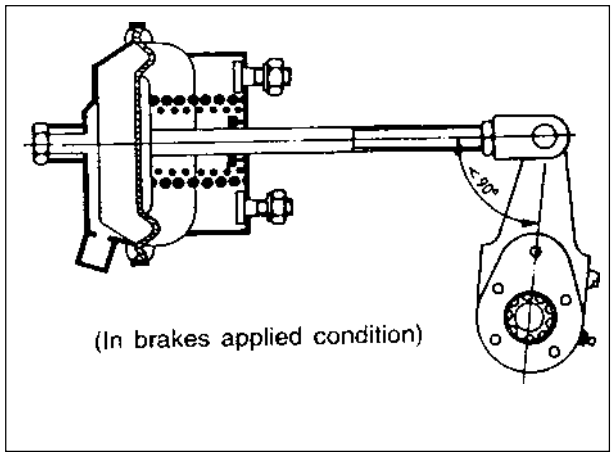


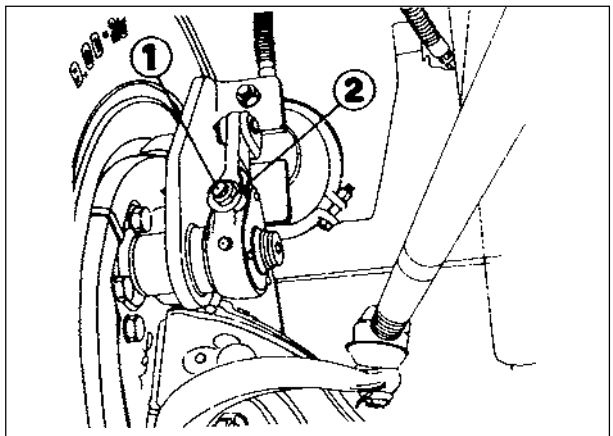

*Fig. 36.1 : Position when Adjustment is required*

All normal adjustments should be made only by means of the adjuster screw of the slack adjuster. Brake adjustment is to be done when drums are cold and not when they are hot.

Improper brake adjustment can cause brake grabbing, more air consumption or lower brake efficiency.

**Procedure**

Jack up the wheels, clear off the ground. Release the hand brake, if it is in 'on' condition. Position a box spanner or a ring spanner (14 mm A/ F) over the adjuster hexagon. By depressing the locking sleeve turn the adjuster screw clockwise until the shoe begins to bind the drum. Then turn the adjuster screw anti-clockwise until the wheel rotates freely. Release the locking sleeve.




1. Adjuster Screw 2. Locking Sleeve

*Fig. 36.2 Adjusting Slack Adjuster*

***Note :*** *Ensure that the locking sleeve engages with the hexagon head of the adjuster screw. It is possible to check the clearance between the drum and lining by using a feeler gauge through the inspection hole after removing the rubber grommet.*

### 6.2 Adjustment of Brakes Controls

#### 6.2.1 Adjustment of Brake Pedal Free Play
(Fig. 37.1, 37.2 & 37.3)

A certain amount of play is kept between dual brake valve spindle and double lever pin . This is to ensure that accidentally brakes do not get operated. There will be slight hard feeling at brake pedal while depressing, when play is zero. The travel of brake pedal till play is zero, can be defined as "brake pedal free play".
Adjust brake pedal free play as below

1. Ensure brakes are in released condition.
2. Loosen check nuts on the pedal stopper screw near stop light switch. Adjust stopper screw such that brake pedal free travel is 3 to 6 mm.
3. Tighten check nut of stopper bolt without disturbing.
4. Operate brake pedal a few times to ensure desired brake pedal free play.

**Adjustment of Stop Light Switch**

1. Ensure that brakes are in released condition.
2. Install stop light switch so that the plunger is pressed by about 3 mm when assembled.
3. Operate Brakes a few times, to make sure that a stop light indication comes properly.

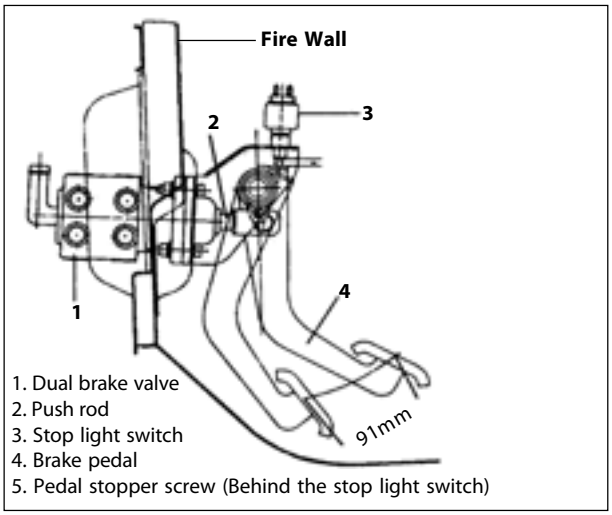



Fig. 37.1 - *Schematic Layout of Brake Controls Brake controls and adjustments*

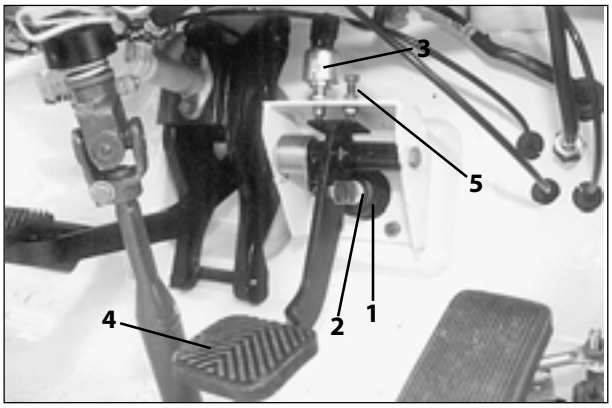



Fig. 37.2 - *Brake pedal adjustment*

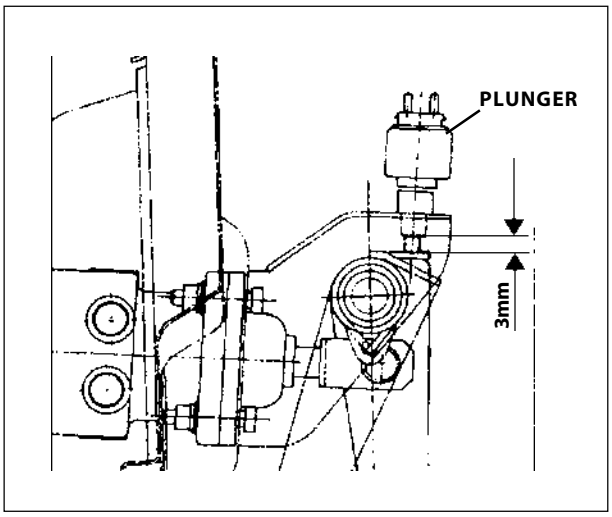



*Fig.* 37.3 *Adjustment of Stop Light switch*

**Brake pedal free play adjustment**
(For LP/LPO/LPT with 1210 face)

Recommended brake pedal free play is 5 to 10 mm.

Build air pressure above 6.4 bar (cut in pressure).

Loosen lock nut A and rotate adjusting screw B with help of DE spanner (Fig. 38).

Increasing the height of adjusting screw will reduce the pedal free play and vice versa.

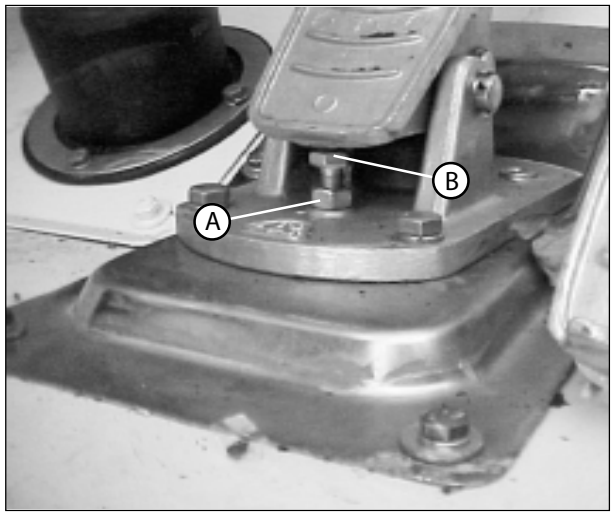



*Fig. 38 : Brake pedal free play adjustment*

*A. Lock nut*

*B. Adjusting screw*

## 7. ENGINE EXHAUST BRAKE SYSTEM

### a) Advantages

A step towards greater economy and better control. Engine exhaust brake is an auxiliary brake supplementing the main service brake.

Use of engine exhaust brake will result in increased life of brake liners/drums.

### b) Operation

Every time you apply brake, the engine exhaust brake comes into play. When the brake pedal is depressed, the double lever operating the truck brake valve of the service brake simultaneously the stop light switch gives signal to electric solenoid valve to open, letting compressed air into the exhaust brake cylinder. This operates the butterfly valve in the exhaust system and applies the exhaust brake.

During this operation, since the accelerator pedal is in idling position and the exhaust opening is restricted, the road wheels will drive the engine, which will act as a compressor (resistor), thus retarding the vehicle speed, without in any way being detrimental to the engine / vehicle.

The use of engine exhaust brake results in increased life of service brake linings and drums.

When the brake pedal is released, then stop light signal goes 'OFF' and solenoid valve closes, thereby cutting off the air supply. The exhaust brake cylinder become open to atmosphere facilitating its spindle to return home.

### c) Operating Instructions

i) Ensure air pressure in the tank is above 6 bar.

ii) Change to lower gear which is appropriate to road conditions. The engine exhaust brake is very effective below the vehicle speed of 40 kmph.

iii) Do not depress the clutch as this would render the exhaust brake ineffective.

iv) Press brake pedal fully when the vehicle is to be brought to a stop. For parking, the vehicle, engage hand brake and low gear.

### d) Lubricating the exhaust brake linkages

i) The exhaust brake requires a minimum of service. Every 5,000 km a few drops of oil should be applied to the ball pins of outer linkages and friction surfaces.

ii) The butterfly valve shaft, which is made of heat resistant material, should not be lubricated since the lube oil would cause seizing of the butterfly valve in the exhaust manifold.

iii) Remove, clean and refit exhaust manifold butterfly valve and shaft (Do not lubricate) once in 80,000 km.

**Exhaust Brake Valve Adjustment**

There is no separate exhaust brake valve adjustment. Stop light switch serves the function of providing signals both for rear tail brake lamps as well as for exhaust brake solenoid valve.

Check proper functioning of engine exhaust brake at PDI and every 10,000 km with brake pedal fully released, there should be no exhaust brake application. If it is on, re-adjust stop light switch suitably. Exhaust brake application can be made out from distinct change in engine noise.

**7.1 AIR CYLINDER** (Fig. 39)

**Function**

The AIR Cylinder with Magnetic Valve is used to operate the butterfly valve in the exhaust manifold of the engine in the exhaust brake system through linkages.

**Description**

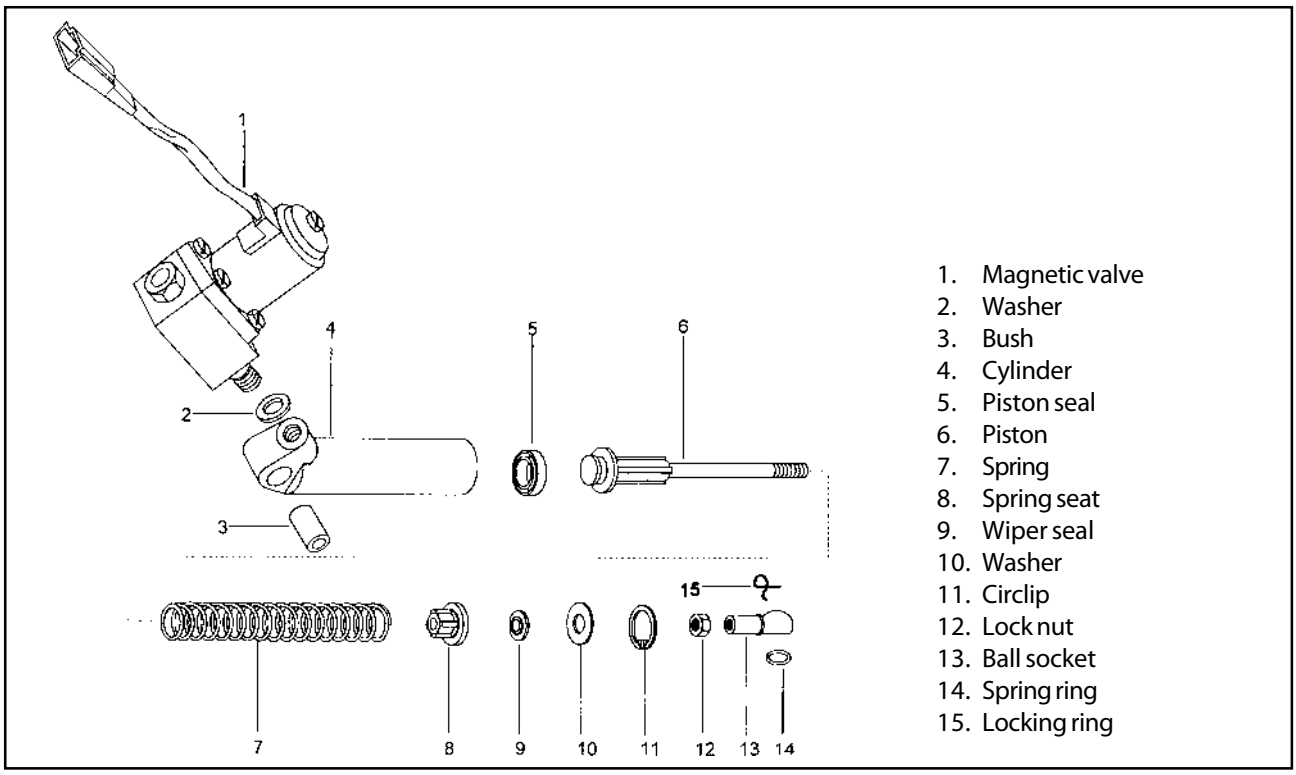
The air cylinder comprises of a cast aluminium cylinder which houses a nylon piston with a rubber seal, a piston return spring, a spring seat and a wiper seal and secured in the cylinder bore by a circlip. A ball socket is screwed on to the piston rod with a lock nut and a locking ring. The cylinder also provides a mounting hole with a rubber bush and a port for air connection. A magnetic solenoid valve is coupled to the cylinder port to facilitate air supply to the cylinder. A port is provided in the solenoid valve for air connection.

**Service Checks**

- Operate the switch and check for smooth movement of the piston during application and release.
- Apply the exhaust brakes and check for air leak. Air leak if noticed, indicates faulty piston seal.

**Removing**

- Block the wheels to prevent movement of the vehicle during working.
- Deplete air pressure from the system.
- Brush away dirt / dust from the air pipe connections.
- Disconnect air pipe and close the open ends of the pipes to prevent dust/dirt entry.
- Disconnect the electrical connections to the magnetic valve.
- Disconnect the exhaust brake linkages from the balls joint of the piston.
- Loosen and remove the pivot pin nut and remove the unit.




1. Magnetic valve
2. Washer
3. Bush
4. Cylinder
5. Piston seal
6. Piston
7. Spring
8. Spring seat
9. Wiper seal
10. Washer
11. Circlip
12. Lock nut
13. Ball socket
14. Spring ring
15. Locking ring

*Fig. 39 : Air Cylinder*

**Replacing**

- Secure the cylinder tightly on the pivot pin.
- Locate the Unit and connect the pipelines after removing the closures from the pipe ends.
- Connect the exhaust brake linkages with the ball joint of the piston.
- Connect the electrical wires properly
- Carry out checks as indicated under operating and leakage tests.

**Dismantling**

- Loosen and remove the magnetic valve
- Mark the position of the lock nut on the piston rod and unscrew the lock nut. Remove the ball joint and lock nut.
- Remove the circlip from the cylinder bore and extract out the washers, wiper seal, spring seat, piston return spring and piston with seal from the cylinder bore.
- Remove the rubber bush fitted on the cylinder mounting hole
- Scrap all the old parts that are serviced in the repair kit.

**Cleaning And Inspection**

- The magnetic valve is a throw away unit and cannot be serviced. The unit is to be tested separately by with air pressure and energising the valve by applying appropriate DC voltage.
- Clean all the components EXCEPT THE MAGNETIC VALVE with a cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present in the components during assembly.
- Check the piston for crack or damage.
- Check the thread and circlip groove of cylinder for damage and bore for excessive wear/score marks.
- Check spring and circlip for distortion, corrosion and permanent set.
- Check for the thread damage in the magnetic valve ports.

**Re-assembly**

- Use recommended repair kit to replace the old parts scrapped during dismantling and also replace the parts found to be unserviceable during inspection, by new ones.
- Lubricate the piston and cylinder bore with silicon MS 33 grease or its equivalent. This grease is supplied with the repair kit.
- Install the seal on the piston groove. Ensure proper orientation of seal while fitting.
- Insert the piston with the seal in the cylinder bore and place the return spring, spring seat, wiper seal and washer on the piston. Ensure that the seal is not folded during assembly.
- Locate the washer and fit the circlip. Ensure that the circlip is seated properly in the groove of the cylinder bore.
- With the lock nut on the piston rod screw the ball socket and tighten the lock nut so that the lock nut lies on the same point where the identification was provided during dismantling.
- Fit the rubber bush in the mounting hole.
- Assemble the magnetic valve with the aluminium washer in position and secure tightly.

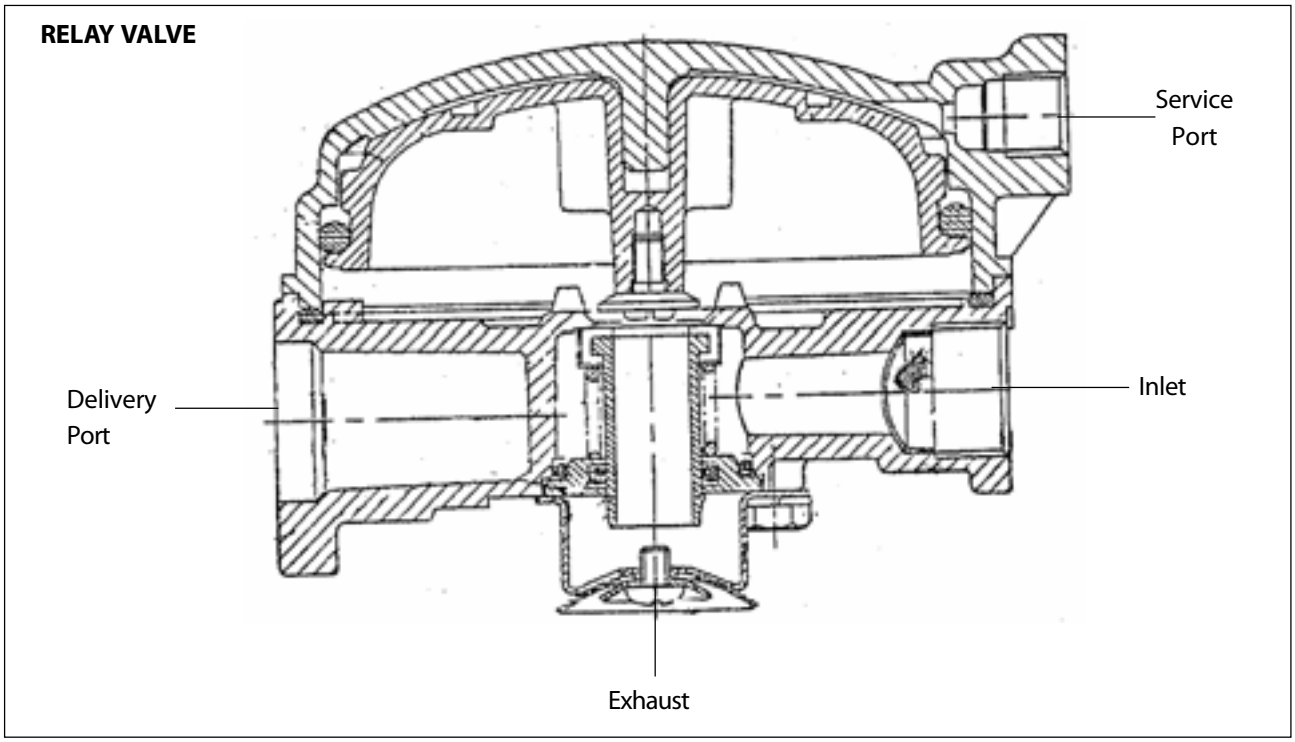



*Fig. 40.1 :* Relay Valve (R6)

## 8. 'S' CAM FULL AIR BRAKE FOR 6x2 VEHICLE.

The brake circuit is consisting of various pneumatic component are as shown in Fig. 1G & 1H. Relay valves are used on 6 x 2 vehicles. Information on all pneumatic components is given in section 4, except relay valve. Information on relay valve is given below.

### 8.1 RELAY VALVE

**Function**

The Relay Valve is a secondary control unit to accelerate the application of air pressure in part of the air brake system. This also serves as a protective unit for tractors in which this is fitted.

**Description**

The assembly comprises of a body and a top cover. The top cover guides the Relay piston during operation and an exhaust valve seat is screwed into the relay piston. Piston returns on its own during exhaust without the assistance of return spring. Valve assembly consists of a spring-loaded Inlet and exhaust valve, which are retained on the valve guide by a snap ring. The valve assembly is housed in the body and retained by a base cover with two screws. Diaphragm type exhaust check is fitted onto the base cover to prevent dirt / dust into the valve.

**Operation**

**Brakes off condition**

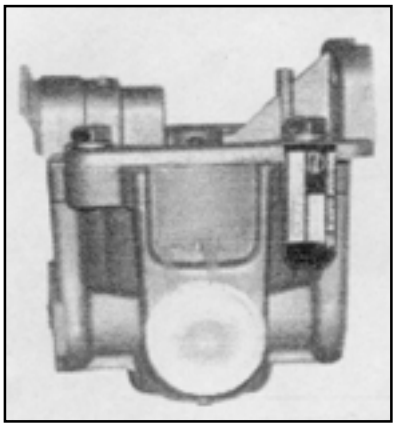
In this position, brake chambers connected to the delivery port is opened to atmosphere through the exhaust passage and the spring-loaded inlet / exhaust valve rests on its valve seat in the body. The Inlet port is connected to the Reservoir and as a result, the system pressure is always present in inlet chamber of the Relay valve.

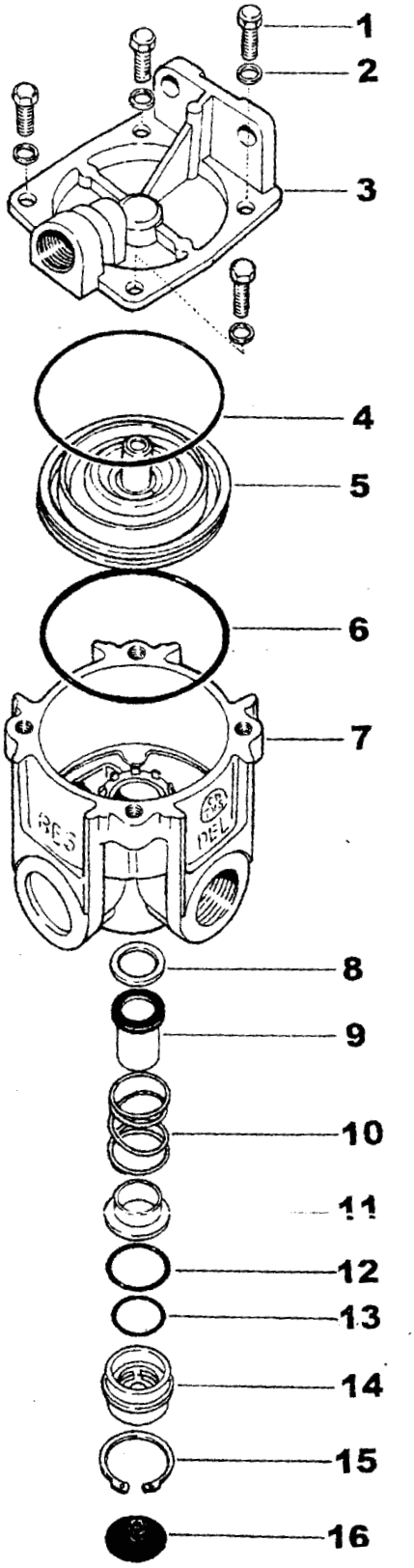
**Brakes 'ON'**

When the brake valve is operated, compressed air is passed through Service port on the top of the Relay piston. The piston moves downwards, closing the exhaust passage as the exhaust seat comes into contact with Inlet / Exhaust valve and subsequently opening the inlet passage by moving the spring loaded Inlet / Exhaust valve away from its seat. The compressed air in the Inlet chamber is now delivered to the brake chambers and applies the brakes.

**Balancing**

Air pressure in brakes applied condition built in the brake chamber line, acts in the bottom side of the Relay piston, thus moving the piston upwards and allowing the inlet / exhaust valve to contact inlet valve seat in the body. In this position the Inlet / Exhaust valve seats are closed: thereby preventing further air supply to the delivery. In this position, air pressure acting below the piston is approximately equal to the pressure acting on the piston. This is the balancing position of the valve.






1. Hex screw (M6 x 1)
2. Spring washer
3. Top cover
4. Sealing ring
5. Piston
6. Sealing ring
7. Body
8. Valve guide
9. Valve
10. Valve spring
11. Spring retainer
12. Sealing ring
13. Sealing ring
14. 'O' ring retainer
15. Internal circlip
16. Exhaust flap

*Fig. 40.2 :* Relay Valve (RG2)

In the balanced position by increasing the air pressure in the service port, once again the inlet / exhaust valve is pushed downwards opening the inlet valve seat and increased pressure in the delivery is achieved. When the pressure in the delivery line equals to the service port pressure again the relay piston moves upwards closing the Inlet passage and prevents further build up in air pressure in delivery line.

In the balanced position by reducing air pressure in the service port, the relay piston is pushed upwards opening the exhaust passage and dropping the pressure in the delivery line. When the pressure in the delivery line equals to the service port pressure again the relay piston moves downwards closing the exhaust passage and prevents further drop in air pressure in delivery line.

**Brakes Release**

When the brake treadle is released completely, air from the service port is exhausted to atmosphere through the brake valve. Air pressure acting below the relay piston pushes the piston upwards, thereby opening the delivery passage to atmosphere: thus exhausting air from the delivery line to atmosphere releasing the brakes.

**Service Check**

**(a) Operating test**

- Charge the system to unloader valve cutout pressure.
- Apply and release the brakes several times and check for free/smooth movement of brake chamber push rod.

**(b) Leakage Test**

- Charge the system to unloader valve cutout pressure and stop the engine.
- Check for air leak on top cover joint, pipe adaptors and exhaust diaphragm by applying the soap solution. Air leak of a 25 mm soap bubble in not less than five seconds is permissible at pipe plugs or fittings and the exhaust.
- Apply the appropriate control valve and recheck for air leakage in the valve. Air leakage more than a 25 mm soap bubble in three seconds is not permissible.

**REMOVING**

1. Block the wheels to prevent the movement of the vehicle during working.
2. Drain the Reservoirs completely.
3. Brush away dirt / dust from the pipelines and the valve.
4. If the tractor is coupled with the trailer, close the shutoff cock fitted on the trailer Reservoir.
5. Disconnect the airlines and close the open ends of pipes to prevent dirt / dust entry.
6. Loosen the running nuts of the pipes and remove the valve from the mounting.

**Replacing**

1. Position the valve on the mounting bracket and secure tightly by the mounting screws with bolts.
2. Connect the pipelines and ensure adequate tightening of running nuts.
3. Open the shutoff cocks and carry out the 'Operating / Leakage tests as given under 'Service Check'.

**Dismantling**

1. Mark the position of top cover with the body to ensure correct positioning during reassembly.
2. Remove the filter from the inlet.
3. Unscrew and remove the 4 screws with spring washers and remove the top cover and relay piston assembly.
4. Remove the sealing ring from the body and the relay piston.
5. Loosen and remove the 2 screws securing the base cover and the body.
6. Remove the valve and guide assembly from the body.
7. Remove the snap ring from the valve stem and slide the valve guide, spring and the valve retainer.
8. Remove the sealing rings from the valve guide.
9. Loosen the self-tapping screw and remove the diaphragm and the exhaust cover from the base cover assembly.
10. Scrap all the old parts, which are serviced in the Repair kit.

**Cleaning And Inspection**

- Clean all the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.
- Check top cover, valve body, base cover and relay piston for excessive wear, nick / score marks, cracks and damages.
- Check the spring for distortion, corrosion and permanent set.
- Scrap all the old parts found to be unserviceable.

**Reassembly**

- Use recommended Repair kit to replace the old parts scrapped during dismantling and also the parts found to unserviceable during inspection by new ones.
- Lubricate all the sliding parts and its mating components with Bharat MP2 grease, which is supplied in the Repair kit.
- Install the sealing rings on valve body, Relay piston and valve guide.
- Base Cover assembly:

  Assemble the diaphragm with Exhaust cover on the base cover and secure tightly by self-tapping screw.
- Relay piston assembly:

  If a new exhaust valve seat has to be fitted onto the Relay piston, smear the threads with 'Loctite 242' or its equivalent and secure the valve seat tightly with relay piston.
- Insert the Relay piston assembly into the top cover.
- Locate the identification marks made during dismantling and fit the top cover on the valve body and securing tightly by 4 nos. in each of bolts and spring washers.
- Valve assembly :

  Slide the valve retainer, spring and valve guide on the valve stem and secure by the snap ring. Ensure that the snap ring is located into the valve stem groove properly.
- Insert the valve assembly into the valve body from the bottom side and simultaneously ensure proper seating of the outer sealing ring of the valve guide in its place in the valve body.
- Locate the base cover assembly in its position on the valve body in the bottom side and secure the base cover with the valve body by 2 nos. of screws and spring washers.
- Fit the Filter in the inlet and ensure proper seating into the valve body.

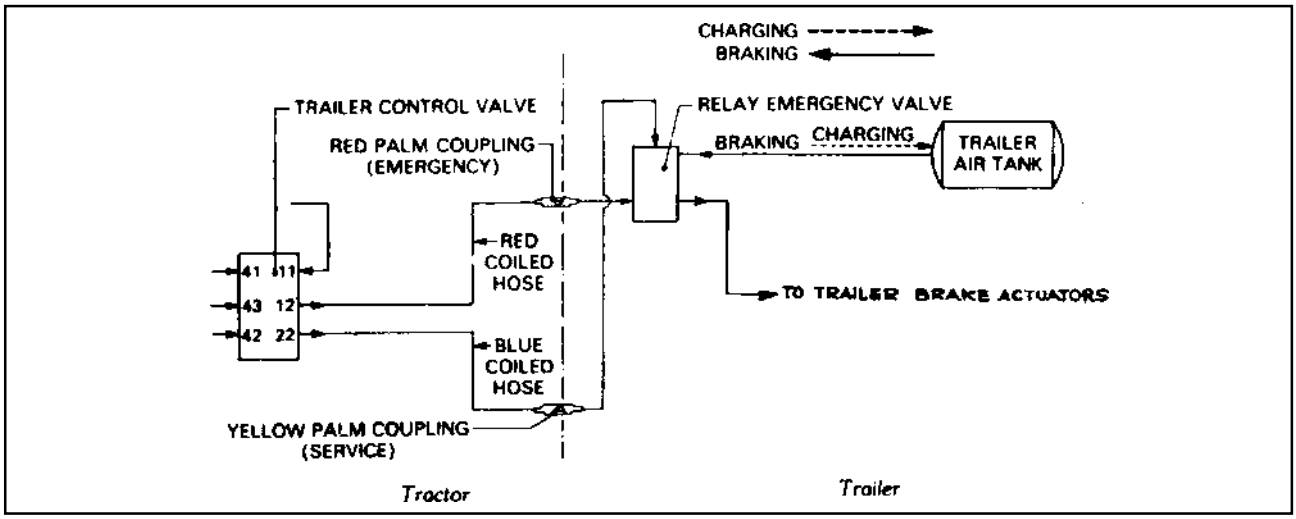



*Fig. 41 : Trailer Brake circuit*

## 9 'S' CAM FULL AIR BRAKE SYSTEM FOR TRACTOR TRAILER VALVE

The tractor brake circuits consisting of various pneumatic components are shown in fig 1 E & 1F. Tractor trailer brake circuit is shown in fig 41. Trailer control valve & relay valve are used in the tractor trailer brake circuit.

The trailer brake components include a relay emergency valve, an air tank, and brake actuators to operate the brakes, and palm couplings to be connected to emergency and service lines of the tractor.

The tractor brake system is coupled to the trailer brake system through the service and emergency palm couplings fitted at the end of the coiled hoses.

Service line is identified by a blue hose and palm coupling with yellow dot and emergency line by red hose and palm coupling with red dot. Separate shut off cocks are provided to seal the air pressure when the palm coupling are disconnected. When the trailer is to be coupled to tractor, care is to taken to see that the palm couplings of the tractor are connected to the corresponding palm couplings of the trailer.

The trailer control valve on the tractor actuates the trailer brakes when either the service or hand brake of the tractor is applied.

The trailer control valve has six ports as shown in the sketch. The port 11 is connected to the system protection valve and is for filling up the trailer air tank through the emergency line taken from port 12. The other inlet ports 41 and 42 are connected to the two outlets of the dual treadle valve and port 43 Trailer brake circuit is connected to the graduated hand brake valve. These inlets give signals to the trailer control valve to operate the relay emergency valve fitted on the trailer. When either the service brake or the hand brake of the tractor is applied, two flexible hoses - one called the emergency line (in red colour) and the other called the service line (in blue colour) are connected to the outlet ports 12 and 22 respectively.

**Operation of Trailer Brakes**

i. Emergency line 12 (Red) is normally under full air pressure (between cut-in and cut-out) and feeds the trailer air tank through the relay emergency valve.

ii. Service line 22 (Blue) under atmospheric pressure when the tractor brakes (either service or hand brakes) are not applied.

***Caution***

*The emergency and service lines give only signals to the relay emergency valve and under no circumstances air required for operating the trailer brake actuators should be taken directly from the tractor air lines. A separate air tank must be provided on the semi-trailer itself for this purpose as it is only this tank that supplies air to the trailer brake actuators to operate the trailer brakes.*

*It is essential that the trailer should have an independent hand brake actuated manually. When the trailer is to be decoupled and parked (for a long time, this independent hand brake should be applied. This is to ensure that even when air in the trailer air tank is leaked out for any reasons, additional braking is available for safe parking.*

### 9.1 TRAILER CONTROL VALVE

**Function**

This valve controls twin line brake system on a trailer from the towing vehicle fitted with Dual Brake System and the Hand brake valve for Spring brake actuators.

In addition, this valve also helps to apply the brakes automatically in the trailer when service brakes are applied on the tractor by exhausting the supply line (12) in the event of failure in the service line (22).

**Description**

Trailer control valve mainly consists of a Direction control valve and a trailer control valve.

Direction control valve has a valve body housing a piston assembly in the top bore with a spring and cover and secured in position by a circlip. This valve has an inlet, a passage for connecting the inlet to the trailer control valve and two more passages in which one to chamber connecting to service line (22) and the other to chamber connecting to Primary delivery line (41). This valve is secured onto the middle body of the trailer control valve.

Trailer control valve has a Upper body, a middle body and a Lower body.

Between the upper and the middle body a relay piston assembly with a return spring is located. The relay piston assembly has another piston with a spring, a spring guide and an adjusting screw in the bore and secured by a circlip.

In the middle body top bore and below relay piston assembly an emergency plunger assembly is located. The emergency plunger assembly has a spring loaded valve and a piston located in the bottom side and secured in position by a circlip. A diaphragm with upper and lower follower is located on the other side of the piston and secured by a flat hexagon nut. The outer lip of the diaphragm is located between the middle and the lower body. The free end of the piston is guided in the bore of the lower body and an exhaust check arrangement is secured to the lower body.

The upper body has a port (41) connecting to primary delivery line from Dual brake valve and a passage connecting to Direction control valve.

The middle body has a passage connecting to the inlet (1) from Direction control valve, supply port (12) and Service port (22) connecting to trailer, port (43) connecting to the delivery line of Graduated hand control valve and a passage connecting to Direction control valve.

The lower body has a port (42) connecting to the secondary delivery line from Dual brake valve.

**Operation**

**Charging (air supply to trailer & brakes off position)**

- When the braking system is charged, the air supply enters through port 11 of the Direction control valve and acts at bottom of the piston pushing it to the upper stop against the spring force.
- The air supply goes to the supply line through the chamber connecting to port 12.
- If the tractor is coupled to the trailer, the trailer Reservoir is getting charged through the Relay emergency valve fitted on the trailer.
- In this process, air pressure acting below the emergency plunger moves it along with the valve upwards and the valve comes into contact with the piston closing the exhaust passage and subsequently opening the inlet passage, allowing the air supply to service line through the chamber connecting to port 22. This leads to brake application in the trailer.

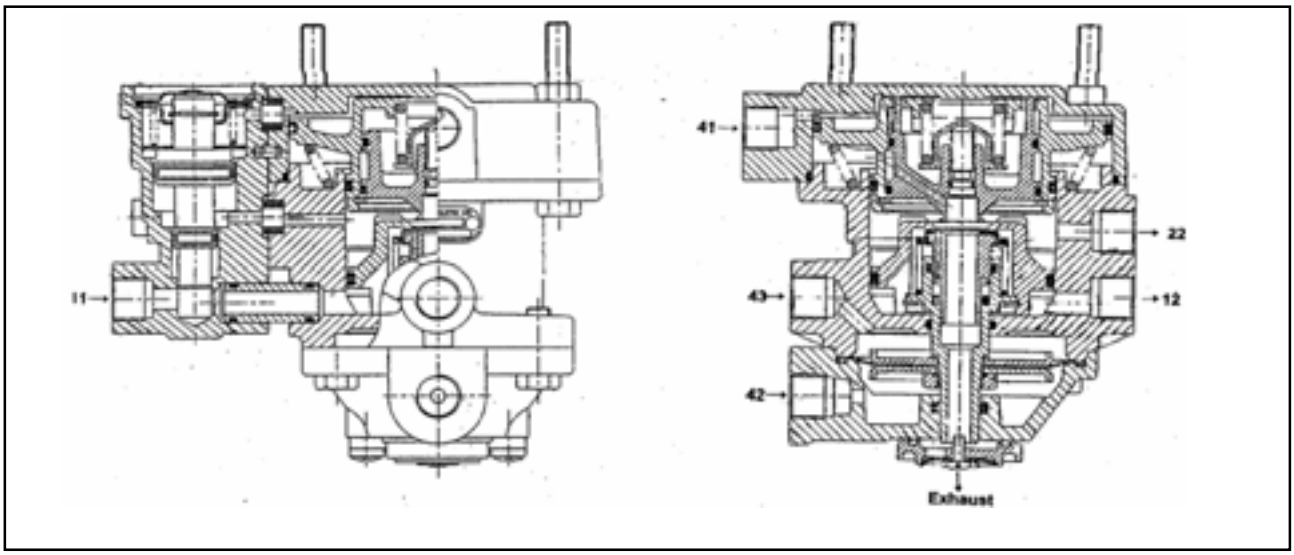
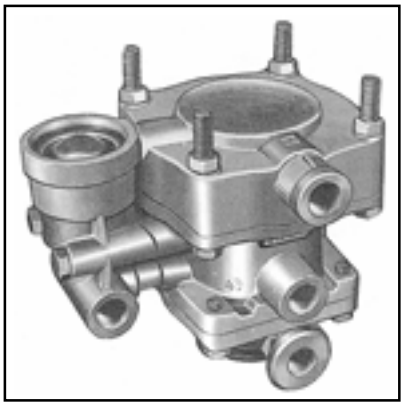



*Fig. 43 : Sectional View of Trailer Brake circuit*

**Trailer Control Valve**



1 Body - middle part
2 Sealing ring
3 Spacer
4 Sealing ring
5 Spring dowel sleeve
6 Hexagon head screw
Direction control valve
7 Body
8 Sealing ring
9 Sealing ring
10 Piston
11 Washer
12 Compression spring
13 Cap
14 Retaining ring
15 Sealing ring
16 Cover
17 Internal circlip
18 Conical spring
19 Sealing ring
20 Piston
21 Retaining ring
22 Sealing ring
23 Compression spring
24 Spring guide
25 Valve
26 Piston
27 Sealing ring
28 Retaining ring
29 Sealing ring
30 Piston
31 Adjusting screw assembly
32 Sealing ring
33 Spring guide
34 Compression spring
35 Piston
36 Sealing ring
37 Sealing ring
38 Body-upper part
39 Hexagon nut
40 Hexagon head screw
41 Sealing washer
42 Retaining plate
43 Diaphragm
44 Sealing ring
45 Flat hex. nut
46 Body - lower part
47 Hex. head screw
48 Sealing ring
Venting guide assy.
49 Venting guide
50 Washer
51 Cap
52 Self tapping screw
53 Fillister head screw

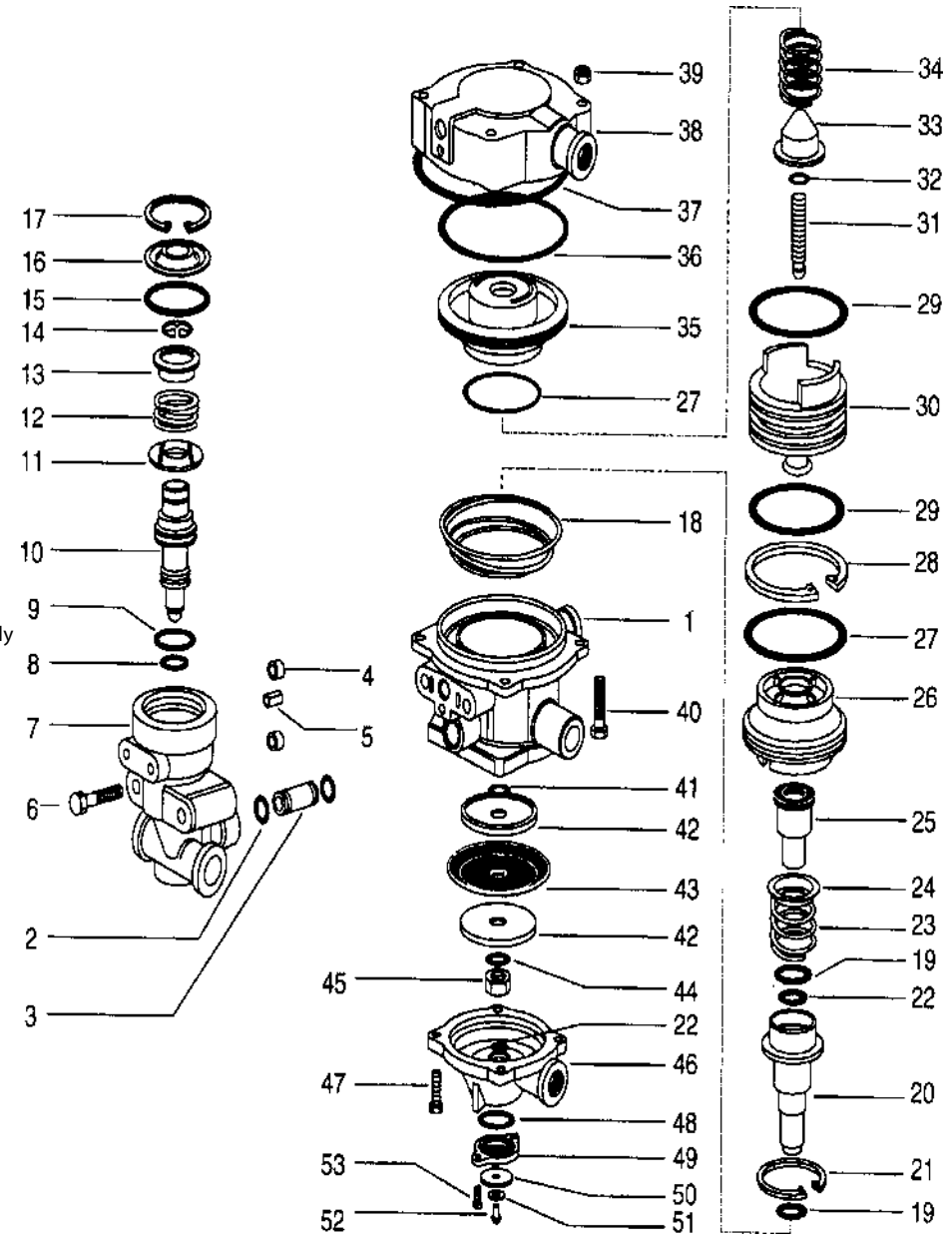



*Fig.42*

The brakes are applied both in tractor and trailer as long as the Graduated hand control valve is in "BRAKES ON" position

- When the hand brake is released ( i.e. Graduated hand control valve in "BRAKES OFF" position ) air is supplied to chamber through port 43.
- Air pressure in the chamber acting on the upper side of the diaphragm pushes the piston downwards along with the emergency plunger. This leads to closing of inlet passage and subsequent opening of exhaust passage allowing the exhaust of air from the service line connecting port 22 ; thereby releasing the brakes in the trailer.
- At the same time, the spring brakes in the tractor are also getting released by air supply through Graduated hand control valve.

**Brakes On Position (Brakes Applied)**

When the Dual brake valve on the tractor is operated, air from the primary delivery enters port 41 and the secondary delivery port 42.

- **Primary**

1. Chambers connecting to port 41 are charged and the air pressure acts on the relay piston (36), piston (30) and piston (10).
2. Pistons ( 30 & 36) move downwards together.
3. When the piston (30) contacts the valve (25) , it closes the exhaust passage and subsequently opens the inlet.
4. Air from the chamber connecting to port 12 then flows into the trailer service line through chamber connecting to port 22.
5. Brakes fully applied

5.1 In brakes fully applied condition, air pressure in the delivery line of Dual brake valve primary connecting to port 41 acting above the piston (36) predominates and inlet remains open.

6. Brakes partially applied ( Predominance )

6.1 In brakes partially applied condition, air pressure in the chamber connecting to port 22 depends on the pressure acting on the relay piston (36) and the preload of the spring (35).

6.2 The preload of the spring (35) can be adjusted by the screw (32).

6.3 The preload of the spring is set to ensure that the outlet pressure in port 22 is higher by 0.5 ? 0.2 bar as compared to pressure at port 41.

6.4 The operation sequence from 1 to 4 continues and the air pressure acting below the relay piston (36) and piston (30) in chamber connecting to port 22 when exceeds 0.5 ? 0.2 bar as compared to the pressure in chamber connecting to port 41, the piston (30) alone moves upwards overcoming the preload of spring (35) and closes the inlet preventing further charging of chamber connecting to port 22.

This is the predominance position.

- **Secondary**

1. At the same time as air enters port 41, air from secondary delivery of Dual brake valve also enters chamber connecting to port 42 and acts below diaphragm (44).
2. However, the pressure in chambers connecting to port 22 and port 43 acting above the emergency piston (26) and diaphragm (44) respectively is greater and the position of the piston is unaltered.
3. If brakes are partially applied, the pressure that builds in chamber connecting to port 22 again forces emergency piston (26) downwards. Thus the inlet passage closes and a balanced condition is reached.

**Brakes released position**

- In brakes released position, air from Chambers connecting to port 41 and port 42 is depleted through Dual brake valve.
- Simultaneously, air in chamber connecting to port 22 acting on the bottom of the relay piston (36) and piston (30) moves together up and air in chamber connecting to port 43 also acting on the diaphragm (44) pushes the emergency piston assembly downwards.
- This leads to opening of exhaust passage and exhausting the air from chamber connecting to port 22 ; thus automatically releases the brakes in the trailer.

**Hand brake application**

- When the Graduated hand control valve is in "BRAKES ON" position, air from the chamber connecting to port 43 and also hand brake line of Spring brake actuators is depleted through Graduated hand control valve.
- Automatically the relay piston assembly is pushed up by the air pressure in chamber connecting to port 12 and intern the valve (25) gets into contact with piston (30) closing the exhaust passage and subsequently opening the inlet passage, allowing the flow of air into chamber connecting to port 22. ( i.e. air is supplied to service line of the trailer)

- This leads to automatic emergency brake application in the trailer.

The brakes are applied both in tractor and trailer as long as the Graduated hand control valve is in "BRAKES ON" position

**Primary Failed**

- When brake is applied on the tractor, air is supplied to port 42 and its chamber.
- Air pressure in the chamber acts below the diaphragm (44) and pushes the emergency piston assembly upwards; thereby the valve (25) comes into contact with piston (30) closing the exhaust passage and subsequently opening the inlet passage allowing air supply into chamber connecting to port 22.(i.e. into the service line of the trailer )
- This leads to brake application in the trailer.

  If the primary of the Dual brake valve fails, operation of the valve is controlled by air from secondary. In this case, the operation of the valve is without predominance.

**Secondary failed**

- When the brake is applied on the tractor, air is supplied to port 41 and its chamber.
- Air pressure in chamber acts on relay piston (36) and piston (30) pushes the pistons together downwards, thereby the piston (30) comes into contact with the valve (25) closing the exhaust passage and subsequently opening the inlet passage, allowing air supply into chamber connecting to port 22. (i.e. into the service line of the trailer )
- This leads to brake application in the trailer.

If the secondary of the Dual brake valve fails, operation of the valve is controlled by air from primary. In this case, the operation of the valve is with predominance.

**Service line of trailer failed**

- In a running vehicle if the service line of trailer breaks from port 22, no air pressure builds up in chamber connecting to port 22 when the service brake on the tractor is applied.
- The piston (10) is then pushed downwards by the air pressure in
- chamber connecting to port 41 and the flow of air supply from port 11 to port 12 is metered (reduced) by reducing the flow passage from 8 mm dia to 2 mm dia. This is the Dumping operation.
- At the same time, air pressure in the chamber connecting to port 41 pushes the relay piston (36) and piston (30) together downwards and simultaneously pressure in chamber connecting to port 42 acting on the bottom of the diaphragm (44) pushes the emergency piston assembly upwards.
- Thus the valve (25) comes into contact with piston (30) closing the exhaust passage and subsequently opening the inlet passage.
- This helps to deplete air from chamber connecting to port 12 and the supply line of trailer through the point at which the service line failed, resulting in automatic emergency brake application in the trailer.

The pressure in the supply line of the trailer ( port12 ) comes down to 1.5 bar in less than 2 seconds.

**Service Check**

**a) Operating Test**

- Connect the trailer and charge the system fully. Keep the hand brake valve in 'BRAKES ON' position and check for brake application in tractor and trailer.
- Release the hand brake by shifting the lever to ' BRAKES OFF' position and check for complete release of brakes both in tractor and trailer.
- Apply the service brakes on the tractor fully and check for brake application on the tractor and the trailer.
- Apply the service brakes on the tractor partially and check for the delivery pressure in port 22 and pressure at port 41 by connecting gauges. The pressure at port 22 should be higher by 0.5 ? 0.2 bar as compared to pressure at port 41.
- Deplete secondary reservoir in the tractor and apply the service brakes and check for brake application on rear axle of the tractor and on the trailer.
- Charge the system fully and deplete primary reservoir in the tractor and apply the service brakes and check for brake application on front axle of the tractor and on the trailer.
- Charge the system fully keeping the hand brake valve in 'BRAKES ON' position. Gradually shift the lever to 'BRAKES OFF' position and with gauges in port 43 & port 22. Pressure in port 22 will start dropping gradually as pressure in port 43 increases above 0.5 bar onwards.
- Charge the system fully keeping the hand brake knob in 'BRAKES OFF' position. Gradually shift the lever to 'BRAKES ON' position and with gauges in port 43 & port 22. Pressure in port 22 will start increasing gradually as pressure in port 43 drops below 6.6 bar.

Prior to the above two tests, charge the system fully and keep the hand brake knob in 'BRAKES OFF' position with gauges connected to inlet and delivery. Inlet and delivery gauge pressure should be the same. If required overhaul the unit to achieve.

- Connect gauges in supply line of trailer connecting to port 12 and port 11. Charge the system fully and disconnect port 22. Apply the service brakes on the tractor and note that the pressure in supply line of the trailer connecting to port 12 comes down to 1.5 bar in less than 2 seconds. Simultaneously check for automatic brake application on the trailer. In this process, the pressure differential between port 41 and port 22 when reaches 2.5 + 0.3/-0.5 bar, the Direction control valve throttle the flow passage reducing flow area and thereby air flow from port 11 to port 12 is minimised. In this condition, the pressure at port 11 is 5.5 bar.

**b) Leakage Test**

- Charge the system fully and ensure that the pipe lines and joints are free from air leakage. Keep the knob of the Graduated Hand Control valve in 'BRAKES OFF' position and proceed with the tests.
- Check for air leakage in exhaust passage and joints of the valve by applying soap solution. Air leakage of 25 mm soap bubble in 5 seconds is permissible.
- Apply the service brakes on the tractor fully. Check for air leakage in exhaust passage by applying soap solution. Air leakage of 25 mm soap bubble in 3 seconds is permissible.
- Graduated Hand Control Valve in 'BRAKES ON' position, check for air leak in the exhaust passage of Graduated Hand Control valve. If excessive air leakage is noticed, then disconnect port 43 and check for air leakage once again to ascertain the leak is due to Trailer control valve.

**Removing**

- Block the wheels to prevent movement of the vehicle during working.
- Brush away dirt / dust from the pipe lines and the assembly.
- Disconnect the pipes lines and close open ends to prevent dust / dirt entry. Identify the pipe connections.
- Loosen the mounting screws and remove the assembly from the mounting bracket.

**Replacing**

- Locate the assembly on its mounting bracket and secure tightly by mounting screws.
- Connect pipe lines to its respective ports as identified during removal.
- Build up air pressure in the system . Apply soap solution at pipe joints and end fittings and attend if required.
- Carryout the ' Operating / Leakage tests' as given under 'Service Check'.

**Dismantling**

1. Clean the exterior of the valve thoroughly.
2. Mark the position of bodies to facilitate reassembly.
3. Remove internal circlip (17) from the body (7).
4. Remove the cover (16) and sealing ring (15) from the body (7).
5. Remove retaining ring (14) from piston (10) and remove cap (13), compression spring (12) and washer (11) from piston (10).
6. Remove piston (10) from body (7).
7. Remove sealing rings (8 & 9) from piston (10).
8. Unscrew Hex head screws (6) and remove the body (7) from middle body (1).
9. Pull out the spacer (3) along with the sealing rings (2) from body (7) .
10. Remove sealing rings (4) from middle body (1).
11. Unscrew Hex nuts (40) and remove upper body (39) from middle body (1).
12. Remove conical spring (18) and sealing ring (38) from middle body (1).
13. Remove sealing ring (27) from piston (36) .
14. Unscrew adjusting screw (32) out from piston (30).
15. Remove sealing ring (33) from adjusting screw (32).
16. Remove retaining ring (28) ,piston (30) , spring guide (34), spring (35) from piston (36).
17. Remove sealing rings (29 & 31) from piston (30).
18. Remove piston (36) from upper body (39).
19. Remove sealing ring (37) from piston (36) .
20. Unscrew Hex head screws (49) and remove lower body (48) from middle body (1).
21. Remove sealing ring (47) from lower body (48) .
22. Unscrew flat hex nut (46) and remove sealing ring (45) from piston (20).
23. Remove retaining plate (43) , diaphragm (44) and sealing ring (42) from piston (20) .
24. Push out piston (20) from middle body and remove sealing ring (19) from middle body (1).
25. Remove the second sealing ring (27) from piston (26).
26. Remove retaining ring (21) and piston (20) from piston (26) .

27. Remove compression spring (23) , spring guide (24) and valve (25) from piston (26).
28. Loosen and remove the screws (55) securing venting guide assembly.
29. Loosen and remove the self tapping screw (54) from venting guide (51) and takeout the cap (53) and rubber washer (52)

**Cleaning And Inspection**

- Clean all the metallic parts in cleaning solvent and blow dry with compressed air. Ensure that no trace of solvent is present during reassembly.
- Thoroughly clean all the bodies and make sure that the air passages are free from blockage.
- Check for any crack / damage in the bodies, damage on port faces / thread, nick / score marks / damages on the valve seats, excessive wear / score marks / damage on the pistons.
- Check the springs for distortion, rust formation and permanent set .
- Scrap all old parts which are found to be unserviceable.

**Reassembly**

- Use recommended Repair kit to replace old parts scrapped during dismantling and also replace all parts which were found to be unserviceable parts during inspection.
- Smear grease (supplied in the repair kit) in the body bores, piston grooves. pistons and on the sealing rings.
- Assemble the sealing rings on the respective grooves of the pistons and bodies.
- Emergency piston assembly
- Locate the valve (25), spring guide (24), spring (23) and piston assembly (20) in piston (26) and secure by retaining ring (21) in the groove of the piston (26). Ensure that the retaining ring (21) is located in its groove properly.
- Insert the above piston assembly in the middle body (1) upper bore and the piston (20) comes out in the bottom of the middle body (1).
- Locate the top follower (43), diaphragm (44) and bottom follower (43) in the protruding end of piston (20) and secure by flat hexagon nut (46) alongwith sealing ring (45) and tighten to a torque of 7 to 10 Nm.
- Locate the piston (20) in the lower body (48) centre bore and check for proper orientation of lower body (48) with middle body (1) as identified during dismantling.
- Locate outer lip of the diaphragm (44) between lower body (48) and middle body (1).
- Secure both the bodies by 4 hexagon head screws and tighten to a torque of 15Nm.
- Place the rubber washer (52) and cap (53) on the bottom side of the venting guide (51) and secure tightly by self tapping screw (54).
- Locate the venting guide assembly in the bottom face of the lower body and secure by two fillister head screws and tighten to a torque of 4Nm.
- Relay piston assembly

a) Locate the spring (35) and spring guide (34) in the bottom side of the piston (36) and slide the piston (30) and secure by retaining ring (28) in the groove of the piston (36). Ensure that the retaining ring is located in its groove properly.

b) With sealing ring (33) on the adjusting screw (32) screw in the adjusting screw in the bottom bore of the piston (30) adequately so that the predominance of 0.5 ? 0.2 bar will be achieved during service check. During testing if the predominance set is found to be incorrect once again resetting needs to be done.

- Insert the above piston assembly in the upper body (39) bore.
- Locate the conical spring (18) on the middle body (1).
- Position the upper body (39) on middle body (1) by locating through the four hexagon head screw and check for proper orientation of upper and middle body. Secure both the bodies by four hexagon nuts and tighten to a torque of 15Nm.
- Direction control valve

c) Locate washer (11), compression spring (12) and cap (13) on the piston (10) and secure by retaining ring ( 14).Ensure that the retaining ring is located in the groove of the piston (10) properly.

d) Insert the above piston assembly in the bore of body (7) Locate the sealing ring (15) and cover (16) over the piston assembly and secure by internal circlip (17). Ensure that the circlip is located in its groove properly.

- Assemble the sealing rings (2) on the spacer (3).
- Locate spring dowel sleeve (5) and sealing ring (4) in upper body (39) .
- Locate the spacer (3) and sealing ring (4) in the middle body.
- Locate the above directional control valve in the corresponding location of spacer and sealing rings and secure by two hexagon head screws and tighten to a torque of 15Nm.

### 10. PUSH TO CONNECT FITTING FOR NYLON TUBES

**a) Function**

Its function is to connect nylon tube to the ports of the air brake system devices. It is assembled by pushing in the nylon tube and tube insert subassembly without any screwing or unscrewing.

**b) Construction and working:**

The above figure shows a typical valve port with push to connect fittings.

**c) Assembly and disassembly process**

The three phases of the process are given below

**d) Benefits**

Following are the advantages of push-to-connect fittings over the conventional adaptors for the nylon tubes.

1. Controlled sealing through 'O' ring
2. Dust sealing
3. Space saving
4. De-skilled no assembly tools required in assembly line.
5. Lesser assembly time.
6. Disassembly possible by unscrewing.

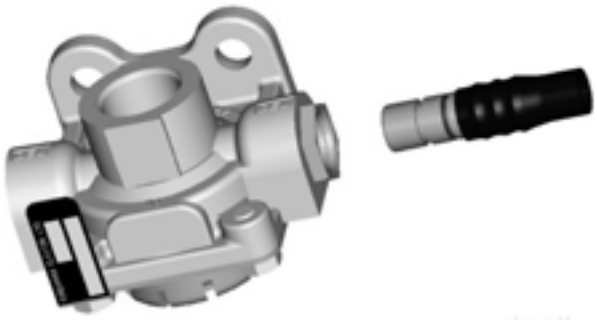


*Fig. 44 : Typical port with push to connect fitting*

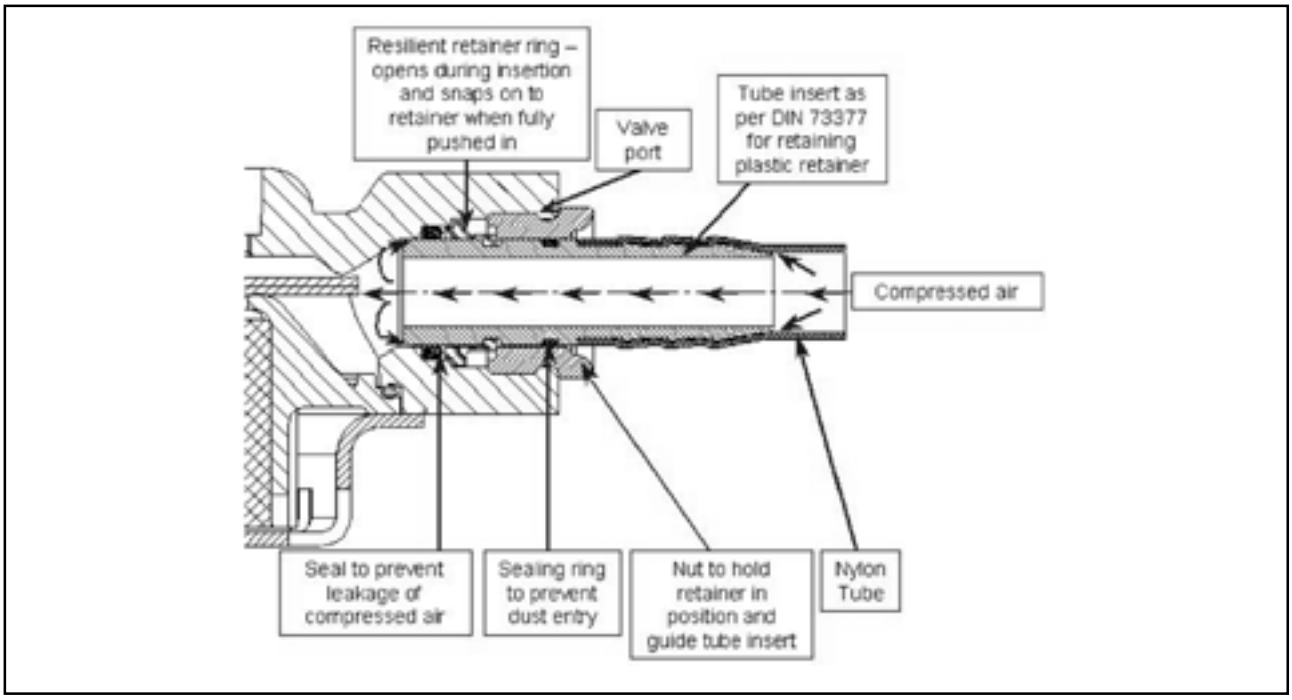
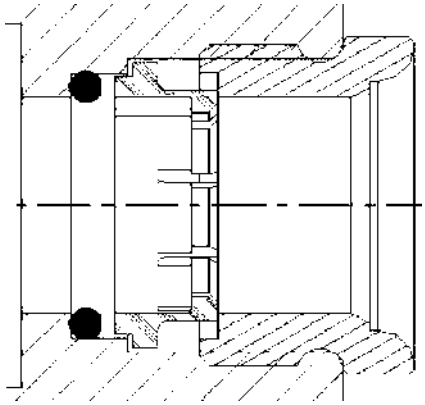
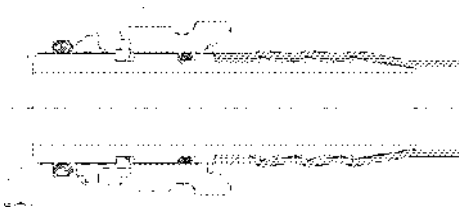
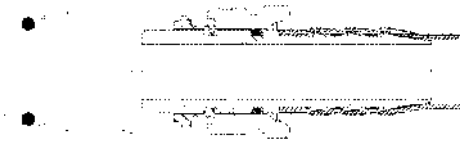



*Fig. 45 : Typical port with push to connect fitting*

| Phase | Figure | Description |
|---|---|---|
| **Preparation** |   | The two stages of the preparation phase are<br>1. Sub-assembly of the nylon tube, tube insert and the dust prevention sealing ring<br>2. Valve port sub-assembly with the sealing ring and retainer. The nut fastened to the port thread. |
| **Assembly** |  | The nylon tube sub-assembly is pushed into the valve port sub-assembly. The retainer expands, allows the tube insert to enter and snaps on to the groove in the tube insert. |
| **Disassembly** |  | To dismantle the joint, the nut has to be unscrewed. Then the retainer is expanded manually to release its grip from the tube insert groove. This makes it possible to remove the tube insert from the nut. |

**11. BRAKE SYSTEM ROUTINE CHECKS**

It is very essential that brake system is kept trim at all times and periodic checks are conducted so that vehicles with brake system defects are not run on road.

The following procedure is recommended for a general check once in 36000 Km or after each brake overhaul. For maintenance data, refer to specifications.

1. Place chocks on both front and rear wheels.
2. Remove drain plugs and exhaust all air tanks. If water is found in the air tanks, check whether purging cycle of air-dryer is occurring after every cut-out. If purging cycle is taking place after every cut-out, than the air-dryer cartridge needs to be replaced. If purging cycle is not taking place , overhaul the DDU / Air Dryer. Deplete air in spring brakes by applying, releasing hand brake valve. Keep hand brake in 'OFF' position.
3. Turn vehicle ignition to 'ON'. The low air pressure and hand brake indicators should operate immediately. The pressure gauges should read zero. If not, rectify.
4. Run the engine at full speed to charge the system. The air pressure in one of the service tanks (the circuit having slightly lesser opening pressure in the system protection valve) will rise at first to a certain limit. then other circuit will follow and both will rise together.
5. The low air pressure indicators should cease to operate at the specified value. If not, rectify.
6. Continue to charge the system till 'cut-out' pressure. The unloader valve should cut out (identified by a hissing noise).
7. Stop engine. The time taken from zero to cut out pressure should not exceed specified pump up time. If it takes more, check for leakages in brake system and rectify. Also open compressor head, check for defects and rectify.
8. After pressure in the system stabilizes, the drop in air pressure (due to leakage if any) with brakes 'OFF' should not exceed specified value. Otherwise, rectify.
9. Make a few brake applications to bring down air pressure. when 'cut in' pressure is reached, the compressor charges the system again till 'cut out'. Put off the engine.
10. Apply hand brake/ Hand brake indicator and audio beeper signals come together. Release hand brake.There will be a small pressure drop in both the reservoirs. Now hand brake warning signals should be off.
11. Apply service brakes and check that rear tail lamps glow.
12. Take road test for

i) Efficient braking

ii) Absence of grabbing/pulling to one side

iii) Absence of brake squealing and rectify defects, if any.

iv) Check that hand brake and exhaust brake are also functioning properly.

13. Check for system protection valve (SPV)

A) Opening pressures

a) Fail one service brake circuit say rear circuit (port 21) by opening any pipe joint.

b) Drain the healthy reservoir (front) below 4 bar and charge air at max. engine speed.

c) Note max. pressure in the gauge of healthy circuit. this is the opening pressure of SPV port 21, connected to failed rear circuit.

d) Repeat (b) and (c) for other circuit (port 22).

e) With all circuits healthy, build up air pressure till cut out. Open connector at SPV port 23 to atmosphere. Pressure in the service tanks will fall to around 4 bar. Run engine at max. speed and note the stabilized gauge pressure (either front or rear gauge).

This is the opening pressure of SPV port 23.

f ) Repeat (e) for SPV port 24.

B) Closing pressures

a) With full pressure in the air tanks, slowly leak out any circuit, say rear (port 21) to zero. The pressure in the other circuit (port 22) falls to a certain value and stabilizes. This is the closing pressure of SPV port 22.

b) Repeat (a) for closing pressure of port 21.

c) For checking closing pressures of port 23, 24 pressure gauges should be connected in their circuits. Leak out air in either front (22) or rear tanks (21). Note down closing pressure of SPV port 23 and 24 after pressure gets stabilized.

d) Note down closing pressures of SPV port 21/22 with air leaked out to zero in hand brake circuit (port 23). These closing pressures will be different from those at (a) and (b).

e) Repeat (d) with air leaked out to zero in exhaust brake circuit (24).

14 CHECK FOR DUAL BRAKE VALVE (DBV)

a) With full pressure in air tanks, check for leakage from exhaust port of DBV with :

i) Brakes in released condition;

ii) Full braking.

b) Open the outlet pipes 21 and 22 and check for leakage in brake 'OFF' condition.

15 CHECK FOR BRAKES CHAMBERS & SPRING ACTUATION

a) With brakes applied at full pressure, check for leakages in front and rear brake chambers.

c) Check that "mechanical wind off" is functional in spring brake actuator.

d) Check for any hole elongation and wear on push rod fork and pin.

16 CHECK FOR SLACK ADJUSTERS

a) For manual slack adjuster, Check that slack adjusters stroke is between the specified limit and adjustment is possible without sticking.

b) Check for any hole elongation and wear in bushes.

c) For Automatic slack adjuster, check that the adjuster stroke at full brake application in static condition is within the specified limit.

d) Jack up all the wheels one by one and check for free rotation of wheels

e) Check that at least two mm of lining is left above the lining wear indicator groove visible from the hole provided for lining inspection in the dust cover.

17 CHECK FOR GRADUATED HAND BRAKE VALVE

a) Check leakage from exhaust port in brake 'ON' and 'OFF' condition.

b) Check lever for proper locking, in brakes 'ON' and 'OFF' conditions.

## 12. MAINTENANCE SCHEDULE

| Sr. No. | Operation | Frequency in km | Daily | Every 1000 km | 3000 -3500 | 9000-9500 | 18000-18500 | 27000-27500 | 36000-36500 | 54000-54500 | 54000 km | 63000-63500 | 72000-72500 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **BRAKES ( `S' CAM )** | | | | | | | | | | | | |
| 1. | Check for effective operation of brakes. | 9,000 | | | | ● | ● | ● | ● | ● | ● | ● | ● |
| 2. | Check for condensed water in air tanks. If water found, replace air dryer cartridge. | 18,000 | | | | | ● | | ● | | ● | | ● |
| 3. | Check and if necessary, tighten : (1) Mounting of air tanks, (2) Air line clamps. | 54,000 | | | | | | | | ● | | | |
| 4. | Check brake system for leaks and rectify, if necessary. | 9,000 | | O | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 5. | Check for proper functioning of engine exhaust brake, free movement of plunger of exhaust brake valve, mounting bolts for loosening and slackness in linkages. | 9,000 | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 6. | Check brake rubber hoses / air pipes for damages / leaks and replace if necessary. | 18,000 | | | T | | ● | | ● | | ● | | ● |
| 7. | Dismantle pneumatic aggregates of brake system, clean, inspect and replace parts if necessary. | 2,00,000km or 2 years whichever earlier | | | | | | | | | | | |
| 8. | Grease with grease gun - brake lever, and camshaft bushes (AAL). | 9,000 | | O | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 9. | Lubricate with oil can : brake chamber fork & pin, linkages of foot brake, ball joints of exhaust brake linkages - hand & foot brake linkages. | 18,000 | | | | ● | ● | ● | ● | ● | ● | ● | ● |
| 10. | For manual slack adjuster, check travel of brake chamber's push rod/brake lining wear and clearance with drum. Adjust service brakes, if necessary. Change lining when worn up to indicator slot. | | | | | | | | | | | | |
| | a. Long route operation. | 9,000 | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| | b. City/Hill/Cross country application. | 4,500 | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 11. | For automatic slack adjuster, check lining thickness. Change lining if worn up to 1 mm above indicator slot. | | | | | | | | | | | | |
| | a. Long route operation. | 9,000 | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| | b. City/Hill/Cross country application. | 4,500 | | | T | ● | ● | ● | ● | ● | ● | ● | ● |
| 12. | Overhaul the automatic slack adjuster | 3,00,000km or 3 years whichever earlier | | | | | | | | | | | |
| 13. | Check brake torque plate mounting bolts and tighten if necessary. | At every lining change | | | | | | | | | | | |
| 14. | Check condition of gaiter in different brake valves, exhaust flap in dual brake valve, exhaust check diaphragm in valve, nylon breather tube and inspect spring brake actuator for external damage. Replace if found damaged. | 36,000 | | | | | | | ● | | | | ● |
| 15. | Check mounting bolts of brake chambers, different valve mountings, air tank mounting, air cylinders mounting, master cylinders mountings, air line clamps hydraulic pipes & tighten if necessary. | 54,000 | | | | | | | | | ● | | |
| 16. | Conduct brake system routine checks | 36,000 | | | | | | | ● | | | | ● |
| 17. | Remove brake drums, inspect brake drums. Rectify defects if any. | At every lining change | | | | | | | | | | | |
| 18. | Grease fulcrum pin bushes and roller ends of S-Cam Brake. | At every lining change | | | | | | | | | | | |
| 19. | Overhaul foundation brakes. Remove brake drum. Inspect brake drums camshaft etc. Rectify defect, if any. | Every second brake shoe relining or as required | | | | | | | | | | | |
| 20. | Replace desiccant cartridge and filter of Air Dryer / DDU. | Every two years | | | | | | | | | | | |
| 21. | Check for excessive play of hand brake shaft in bushes. Replace bushes, if necessary. | 18.000 | | | | | ● | | ● | | ● | | ● |

## NOTES

# Tipper Hydraulic System 44

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## 1. INTRODUCTION

The hydraulic system consists of axial piston pump, manual control valve, two stage telescopic cylinders and hydraulic tank. The schematic arrangement is as shown. The axial piston pump is driven by the counter shaft of GBS-40 gearbox. The pump drive engagement is controlled by pneumatic cylinder. The hydraulic oil is continuously cleaned by return line filter housing in the tank.

The hydraulic system comprises of the hydraulic tank, axial piston pump driven off the counter shaft of gear box, manual control valve with an inbuilt pressure relief valve to control system pressure. A two stage telescopic cylinder and an oil filter on return line, housed in hydraulic tank, to ensure continuous cleanliness of oil. A schematic arrangement of the system is shown in Fig. 1B.

This manual gives details of hydraulic system on tippers fitted with two stage telescopic cylinder (double acting), in respect of operation, maintenance and over hauling procedures along with trouble shooting chart. The need of cleanliness in hydraulics cannot be over stressed. All disassembly, inspection and assembly work on hydraulic components should be carried out in absolutely clean surroundings. To avoid down time later, it is a good practice to replace all rubber components, and gaskets when once removed, even if no damage is visible to the naked eye. Apply little oil/grease to 'O' rings/seal when installing. Use special mandrels/tools for installing 'O' rings and seals.

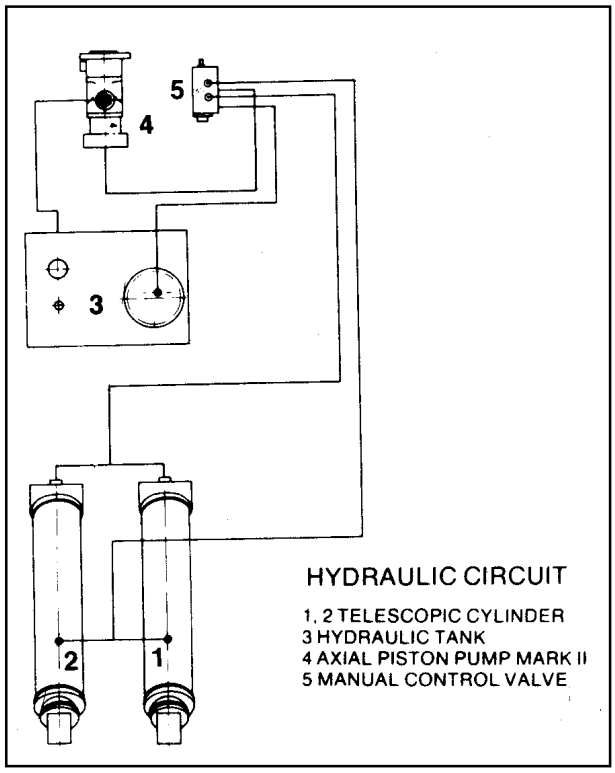



*Fig. 1A*

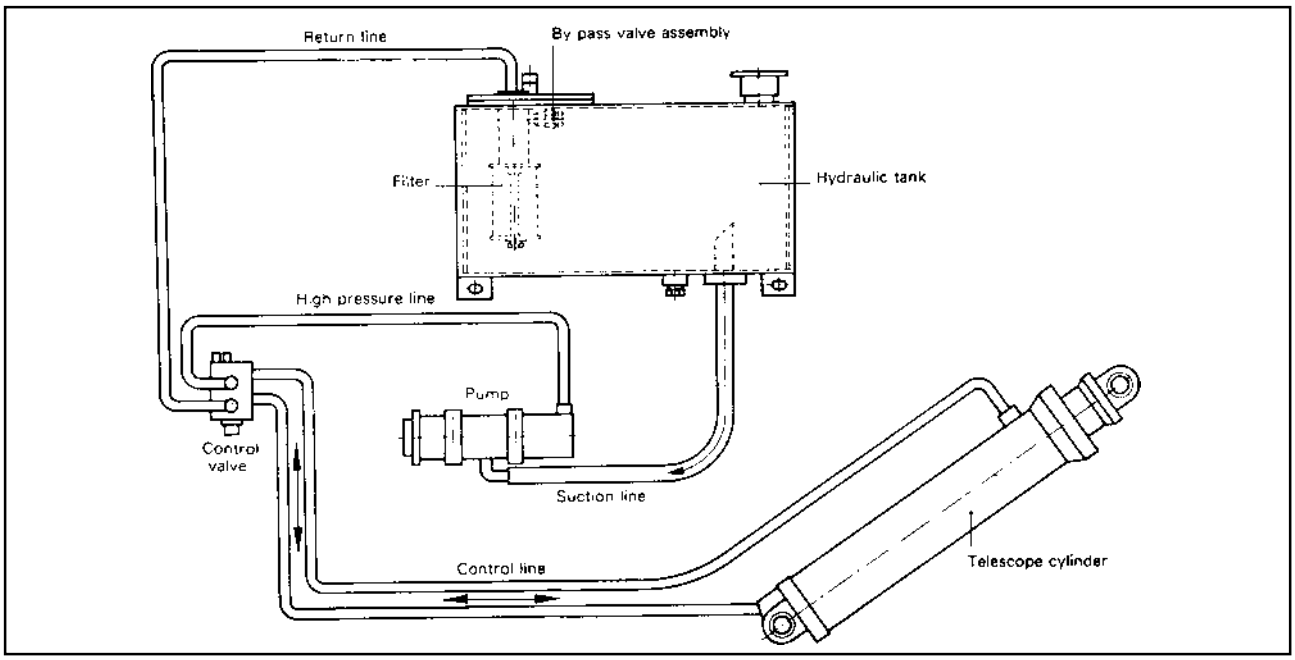



*Fig. 1B*

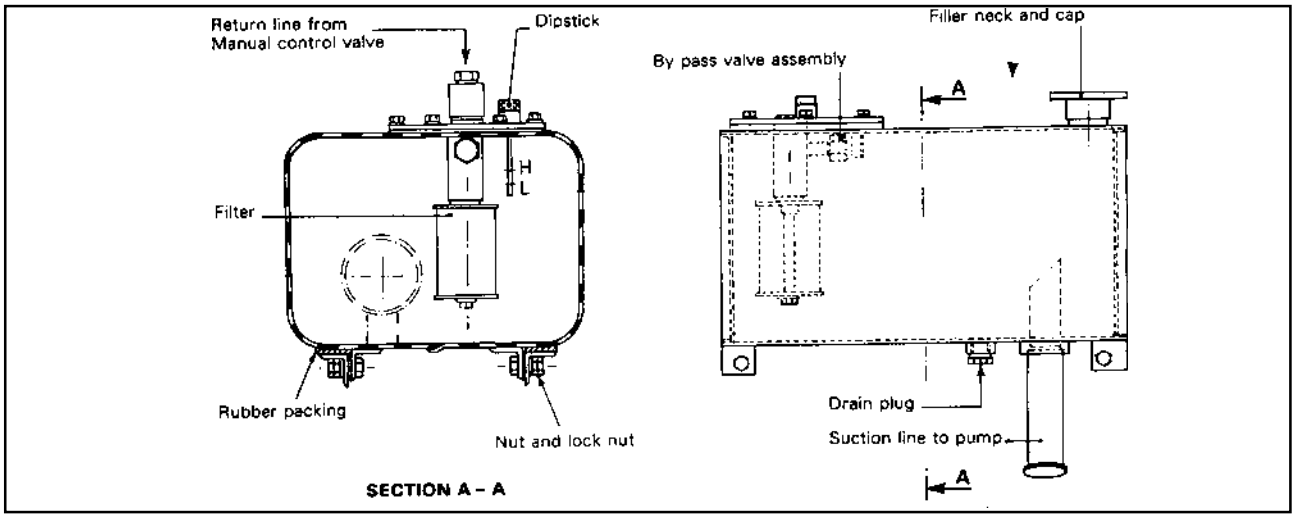



*Fig. 2*

**Operating instructions**

i. Park the vehicle on level ground.

ii. Apply hand brake.

iii. Disengage clutch and shift the pump engagement lever. Now engage the clutch.

iv. To tip the body.

Pull the control lever up and to position 'Dump' and hold in that position. Increase the engine speed to get required tipping speed. The load body will start rising (tipping).

Release the control valve lever, as soon as the body is fully raised (tipped). The lever will return to neutral position because of the centering spring.

If the control valve lever is held in position 'Dump' even after the body has fully tipped, the full system pressure will act on the components and reduce their life.

If it is desired, to hold the body fully or partially tipped for a longer period, the control valve should be released and pump disengaged.

***Caution :*** *As a safety measure use a prop underneath a raised body, when working under body*.

- To lower the body.

Shift the control valve lever down to lower position and hold in that position and proceed as follows :

Accelerate the engine, the body starts coming down. Release the control valve lever after the load body is fully lowered on the subframe. The control valve lever will return to neutral position of its own.

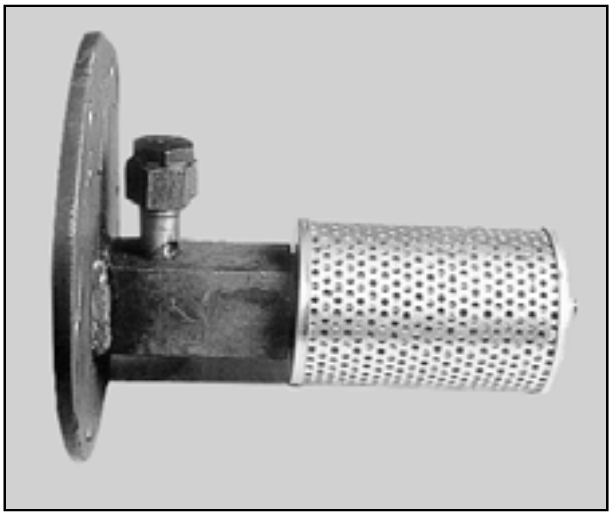


*Fig. 3*

**HYDRAULIC EQUIPMENT**

**Hydraulic tank**

The hydraulic oil tank is rectangular in shape and is mounted on the subframe, between long members behind driver's cab, for easy approach. To ensure continuous cleanliness of hydraulic oil a filter has been provided on return line and housed in the tank. The filter is mounted on cover. See Fig. 3. A bypass valve has been provided on the filter, which allows the oil to return to tank in case the filter cartridge gets clogged. See Fig. 2. A dipstick with breather hole in it has been provided to measure the oil level in tank. The oil capacity at 'H' marking is 55 litres and total system capacity is 70 litres. The opening which is normally closed by the cover carrying filter can be used for cleaning the tank from inside.

**Axial piston pump (Mark II)**

The axial piston pump is of swash plate design with six plungers, driven off the counter shaft of GBS-40 gear box. See Fig. 4. The rotary motion of swash plate results in reciprocatory motion of plungers. During the suction stroke the oil gets filled in the plunger bore through the plunger and poppet clearance. During delivery stroke, the oil under pressure lifts the check balls and flows through the drilled passages to the outlet port. The poppet seals the suction passages during delivery strokes.

**Manual control Valve MCV-90**

The following describes a valve which can control a double acting cylinder. Ref. Fig. 5A, 5B, 5C.

**Neutral Position**

The centering spring at the spool end holds the spool in neutral. The pump delivery is routed through port 'A' to the outlet port in this position. Port 'B' which is connected to the cylinder bottom port is blocked preventing the cylinder movement.

**Dump Position**

The pump delivery is directed to port 'B' when the spool is pulled out. Port 'A' is connected to tank, the cylinder extends, raising the body.

**Lower Position**

The pump delivery is connected to Port 'A' when the spool is pushed IN. Port 'B' is connected to the tank port. The cylinder retracts lowering the body.

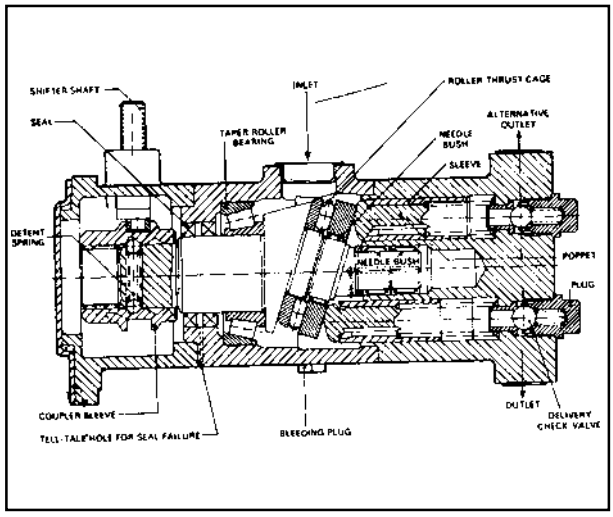



*Fig. 4*

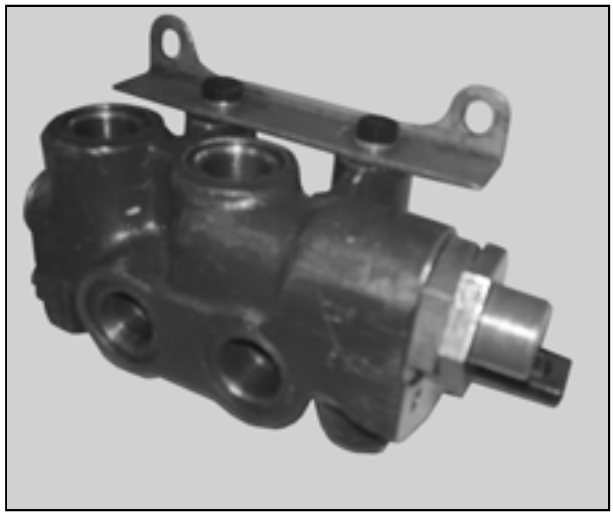


*Fig. 5A*

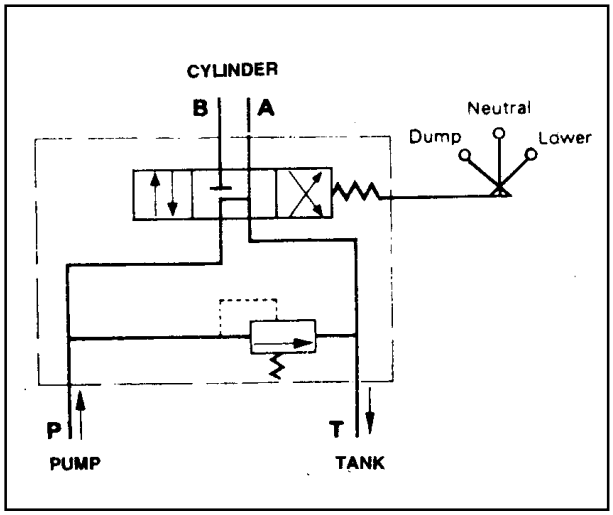



*Fig. 5C*

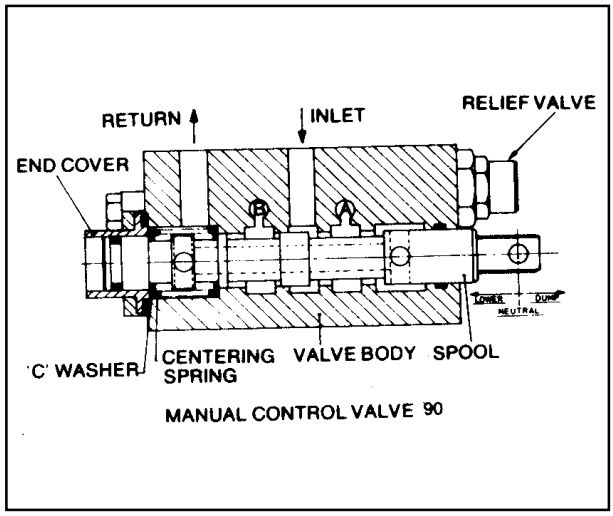



*Fig. 5B*

**Two stage telescopic cylinder** (Fig. 6 & 7)

The two stage telescopic cylinder is a inherently compact, making a more favourable mounting possible, and only one cylinder has therefore replaced the old twin ram arrangement. Self energizing type cup seals and 'O' rings, with teflon back up washers has been used. Piston seals are of pure elastomeric material, but rings are reinforced with fabric. Wiper seals has been provided to prevent ingress of dust. Piston rods are hard chrome plated, ground and polished for long trouble free operation.

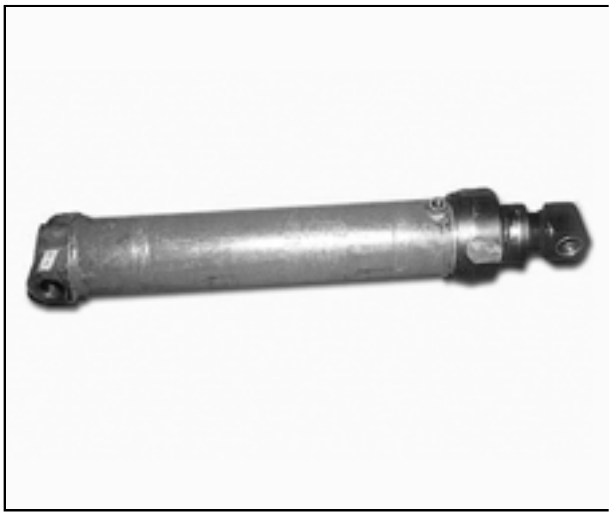


*Fig. 6*

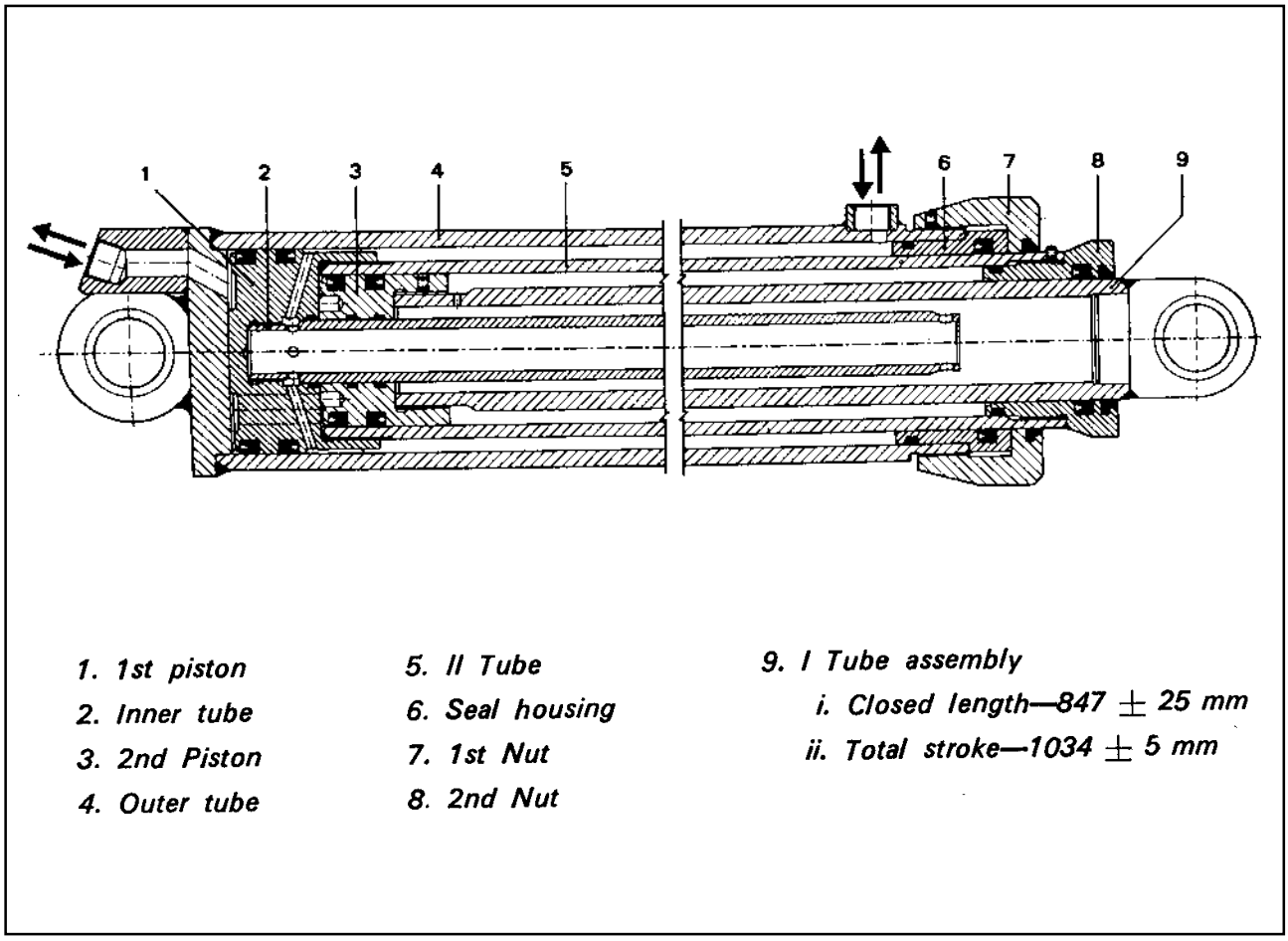



*Fig. 7*

## 2. TECHNICAL SPECIFICATIONS

**Axial piston pump MK - II**

| | | |
|---|---|---|
| Mounting - Suitable for direct mounting on GBS-40 gearbox | | |
| Maximum intermittent pressure rating | | 180 kg/cm$^2$ |
| Maximum permissible suction pressure | | 13 cm of Hg. |
| Maximum speed | | 1400 rpm |
| Weight | | 16 kg |
| Maximum permissible temperature | | $60^0$ C |
| Output at 180 kg/cm$^2$ pressure | | 55 lpm at 1400 rpm<br>(At suction Pressure of 5 cm of Hg.) |

**Manual control valve**

| | | |
|---|---|---|
| Manually operated, double acting, single spool, direction control valve | | |
| Model | | MCV 90 |
| Maximum operating pressure | | 180 kg/cm$^2$ |
| Pressure setting | | 180 kg/cm$^2$ |
| Spool travel | | 8 mm on either side from neutral |
| Port connection | | M22 x 1.5 (all ports) |
| Rated flow | | 90 lpm |

**Hydraulic tank**

| | | |
|---|---|---|
| Tank capacity | | 55 litres |
| Hydraulic system capacity | | 70 litres |

**Telescopic cylinder**

| | | |
|---|---|---|
| Two stage double acting telescopic cylinder | | 2 number |
| First stage piston diameter | | 120.8 mm |
| Second stage piston diameter | | 89 mm |
| Stroke | First stage | 513 mm |
| | Second stage | 521 mm |
| Total stroke | | $1034^{+5}_{+3}$ mm |
| Closed position (eye to eye end distance) | | 847 $\pm$ 2.5 mm |
| Maximum working pressure | | 180 kg/cm$^2$ |

**SPECIAL TOOLS**

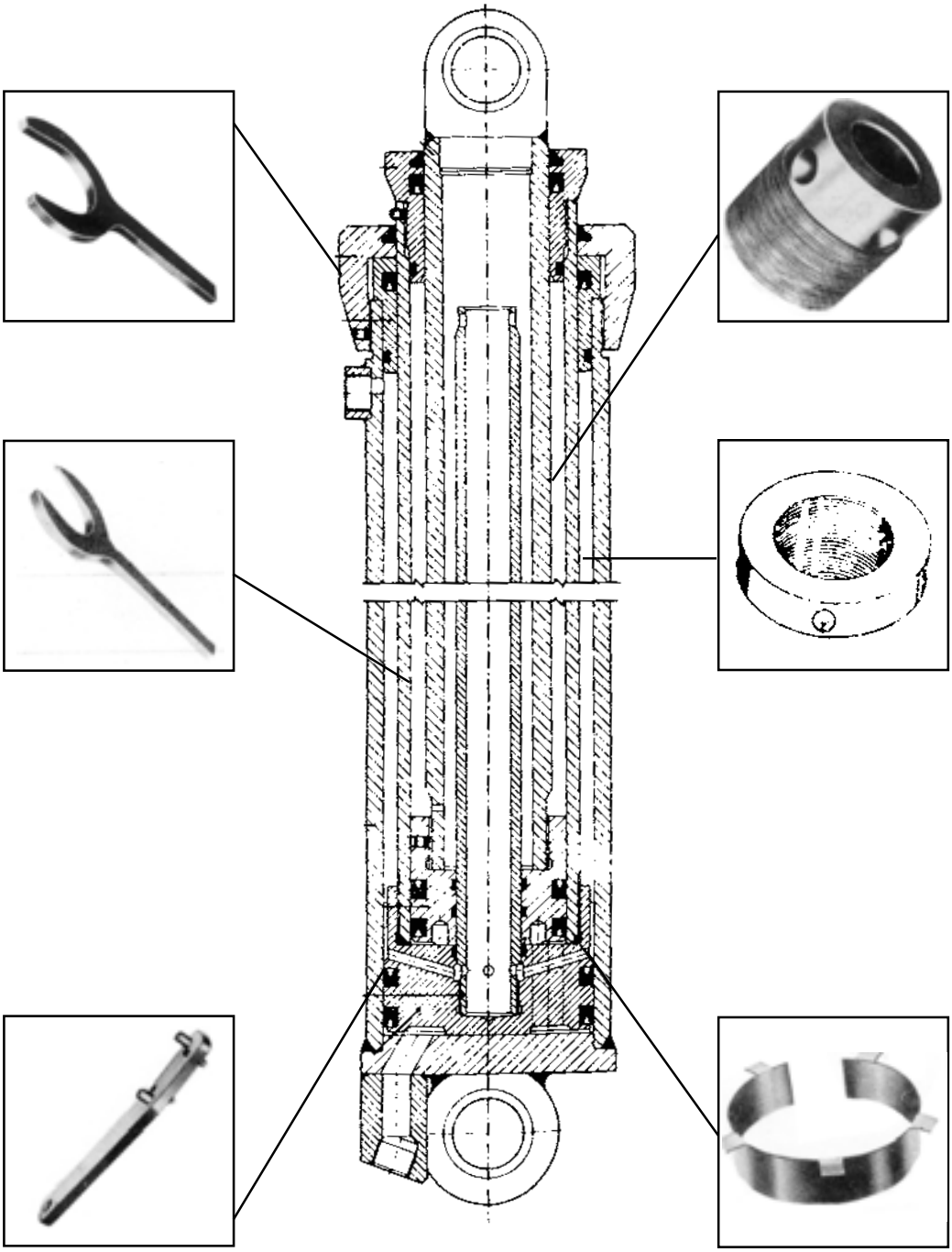


*Fig.8*

## 3. LIST OF SPECIAL TOOLS

| Sr. No. | Description | Part No. |
|---|---|---|
| 1. | Spanner 104 A/F | 2510 5890 01 03 |
| 2. | Holding device (tube 2nd stage) for piston assembly | 2510 5890 79 01 |
| 3. | Locking tool for 2nd stage | 2510 5890 79 02 |
| 4. | Tool for 2nd stage piston seal | 2510 5890 82 01 |
| 5. | Spanner for piston 1st and 2nd stage | 2510 5890 01 01 |
| 6. | Spanner 157 AF | 2510 5890 01 02 |

**4. REMOVAL FROM VEHICLE**

**i. AXIAL PISTON PUMP MK- II**

1 Drain tank. Remove suction and delivery hose connections from the pump and cap them.

2 Disconnect the pneumatic line from pump engagement cylinder.

3 Drain the gearbox oil in a clean container.

4 Cap the ports of the pump. Remove the mounting bolts holding the pump to the gearbox. Pull out the pump assembly along with pump engagement cylinder.

5 Clean the outside of the pump.

**ii. MANUAL CONTROL VALVE**

1 Drain tank.

2 Remove the four hydraulic pipe connections to the control valve.

3 Disconnect the control valve operating linkage.

4 Take out the control valve mounting bolts and remove the control valve.

5 Cap the ports and clean the outside surface.

**iii. TELESCOPIC CYLINDERS**

1 Lift the body and provide suitable props underneath to facilitate the filling of oil and assembly of cylinder.

2 Support the cylinders suitably. Remove the top pivot pins holding the cylinder with body.

3 Start the engine and engage the hydraulic pump. Operate the control valve to push back the piston inside the cylinder.

4 Put the control valve in neutral and stop the engine.

5 Drain the hydraulic tank and disconnect the hydraulic pipe connection to the telescopic cylinders. Cap the cylinder ports.

6 Remove the bottom pivot pins of the cylinders after suitably supporting them.

7 Remove the cylinders from the vehicle and clean them.

**iv. HYDRAULIC TANK**

Hydraulic tank need not be removed from the vehicle for cleaning or servicing of filter cartridge.

FOR INSTALLATION OF AXIAL PISTON PUMP, MANUAL CONTROL VALVE AND TELESCOPIC CYLINDER PROCEED IN REVERSE ORDER OF REMOVAL FROM VEHICLE

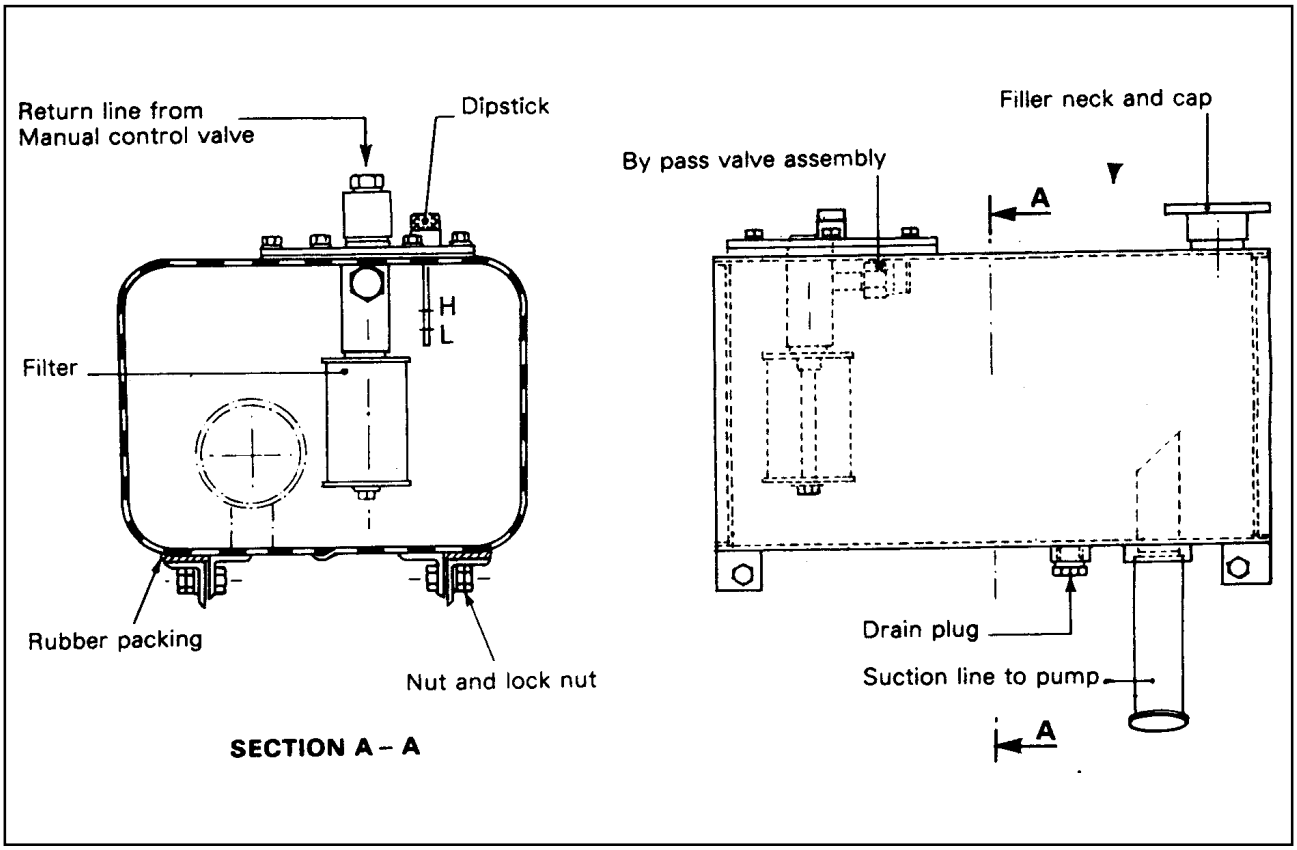



*Fig. 9*

**5. DISASSEMBLY, INSPECTION AND ASSEMBLY**

**i. HYDRAULIC TANK** (Fig. 9)

**Cleaning the tank**

It is not required to remove the tank from tipper for cleaning it.

Raise the body sufficiently to have access to hydraulic tank. Put a prop under the raised body. Open the drain plug and drain the oil in a clean container of approx. 50 Ltr. capacity.

Disconnect the return line on cover. Unscrew the screws mounting the cover and remove cover along with filter assembly. Unscrew and remove suction line strainer if provided. Disconnect suction line from tank. Clean the tank from inside with kerosene or diesel and dry it.

**Servicing filter cartridge**

Remove and clean bypass valve, unscrew centre bolt nut and remove filter cartridge from the cover. Replace filter cartridge and assemble correctly as shown in Fig. 9.

**Reconnecting suction line**

Fit the cover assembly with filter on tank. Reconnect the return line banjo. Fill in the filtered or fresh oil in tank, and bleed the system. Remove the prop.

**Filling the oil**

When filling the oil, after first filling of oil in the tank, the pump should be started and manual control operated so that the oil enters the either side of cylinder also. Otherwise, hydraulic oil starvation may occur.

Do not mix different brands of oils. Check oil level on dipstick with body lowered.

### ii AXIAL PISTON PUMP (MK II)

**Disassembly**

Lift the body and provide props underneath to facilitate filling afterwards.

Drain tank. Remove suction and delivery hose connections from the pump and cap them.

Drain the gear box oil in a clean container.

Remove the five bolts holding the pump to the gear box.

Cap the ports of the pump and clean the outside.

Remove the four screws connecting the plunger housing to seal housing and separate the housings. See fig. 10.

Remove the larger race, cage and the smaller race of bearing from shaft. See Fig. 11.

Remove the poppets, plungers, springs. See Fig. 12.

Remove only those plugs where delivery check ball is suspected to be sticking. This can be checked through the plunger bores.

Separate the shifter housing by removing the four nuts. With a light tap (to overcome detent), remove coupler sleeve from shaft. See Fig. 13.

Remove the detent spring, balls, shifter piece and shifter shaft from the shifter housing and shaft. See Fig. 14.

The taper roller bearing races and seals need be removed only in case of damage.

**Inspection**

Check the gaskets and oil seals. Replace if necessary.

Check the bearings for pitting/wear marks. Two holes are provided on swash plate for removal of cone of the taper roller bearing as shown in Fig. 15. Smaller race of the thrust bearing can be removed by hand.

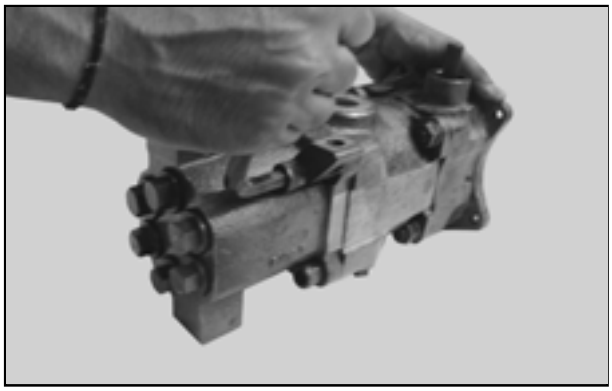


*Fig. 10*

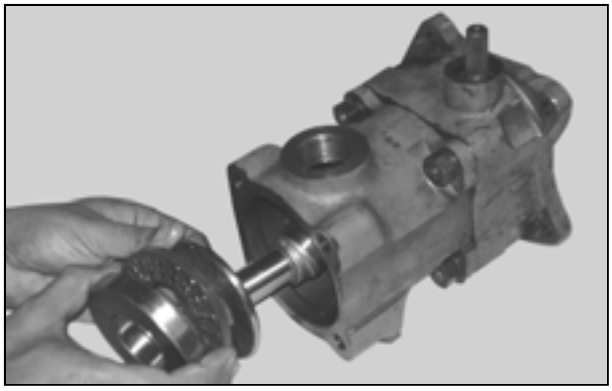


*Fig. 11*

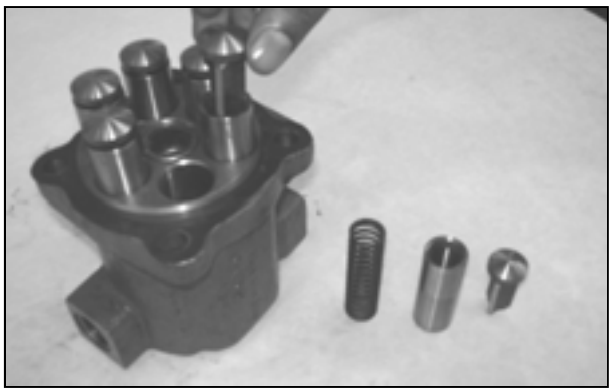


*Fig. 12*

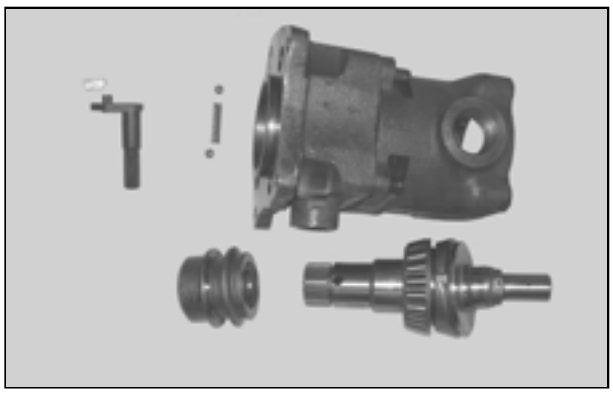


*Fig. 14*

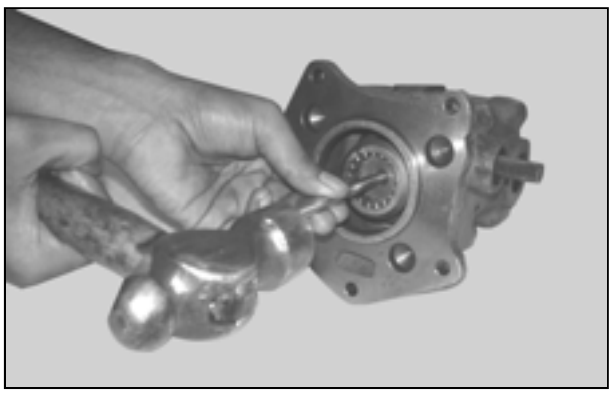


*Fig. 13*

Check poppet domes and sleeve outer dia.

Check splines on the shifter sleeve for wear.

Check two side faces of shifter piece for wear.

**Assembly**

Clean all the parts thoroughly.

Press the oil seal in the shifter housing after coating the seal with grease.

Insert the shifter shaft in shifter housing from inside. See Fig. 16.

Put the shifter piece in shifter shaft. Ensure that the chamfered end is towards shifter shaft side. See Fig. 17.

Smear the oil seals with a light coat of grease and press in the seal housing. The seals assembled back to back should be flush with bore faces.

Press the outer race of the taper roller bearing in the seal housing, see fig. 18. Press the inner race with cage, on the shaft, See Fig. 19.

Screw in full, the bleeding plug with sealing washers.

Put the gasket on the seal housing over the spigot.

Insert the shaft in the seal housing.

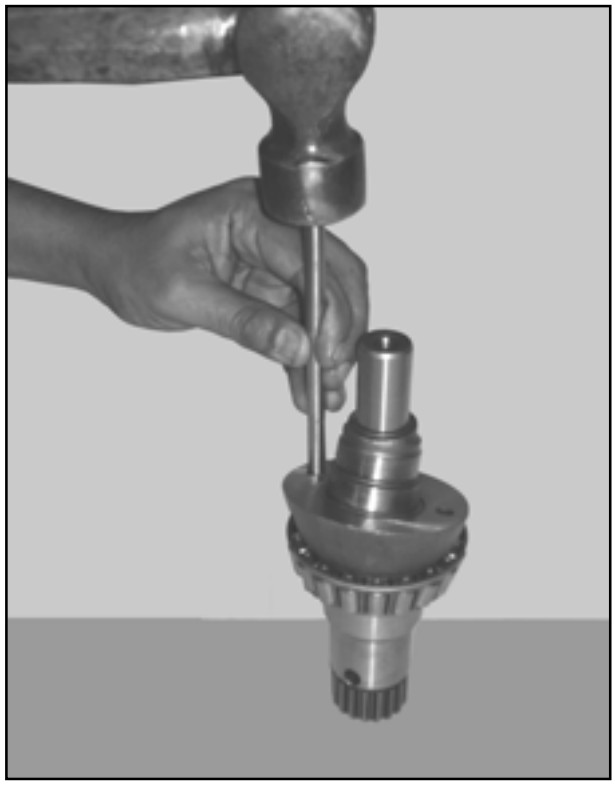


*Fig. 15*

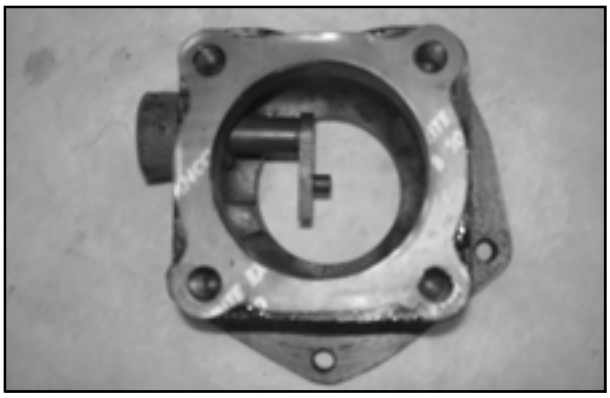


*Fig. 16*



*Fig. 18*

*Fig. 19*

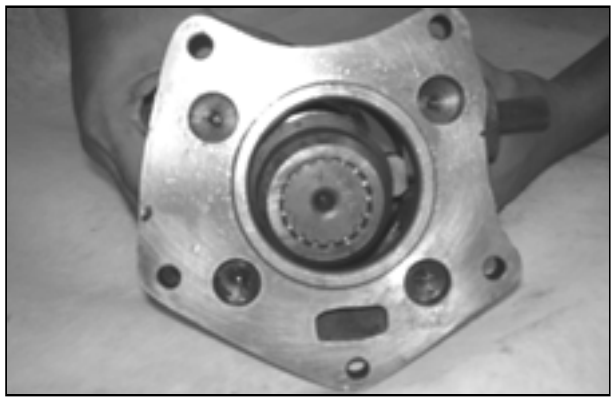


*Fig. 17*

Put the detent spring and the balls in the cross hole of the shaft and assemble the coupler sleeve over it. Notch marks are provided for matching the sleeve over shaft, which should be aligned while fitting. See Fig. 20.

Assemble the shifter housing and the seal housing together. During this assembly, the shifter piece along with shifter shaft is to be engaged in the groove of the coupler sleeve. (The coupler sleeve should be preferably in the 'Engage' position). Tighten the nuts with spring washers.

Press the needle bush in the thicker race of the thrust bearing.

Put the thinner race, roller cage and the thicker race on the shaft.

Assemble the spacer on shaft.

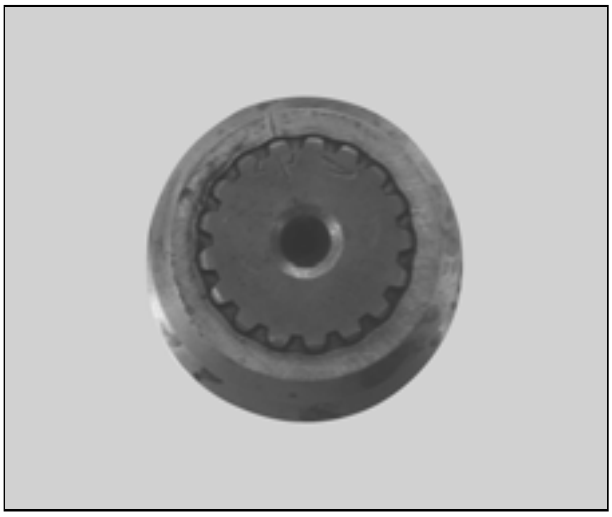


*Fig. 20*

Fit needle bushes using DRIFTS. See Fig. 21. Maintain 0.8 to 1 mm gap between them.

Assemble the ball and spring and tighten the plugs with tightening torque of 15 mkg. One of the two alternative outlet ports also should be plugged.

Assemble the washer, spring, sleeve and poppet in each bore of the plunger housing after smearing with clean hydraulic oil. See Fig. 22. Sleeve of a particular identification mark should be assembled in bores with the same identification mark.

Put the gasket on the plunger housing.

Assemble the plunger housing and the seal housing. Tighten the cap screws with spring washers fully.

Rotate the coupler sleeve to check the rotation of the shaft and observe through the suction port for smooth movement of components.

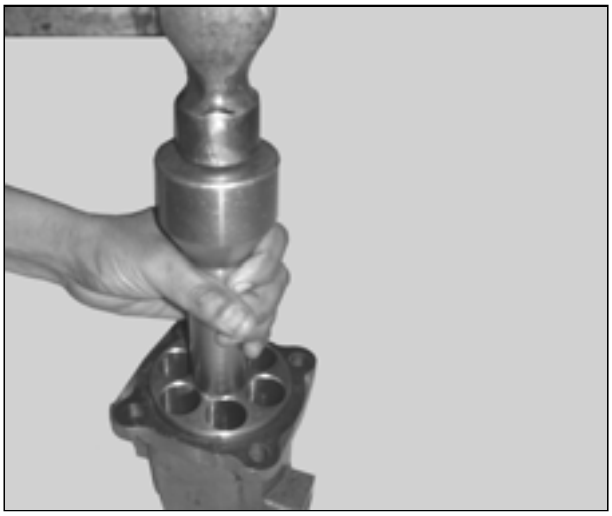


*Fig. 21*

***Note :***

1. *The relative positions of the three housings should be to suit vehicle fitment.*
2. *Do not hold the plunger housing over the spigot in a vice.*
3. *While assembling needle bush, apply force on the face of bearing having identification marking.*

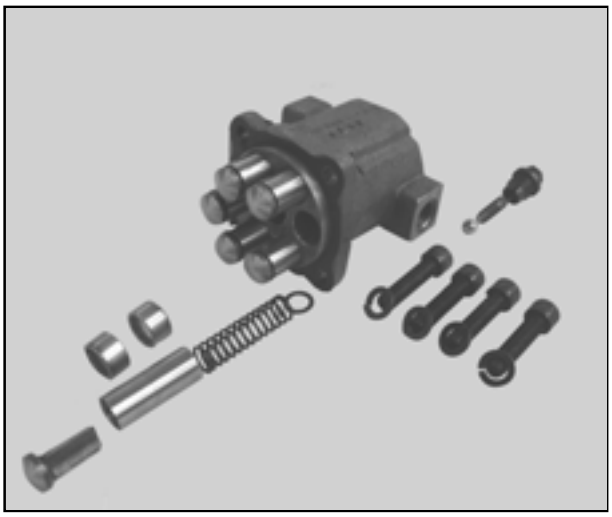


*Fig. 22*

**iii. MANUAL CONTROL VALVE** (Fig. 5B)

The valve is a precision component. The spool and valve body are matched together and hence should be used as a pair only.

The relief valve, which is a separate cartridge and factory set. NO REPAIR OR TAMPERING OF THE INTERNAL PARTS OF THE CARTRIDGE SHOULD BE ATTEMPTED.

**Disassembly**

Remove the two hex. screws which hold the end cover to the valve body. See Fig. 23.

Take out the spool sub-assembly from the rear. See Fig. 24.

Remove the 'O' rings from the spool and the valve body. See fig. 25.

Remove the "C" washers and the centering spring from the spool sub-assembly. See Fig. 26.

**Inspection**

Clean all the metal parts with solvent. Dry with filtered and compressed air. Dip in oil.

Discard the old 'O' rings.

Any small burrs, nicks, scratches etc. to be removed by fine emery paper.

No repair of sealing lands of both the spool and the valve body should be attempted.

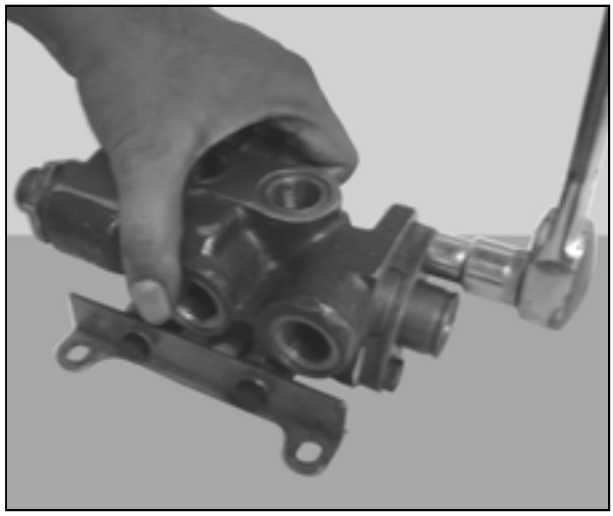


*Fig. 23*

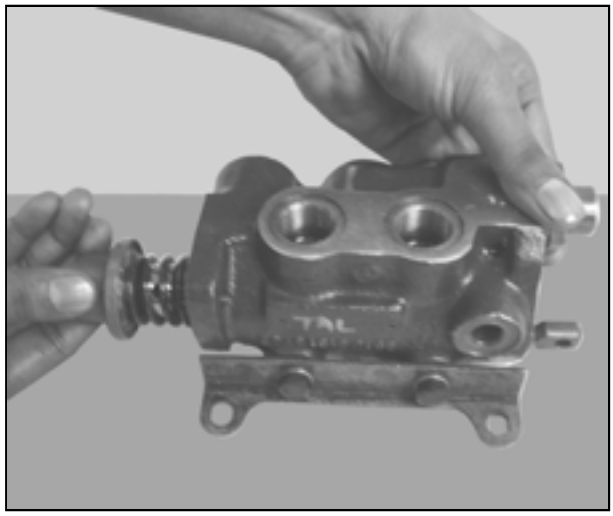


*Fig. 24*

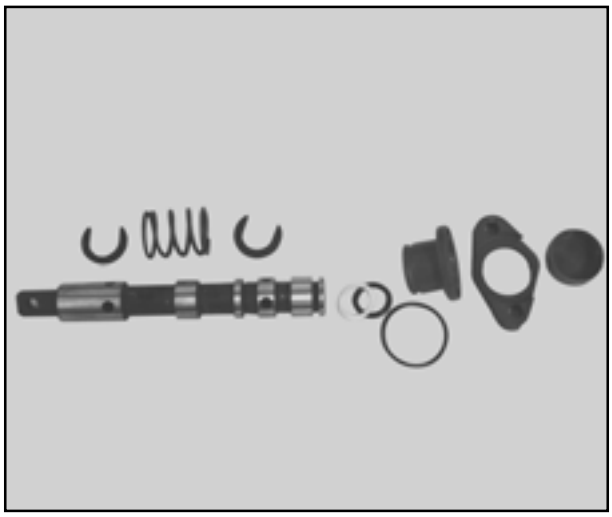


*Fig. 26*



*Fig. 25*

**Assembly**

Put one "C" washer and the centering spring on the spool. Compress the spring in a suitable fixture and then assemble the other 'C' washer.

Put 'O' rings in their respective grooves on the spool and the valve body. Smear with a light coat of grease.

Insert the spool in the valve body. Ensure that the spring and the 'C' washers are centralised with respect to the spool and do not rub on the bore of the valve body.

Put the end cover and the cover.

Tighten the hex. screws fully after checking that the spool moves freely without sticking.

**PRESSURE SETTING OF CONTROL VALVE**

1 Connect calibrated pressure gauge at the cylinder bottom port.

2 Ensure that engine speed is as per recommendations.

3 Lift the body fully with control valve lever in fully 'DUMP' position and accelerator fully depressed.

4 Read the pressure gauge reading. The pressure setting should conform to 180 kg/cm$^2$.

**iv. TELESCOPIC HYDRAULIC CYLINDER** ( See Fig. 7 )

**Disassembly**

Loosen and remove the grub screws on the 1st stag nut. See Fig. 27.

Unscrew the 1st stage nut out. See Fig. 28.

Take the 2nd stage assembly out of the outer tube.

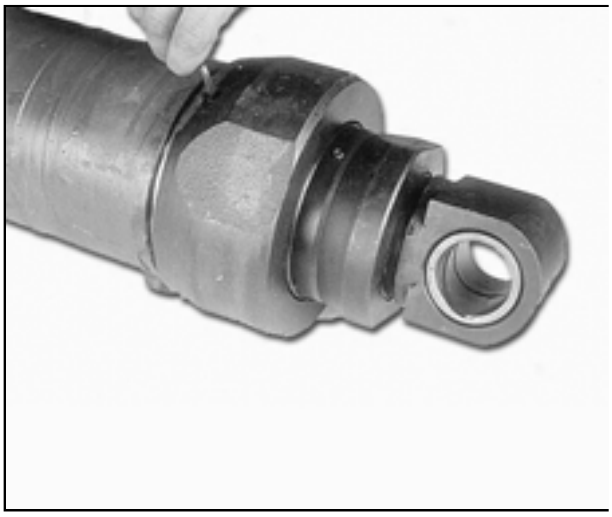


*Fig. 27*

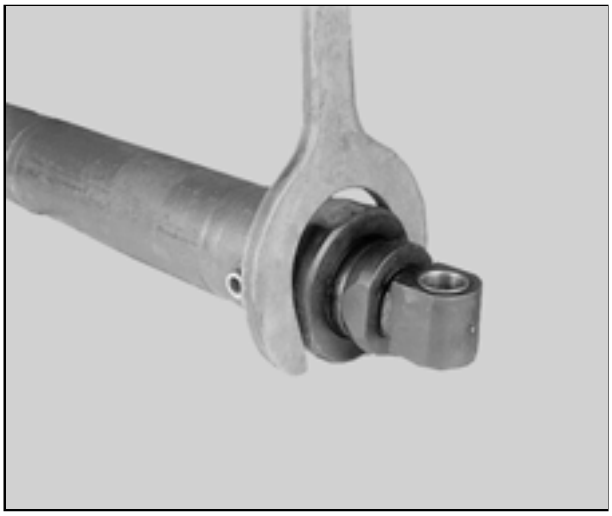


*Fig. 28*

Loosen/Remove the grub screws from the 2nd stage nut. See Fig. 29.

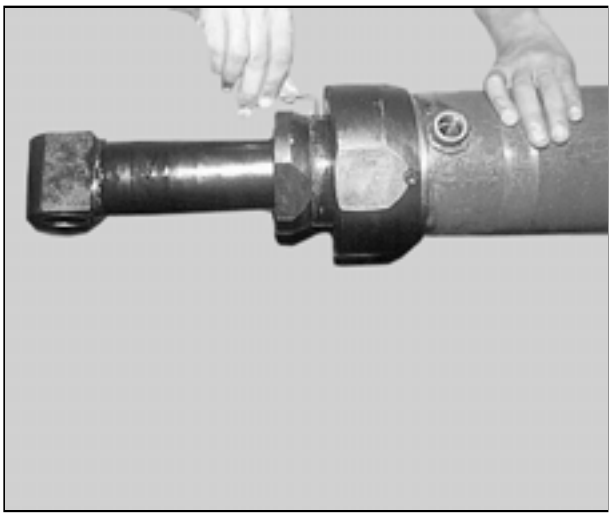


*Fig. 29*

Unscrew the 2nd stage nut. See Fig. 30.

Remove tube assembly and 2nd stage piston from the intermediate tube. See Fig. 31.

The 1st stage nut and the seal housing can then be slid out over the tube.

Remove the wiper seal from the 1st stage nut.

Remove the 'O' ring and the gland seal with the back up rings from their respective grooves in the seal housing.

Loosen and remove the grub screws from 1st stage piston. See Fig. 32.

Unscrew the 1st stage piston using special tools.

Use tool part Nos. 2510 5890 01 01 and 2510 5890 79 01.

Unscrew the inner tube from the 1st stage piston. See Fig. 33.

Remove piston seals and 'O' rings and back up rings from the piston.

Loosen and remove grub screws from the 2nd stage piston. See Fig. 34.

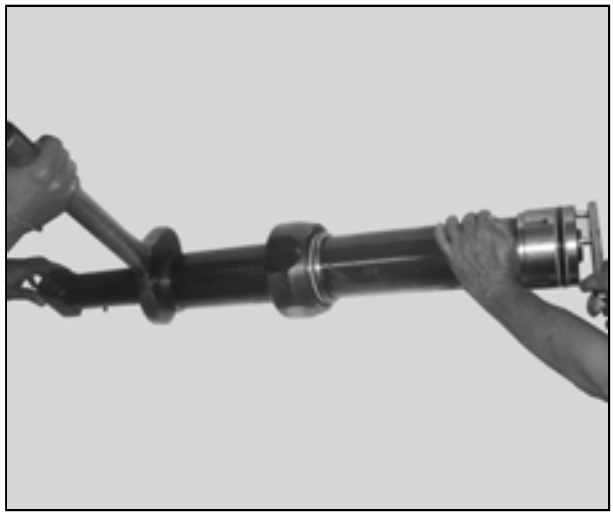


*Fig. 30*

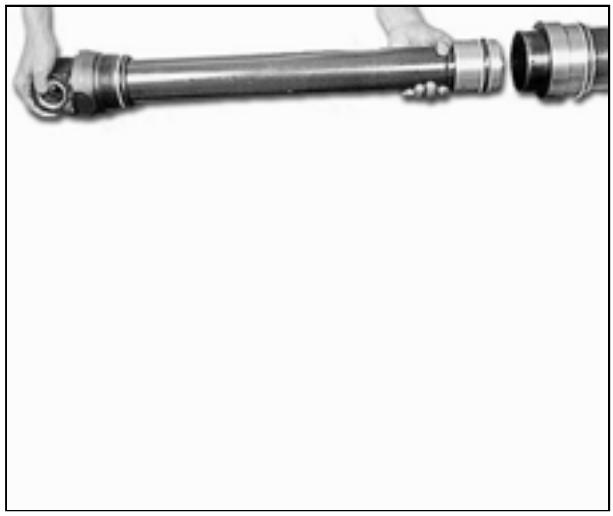


*Fig. 31*

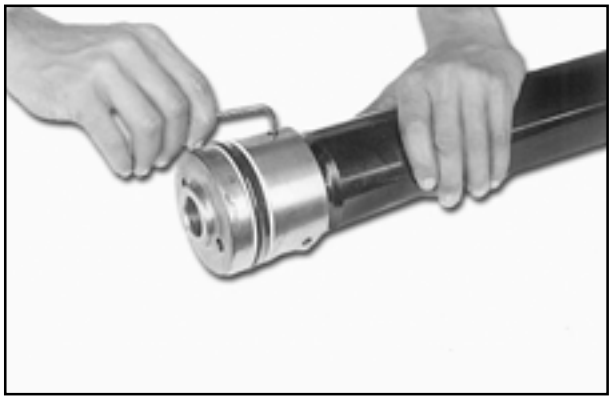


*Fig. 34*

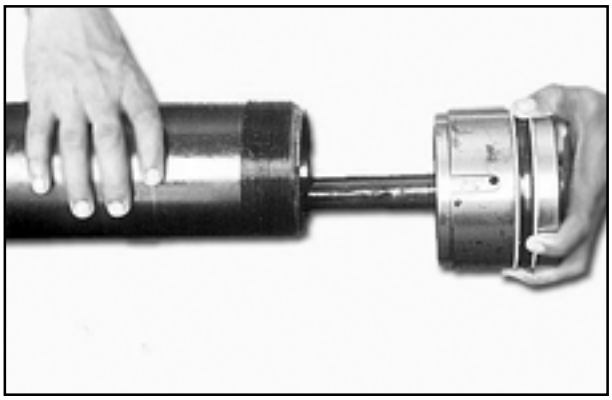


*Fig. 33*



*Fig. 32*

Unscrew the piston from the tube sub-assembly. See Fig. 35.

2nd stage nut can now be slid off the tube sub-assembly.

Remove all seals 'O' rings, back up washers from their respective grooves in the nut and the piston.

**Inspection**

Wash all metal parts in solvent. Dry with filtered compressed air. Flush the cylinder tubes with hydraulic oil. Apply a light coat of hydraulic oil on all parts.

Check all the seals, 'O' rings and back up rings.

Replace all elastomeric parts.

Check the tube I. D. and O. D. for wear marks, scratches and burrs.

If the marks are deep enough to cause damage to the seals the relevant component must b replaced. Minor scratches etc. can be smoothened out by fine grained oil stone or emery paper.

**Assembly**

Put the 'O' ring and the back up ring in the groove on the 1st stage piston.

Smear the 'O' ring with a light coat of grease.

Screw in the inner tube and tighten fully.

Put the 'O' ring in the undercut of the piston thread. Screw in the 1st stage ram fully.

Secure the piston to the ram by the grub screws and nylon pieces.

Assemble the 'O' ring, gland seal and back up rings in their respective grooves in the seal housing. See fig. 36. Apply a light coat of grease and slip it over the 1st ram.

Put the scraper ring in the 1st nut. Apply a little grease and slip this also over the ram. See Fig. 37.

Assemble the 'O' ring, gland seal, scraper ring and the back up rings in their respective grooves in the 2nd stage nut. Apply a little grease on the seals and slip it over the tube sub-assembly.

Put the 'O' rings and back up rings in the 2nd stage piston.

Screw in the piston on the tube sub-assembly and tighten fully. Secure by means of grub screws and nylon pieces.

Assemble the back up rings and piston seals on both the pistons and smear them with a little grease.

Insert the tube sub-assembly with the 2nd stage piston into the 1st stage ram.

Tighten the 2nd stage nut and secure by means of grub screws and nylon pieces.

Insert the above assembly in the outer tube.

Tighten the 1st stage nut. Secure by means of grub screws and nylon pieces.

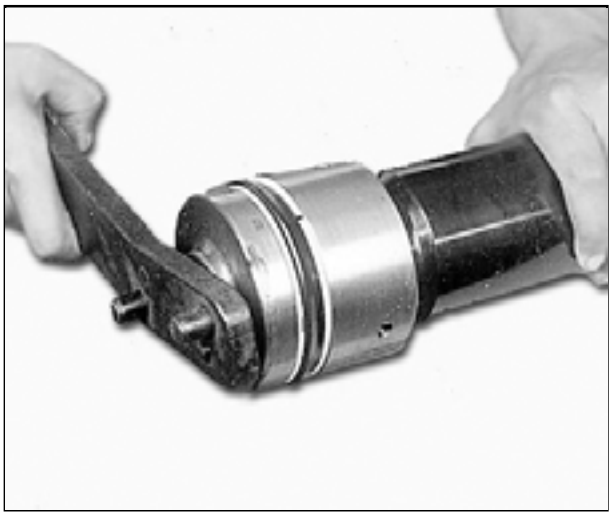


*Fig. 35*

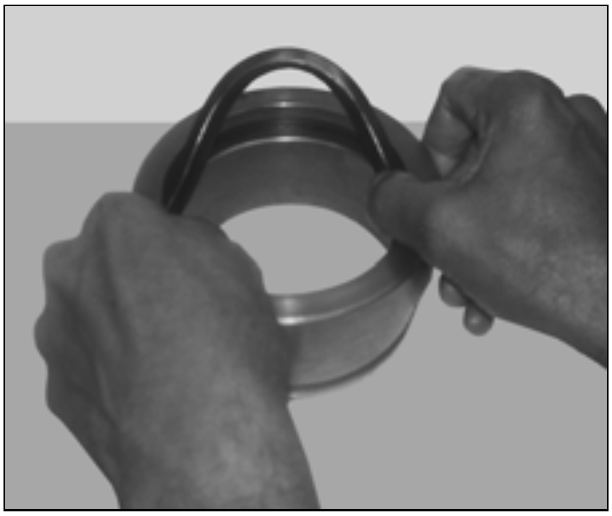


*Fig. 36*

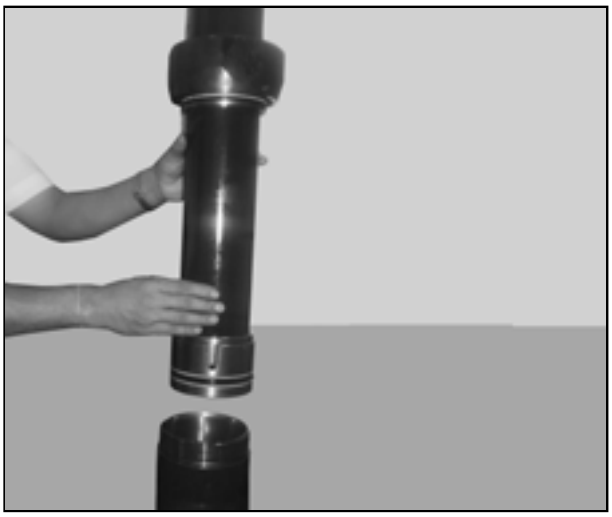


*Fig. 37*

## V. FILTER

A 25 micron full flow filter is installed on the return line of the system and is located in the tank. This location permits using a low pressure type filter.

The filter element traps the foreign materials before the oil returns to tank. The travel of the flow is from inside to outside and the dirt gets collected inside the filter element. See Fig. 38.

**Removal and installation of filter cartridge along with the cover plate**

To remove tank cover proceed as follows :

i. Raise the body and put a prop under it (if required).

ii. Clean the tank cover plate and its surroundings thoroughly to ensure that no dirt gets into the tank.

iii. Remove the banjo bolt and cover the banjo body with polythene wrapper.

iv. Unscrew six screws fixing the cover plate to tank.

v. Lift the cover plate with filter cartridge assembly and hold it in the tank till all the oil gets drained.

vi. Take out the cover plate and filter assembly carefully.

**Installation**

Proceed in reverse order of removal. Replace the cover plate gasket and sealing washers if necessary.

**Filter Cartridge Replacement**

i. Remove the nut spring washer and bright washer.

ii. Withdraw the old cartridge from the stud. See Fig. 39.

iii. Unscrew the bypass valve assembly.

iv. Clean all parts thoroughly in solvent and dry with compressed air.

v. Fit back the bypass valve assembly.

vi. Fit a new cartridge on the stud.

vii. Ensure that cartridge is assembled in correctly. See Fig. 38.

viii. Refit the washer on grommet, and put a spring washer on stud and fix the nut.

ix. Ensure that the filter has sealed properly with rubber washer and tighten the nut.

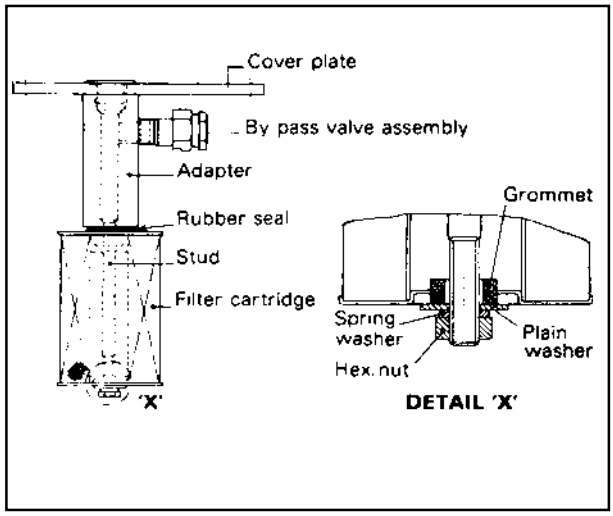



*Fig. 38*

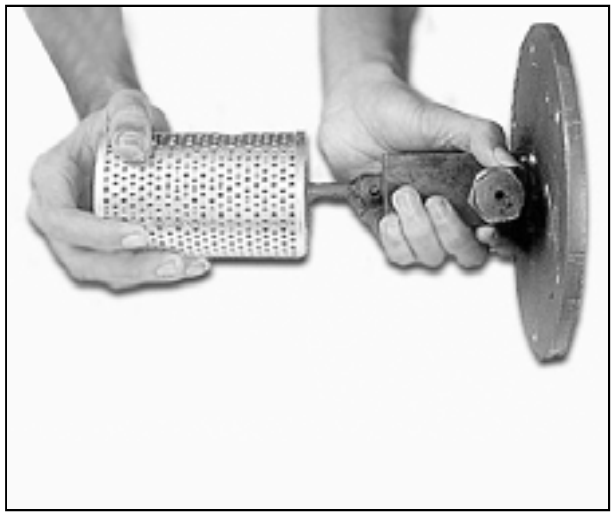


*Fig. 39*

**6. BLEEDING THE HYDRAULIC SYSTEM**

**A. Bleeding axial piston pump**

i. To be done every time the suction line is opened or pump is refitted on the vehicle. (Do not start the engine.)

ii. Unscrew the bleeding plug by about 4 turns provided in the seal housing. There are, two plugs on the housing, only the plug on the top side should be unscrewed. Keep it open till only clear oil comes out the small holes. Tighten the plug again.

**B. Bleeding the system**

Whenever the hydraulic high pressure pipes or hydraulic cylinder is replaced the system should be bled to remove the trapped air in the line or cylinder. Proceed as follows :

(Engine running)

i. Engage the pump.

ii. Pull control lever up and hold in that position.

iii. Slightly loosen the joint of pipe connecting the bottom port 'B' of the cylinder. The hydraulic oil will start coming out along with trapped air if any.

iv. When oil coming out is free from air bubbles, tighten the pipe connections.

v. Release the control lever so that it comes back to neutral position.

vi. Now press down the control valve lever and hold in that position.

vii. Loosen the pipe connecting top port 'A' of the cylinder.

viii. When the oil coming out is free from air bubble tighten the pip connection.

ix. Release the control valve lever.

x. Disengage the pump.

**Caution**

When working under a raised load body always use a prop under it.

**Trouble shooting**

**Before attempting trouble shooting check the following**

1. Oil level in tank is upto the H' mark on dipstick with cylinder retracted. Breather hole in dipstick is clean. Filler neck cap is clean.
2. Filter element is okay.
3. Pump shifter shaft movement is free.
4. Control valve lever moves smoothly to full stroke.
5. All suction line fittings are tight.
6. The pump has been bled.
7. There is no foaming of oil in the tank with pump running.
8. The time for lifting should be within 14 seconds.

**9. Pressure setting on vehicle:**

The pressure setting should be measured at the cylinder bottom port, when cylinder is extended fully with Control valve shifted and with accelerator pedal fully depressed. The pressure gauge should be a calibrated gauge and it should be ensured that engine rpm is also as per recommendation in the data book.

Refer group 00 for pressure setting value.

**Caution :** Whenever tipper body is lifted for test/repair purposes, a prop should be suitably used for safety, in the event of hydraulic failures.

## 7. TROUBLE SHOOTING

| Complaint | Possible cause | Remedy |
|---|---|---|
| Hydraulic system does not perform satisfactorily, i.e. load is not lifted at all or load is lifted at slow speeds. | Restrictions in lines | Check and clean the suction line and other lines. |
| | Load to heavy | Check the maximum working pressure. Should be as specified. |
| | Worn cylinder | Repair or replace as per instructions in this manual. |
| | Defective pump | Repair or replace as per instructions. |
| | Defective control valve | Repair or replace as per instructions. |
| | ***Note :*** *Do not attempt repair of pump, control valve or cylinder without ensuring and checking other points as mentioned above.* | |
| Foamy oil | Incorrect type or viscosity of oil | Drain the tank and entire system and refill with recommended oil after cleaning the entire system. |
| | Relief valve cracking due to exces -sive load | Try to eliminate long periods of operation with the maximum load of with piston bottoming in cylinder at either end. |
| High oil temperature | Over loading | Avoid over loading |
| | Severe working cycle | Change the working cycle |
| | Control valve defective | Inspect and repair/replace as per instructions. |
| Pressure does not build up | Pump not engaged | Engage pump |
| | Cylinder leaking | Repair/replace as per instructions |
| | Worn seals in pump | Repair/replace as per instructions |
| | Relief valve sticking | Repair. Open plug & clean. Do not open inner cartridge. |

**TROUBLE SHOOTING**

| Complaint | Possible cause | Remedy |
|---|---|---|
| Difficult movement of manual control valve | Damaged 'O' rings seals on the spool | Remove and replace. |
| | Dirt or foreign particles on the spool | Remove and clean as per instruction. |
| | | **CLEAN THE ENTIRE SYSTEM.** |
| | Over heated oil | Refer to high temperature and rectify. |
| | Linkage sticking | Rectify |
| | Valve spool bent | Replace |
| | Valve wrapped | Loosen the mtg. screws and tighten uniformly |
| | Fittings too tight | Loosen fittings and retighten |
| | Centering spring damaged | Replace |
| Load slips with valve in neutral | Oil leakage through cylinder seals | Repair cylinder |
| | Oil leakage in control valve excessive | Check and replace control valve. |
| Pump does not deliver | Pump section line restricted | Check the lines and clean |
| | Bleeding is not adequate | Bleed thoroughly |
| Pump making noise | insufficient oil supply | Clean the suction line and remove the restrictions |
| | Air in suction line | Refer to air in line above and rectify as per instructions |
| | Foaming oil | See instruction in 'Foaming oil' and rectify |
| | Pump components damaged | Check bearings, shaft, seal for damage. Replace if necessary. |

## NOTES

## NOTES

# Steering 46

# ZF Power Steering 46

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**ZF hydraulic ball and nut power steering Short version**

**DESIGN AND FUNCTION**

**Design**

**1 Worm:**

Both radial **and** axial roller bearings are mounted in the intermediate cover (122*) and cover (128) or only in the cover (128) depending on the version. Worm Shaft with grooved channel for ball circulation is mounted in this cover.

**2 Piston**

The valve bush which accommodates the valve spool is pressed into the cross bore hole. The underside of the piston is machined as a gear rack, which engages in the toothed segment of the sector shaft. The steering nut and finger (driver) passes into the longitudinal bore hole of the piston, thus establishing the connection with the valve spool through the worm.

Depending on the version, the valve is centered by means of centering springs or bending bar.

**3 Steering nut**

Longitudinal bore hole for worm engagement with grooves for ball circulation are provided. The groove on the external diameter is milled and ground for accepting the finger (driver), which engages in the cross bore hole of the valve spool. This establishes the connection to the worm by means of the ball chain, which depends on the selection of the corresponding type of ball.

The steering nut is mounted in piston, play-free, between two roller bearings. Adjustment is carried out by turning the threaded ring (118) which is secured on the open side of the piston. .

**4 Housing**

The housing has integrated passages for the pressure and return lines and, a built-in pressure limiting valve. Oil passages which are required within the steering system are arranged as bore holes in the housing, housing cover / plate or in the piston. No external connecting lines are required due to this design. The housing has mounting holes and machined surfaces for securing the steering gear box on the mounting bracket of the vehicle.

**5 Sector shaft**

The sector gearing is cut with a flat angle to the shaft axis in order to facilitate, service adjustment in the axial direction. The center tooth is shaped more convex, so that the readjustment can be carried out in straight ahead position (SAP), since this is the area where the greatest amount of wear occurs, without the following gear teeth, both left and right, becoming jammed.

The forces in the axial direction are taken up, by means of an adjustment screw (31); the screw is held into the bore hole of the sector shaft, play-free and passes through threading in housing cover. Adjustment in axial direction is carried out by utilizing this thread pitch and locking is done by means of a lock nut.

**6 Housing cover**

It houses the adjustment screw for supporting the sector shaft & two built-in adjustable valves (55) for limiting the pressure at wheel lock. The valves are pushed open by the cam of sector shaft in predetermined position at left or right lock. This enables the pressurized oil to flow from the corresponding side of the cylinder chamber to a reduced required pressure of approximately 30 to 35 bar. The device is described as “hydraulic steering limiters”.

**Function**

In order to obtain hydraulic support during steering of vehicle, spool valve must be moved out of the neutral position.

The spool valve is held in the neutral position by means of a centering spring or bending rod depending on the version. Steering forces must therefore be applied in order to overcome this initial setting.

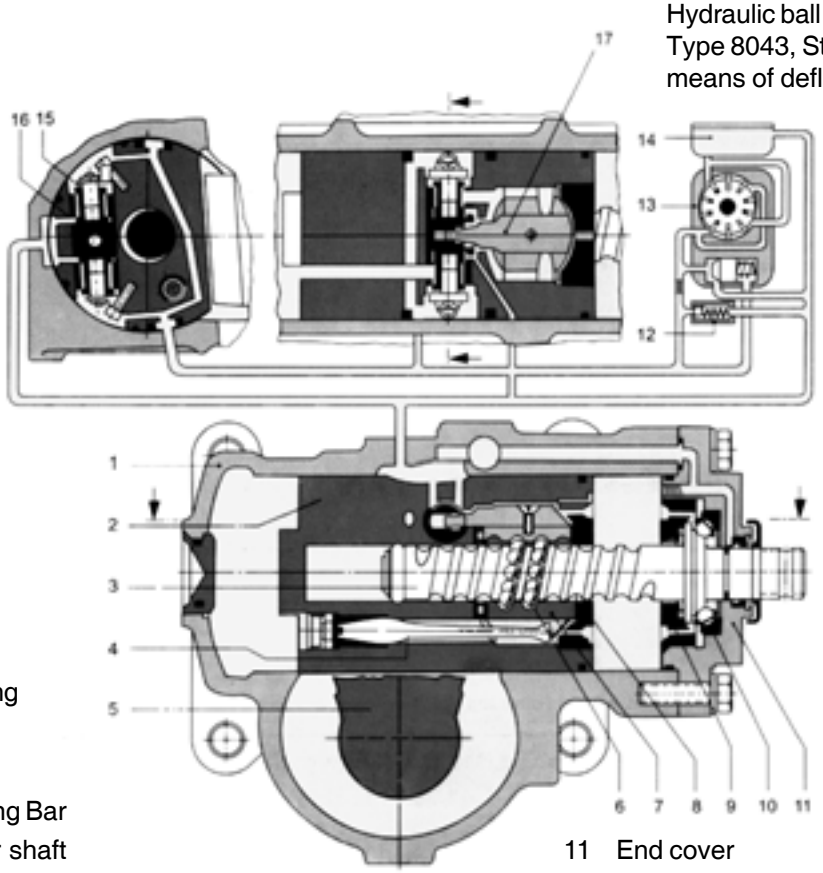
The piston which is positively connected with the sector shaft and the steering wheels, offers resistance to rotation. The steering nut is therefore rotated by the worm and the ball chain during the steering process thus overcoming the initial setting of the centre spring or bending bar. The pressurized oil flowing into the gearbox housing from the Engine driven pump is then routed into the chambers from which the steering procedure is hydraulically supported.

The oil flows in from the housing side into a longitudinal groove of the piston and beneath the

valve. It also flows into a longitudinal groove of the same size on the opposite side in order to assist the pressure compensation and then reaches, by means of cross bore holes, at the front surfaces of the valve pistons which are separated from the chambers by means of seals. In the neutral positions of the valve the oil-flows to the centre of the valve piston after first flowing through the forward and return edges, and from there the oil flows up through the corresponding holes into an opening of the piston. The oil is then drained for return motion. By operating the valve, the side of the piston which is under pressure is separated from the return and the opposite side of the piston which is connected to the return flow. The spool valve is equipped with two feed-back pistons (reaction components) which have the task of making the movement of the valve, from the neutral position more difficult, depending on the oil pressure. The activating force on the steering wheel increases proportional to the forces which are applied to the wheels.

Steering units which only require a proportional increase of the steering force only up to a predetermined oil pressure, are equipped with Hydraulic reaction components (feedback piston). The valve which is into the feedback piston ensures that after reaching the cut-off pressure the force on the steering wheel only increase insignificantly.

**Steering valve in neutral position**
Hydraulic ball nut steering in short form, Type 8043, Steering valve centering by means of deflection rod, Bending bar.




1 Housing
2 Piston
3 Worm
4 Bending Bar
5 Sector shaft
6 Balls
7 Steering nut
8 Threaded ring
9 Threaded ring
10 Angular ball bearing
11 End cover
12 Pressure limiting valve
13 Vane pump with flow limiting valve
14 Oil Reservoir
15 Feedback piston (Hydraulic Reaction)
16 Valve piston

*Fig. 1*

**Function of the feedback pistons :**

(Hydraulic Reaction)

They are floating pistons mounted in the bore hole of the valve spool. They are, however, held axially and secured by connecting them with retaining plates. The outer front areas of the two pistons are continually under pressure while only one of the internal front surfaces is under pressure in the working position of the valve. The same applies for the front surface in the bore holes of the valve spool. In this way, no force occurs which tries to push the valve spool into the neutral position. This property is described as “hydraulic reaction”.

**Steering spool valve in working position**

Steering wheel turned in clockwise direction, worm moves to the right, pressure in the right cylinder chamber.

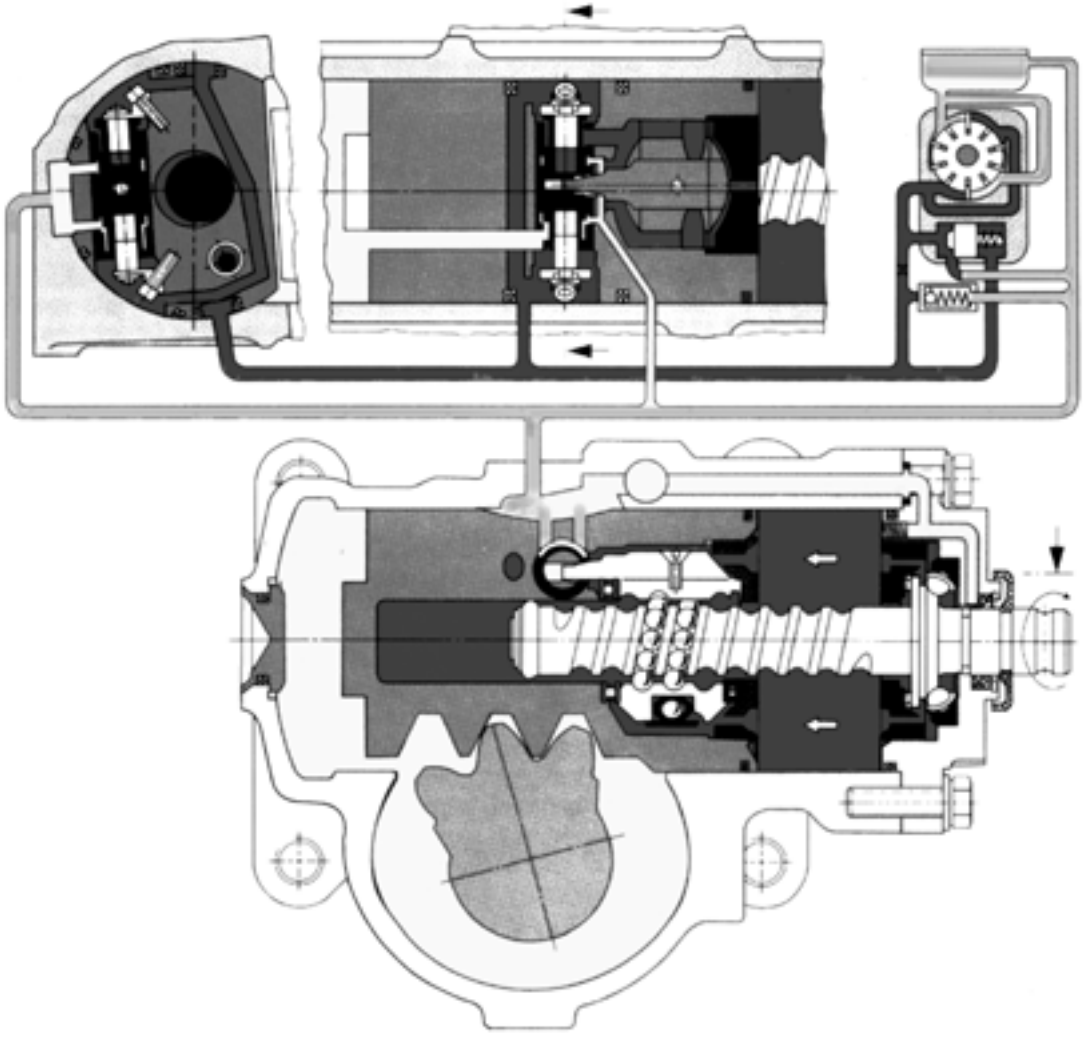


*Fig. 2*

**Steering spool valve in working position.**

Steering wheel turned in counter clockwise direction, worm moves to the left, pressure in the left cylinder chamber.

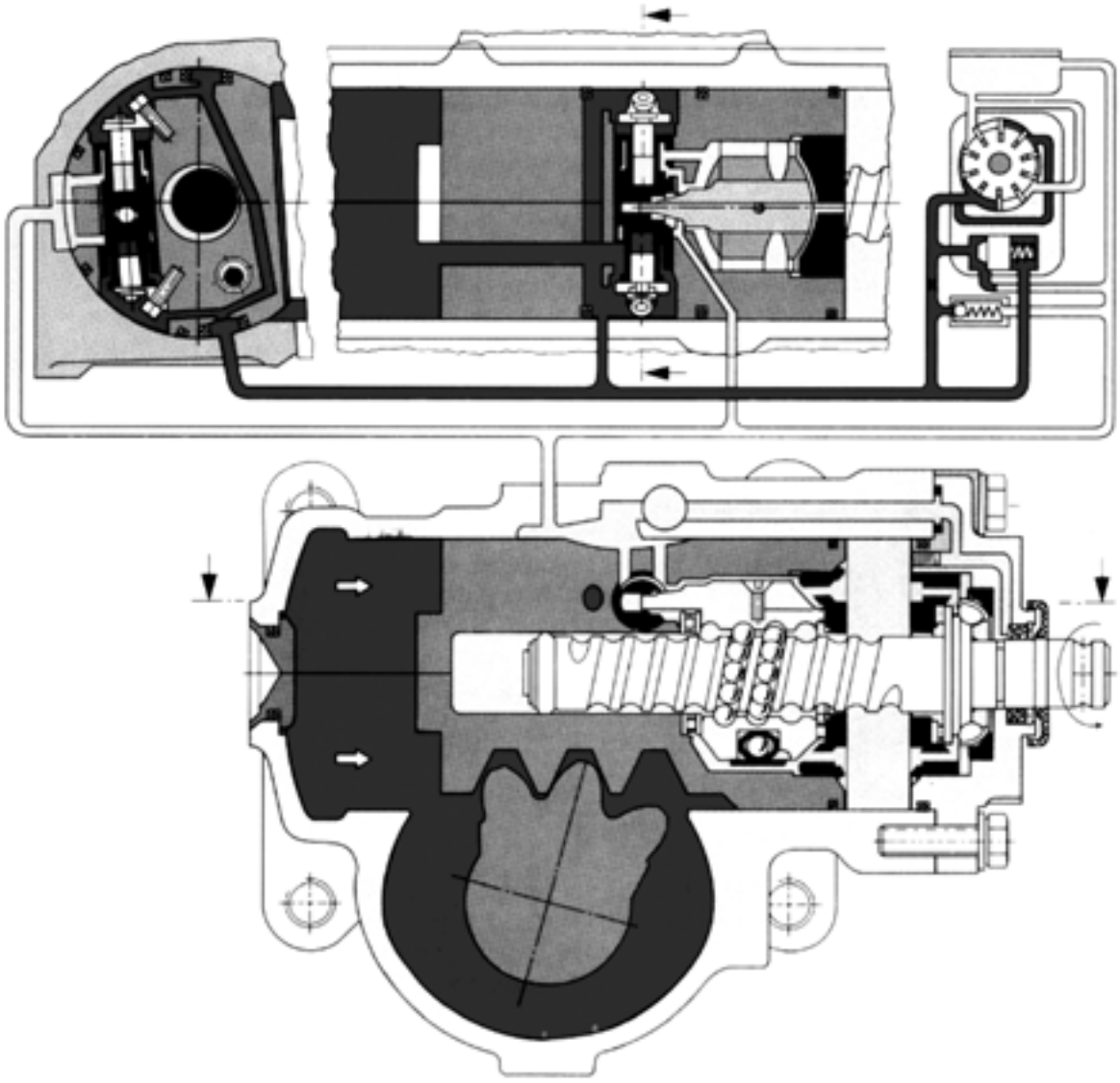


*Fig. 3*

**FUNCTION AND ADJUSTMENT OF THE HYDRAULIC STEERING LIMITER VALVES.**

**A) Function of the hydraulic steering limiter valves.**

1. Adjustable steering limiter
2. Non - adjustable steering limiters.

When the piston moves to the left, the oil can flow into the housing return flow channel before reaching the stop by means of a piston hole at right angles to the piston axis. When the piston moves to the right, the edge of the piston base clears the path for the return flow in the housing.

**B) Adjusting the hydraulic steering limitation**

The first adjustment of the hydraulic steering limiters system is always carried out on the test stand at the works according to the drawing and the test regulations of the vehicle manufacturers.

It is necessary to carry out a further adjustment after installing the steering system into the vehicle at the prescribed inspections with the aid of a manometer.

Adjusting the hydraulic steering limiting system in the vehicle with the aid of a manometer.

A manometer (pressure range up to 250 bar) is installed in the pressure line between the pump and the steering unit (see Figure 5), and the steering axle is jacked up if rigid axle. Place the lifting jack beneath the axle. If the vehicle has independent wheel suspension the steered wheels must be on turn tables so that the hydraulic steering limiting system can be adjusted; the steering axle must, under all circumstances, be underload in order to approximately compensate for possibly occurring faults in the spring action during measurement. Turn the steering without using much force up to the wheel stop when the engine is running. For some vehicle types it may be necessary for a second fitter to hold a distance piece with a thickness of 2-3 mm between the parts of the wheel stop so that a small reserve is maintained (follow the adjustment regulations of the vehicle manufacturer). The thickness of the plate depends on the steering unit. When the wheel stop has been reached, the restoring forces of the steering valve are overcome by briefly (max. 5 sec) turning the steering wheel further until a solid steering wheel stop is reached, a peripheral force of approximately 100-200 N is needed on the steering wheel depending on the size of the hydraulic reaction. The manometer should indicate an oil pressure between 30 and 35 bar if the setting of the steering limiter system is correct. For adjustment purposes, the lock nut (a1 or b1) should be loosened and the relevant limiter valve (a2 or b2) should be turned either in or out. The steering wheel should be held so that only the flow pressure is allowed to build up during this work. Then retighten lock nut (a1 or b1) with a torque of 25 to 35 Nm. The setting for the second wheel stop should be carried out in the same manner. The lock nut (a1 or b1) with torque of 25 to 35 Nm. The setting for the second wheel stop should be carried out in the same manner. The valve (a2) and the lock nut (a1) in Figure 5 must be adjusted when the steering drop arm moves in the direction "A" as in Figure 5. The valve (b2) and the lock nut (b1) must also be adjusted in the same way when the steering drop arm moves in direction "B".

In the case of steering systems in the new series, e.g. 8043 (See Fig. 4), the pressurized oil flows from the left cylinder into the space below the steering limiting valve when the left valve piston is operated. The oil pressure which builds up lifts the right valve piston from its seat against the spring resistance and opens up the path into right cylinder chamber which is linked to the return flow.

After the setting has been carried out, the hydraulic support should be in operation shortly before reaching the wheel stop. The setting should be checked on the vehicle, normally loaded and traveling slowly, steering the wheel so far until the hydraulic assistance is switched oft. In this position, a gap of approximately 1 to 3 mm should exist between the the wheel stop. The correct thickness of the distance pieces can also be determined with this test.

If the pressure drops too early or too late when turning the steering drop arm in the direction “A” or “B” the limiter valves bushes (a2) and (b2) must be turned as follows.

If a pressure higher than 35 bar is measured, the corresponding steering limiter valve (55) must be turned further in towards the cover (in a clockwise direction).

If a pressure lower that 30 bar is measured, the corresponding steering limiter valve (55) must be turned further out (counter clockwise direction).

In figure 6, the distance which is represented by dimension “F” and which is the distance which should exist between the parts of the wheel stop when the hydraulic steering limiter system is activated and should be approximately 2 mm.

Digrammatic representation of short version ball and nut power steering gear Type 8043 with adjustable steering limiter in the housing cover, movement of piston to the right, left steering limiting valve opened, oil pressure heavily reduced.

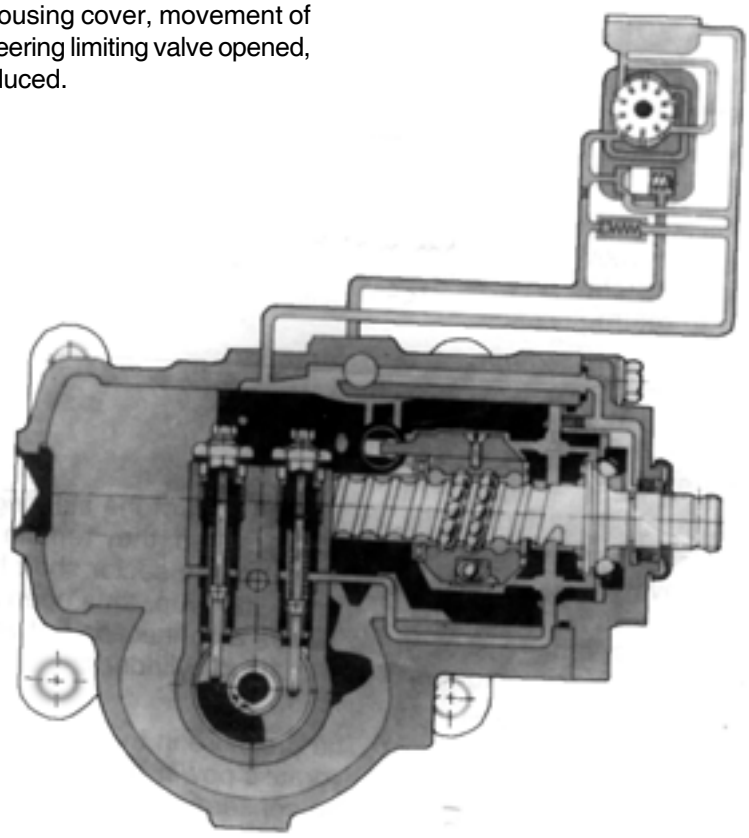
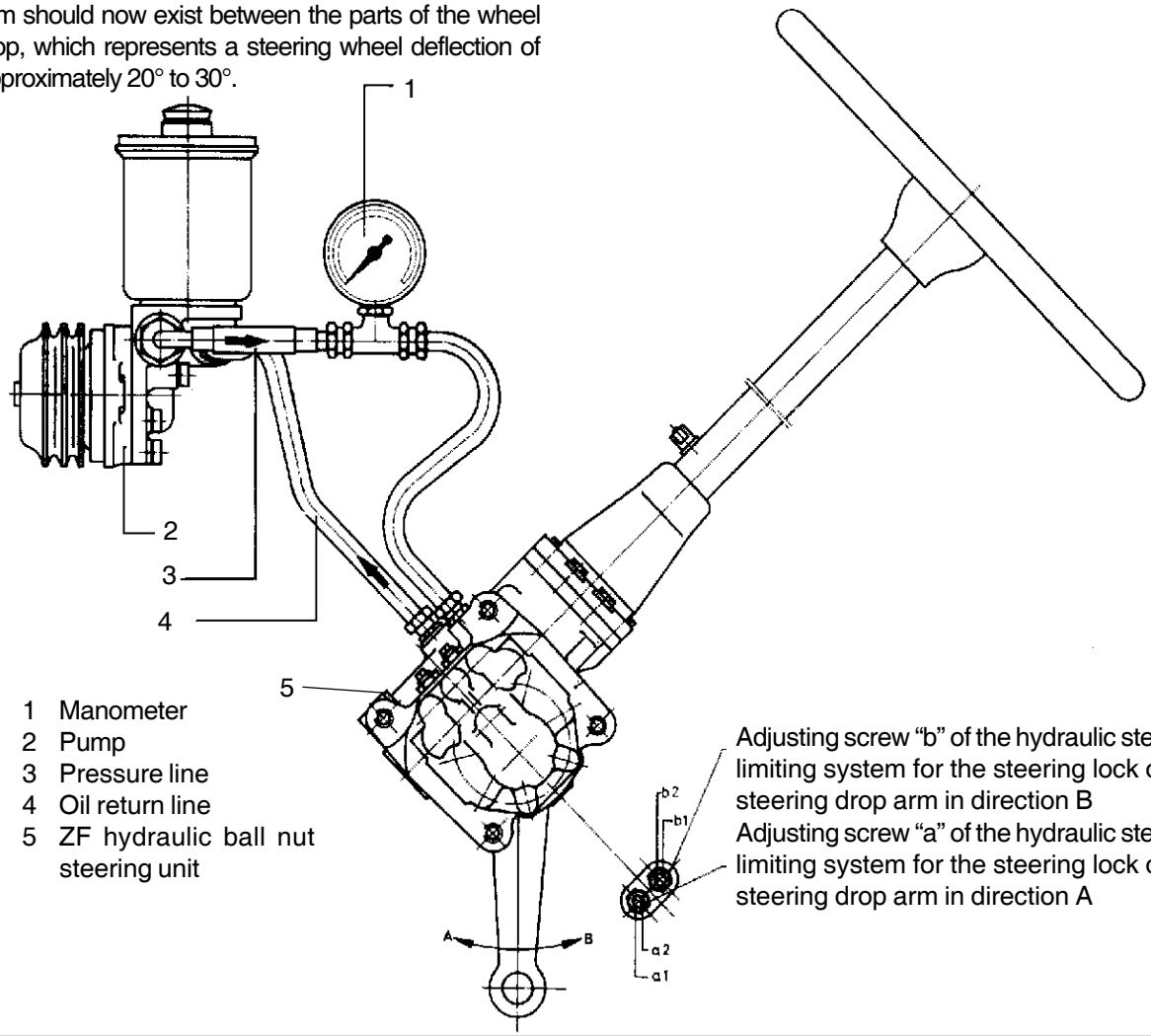


*Fig. 4*

**Checking:**

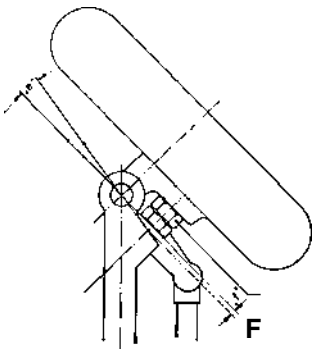
Steer the normally loaded vehicle traveling slowly until the assisting force is disconnected. A clearance of 2 mm should now exist between the parts of the wheel stop, which represents a steering wheel deflection of approximately 20° to 30°.




1 Manometer
2 Pump
3 Pressure line
4 Oil return line
5 ZF hydraulic ball nut steering unit

Adjusting screw "b" of the hydraulic steering limiting system for the steering lock of the steering drop arm in direction B
Adjusting screw "a" of the hydraulic steering limiting system for the steering lock of the steering drop arm in direction A

*Fig. 5*




Position of the stop bolt
Wheel stop on the axis
Wheel stop lid"
Adjustment screw lie

*Fig. 6*

**OIL FILLING AND AIR BLEEDING**

*Note: There is a danger that dirt particles may enter the steering oil circuit when filling the steering unit with hydraulic oil. A high degree of cleanliness must be observed for the first filling and for all subsequent topping up operations in order to prevent failure due to foreign bodies in the system. For this reason, thoroughly clean the oil reservoir and the area around it before removing the oil reservoir cover or dip- stick so that dirt does not get into the hydraulic oil.*

1. **Type of oil :**

   A suitable hydraulic oil must be used in order to ensure perfect function of the steering unit and the pump. The hydraulic oil also carries out the lubrication of the steering gearbox and the pump; therefore only one type of oil is necessary for the entire unit.

   The unit should be filled with ATF oils with a viscosity of approximately 26 mm2/s (cst) at 50° C, a setting point below-35° C and with low inclination to foam formation. Oils with a high viscosity may lead to the situation that the under pressure in the inlet line becomes too great thus causing noises in the pump. Oil types recommended are given on the oil tank.

2. **Oil quantity:**

   The hydraulic steering system is delivered from the factory without being filled with oil. The required oil quantity for the steering gearbox system is as follows for the individual steering sizes. The oil required for the complete system depends on the length of pipes used in the system.

   Type 8043 1.4 Litres in Steering Gear assy. and 3 Litres in the system.

3. **Oil filling and air bleeding**

   **Oil filling**

   ***Note:*** *Special care must be taken during the procedure described as follows to ensure that the oil reservoir is not allowed to run empty since this would cause air bubbles in the steering system. In addition to this, special care must also be taken during oil filling and air bleeding to ensure that the pump only turns at the lowest possible speed (idling). If the inlet flow is too great small air bubbles would enter the pump and be split up into extremely small air bubbles during its passage through the pump; this situation may lead to foam formation thus greatly extending the bleeding process. Due to the various types of installation possibilities of our hydraulic steering systems (inverted, vertical, horizontal etc.) it can occur under certain circumstances that for a short period of time, the steering system cannot be bled in certain types of vehicle and the air in the steering gearbox is only removed very slowly. In such a case, we recommend that the steering drop arm should be removed so that the entire piston stroke from stop to stop can be utilized in the steering housing for the bleeding process.*

   In this way the air remaining in the cylinder is reduced to a minimum. This is an insignificant amount which is automatically absorbed by the oil and separated during operation.

   The steering system and pump should be filled through the opening on the oil reservoir. For the first filling and for oil changes it is recommended to remove the cover of the container and fill with hydraulic oil up to the edge of the container.

   The engine should then cranked over briefly a number of times with the starter in order to fill the entire hydraulic system with oil. Since this causes the oil level in the container to fall rapidly, the oil must be continually topped up during this process and under all circumstances the pump must be prevented from taking in air.

   **Bleeding:**

   The engine can be started with the steering axle jacked up when the steering system is filled with oil so that the oil level no longer falls below the upper marking on the oil dipstick when the engine is briefly turned over.

   Allow the engine to run for some time at low speed, thus allowing most of the air to escape from the cylinder. The oil level must be observed during this process. The oil must be topped up immediately if the level still sinks.

   When the above instructions have been observed the oil level in the oil container must not rise higher than approximately 1 to 2 cm when the engine is switched off, according to the size of the steering system.

   Steering gear 8043 / 8033 / M033 are system with automatic bleeding and do not have a bleeding screw. , These steering systems automatically bleed the remaining air in the housing after the bleeding process has been carried out as described above.

Switch off engine and remove the blocks from the steering axle.

**4. Checking the oil level :**

The oil level should be checked at operating temperature at intervals of 9000 kms.

**Oil check on stationary engine:**

In order to establish that no air is sucked in when the engine is started, it must first be established whether oil loss has occurred when the engine is stationery. Therefore, the container should be filled with so much oil that the oil level is approximately 1 to 2 cm above the upper marking on the oil dipstick.

**Oil check on running engine:**

The oil level falls slightly when the engine is running since the oil requires a pressure of approximately 2 to 4 bar to flow through the steering unit as a result of the resistance to flow. The oil should therefore once again be topped up so that the oil level lies constantly at the upper marking. The engine can then be switched off again. If this level is exceeded, then this is a sign that there is still air in the oil.

**5. Changing the oil and Filter**

It is recommended to change the oil when the steering gear or pump or both the units are repaired or replaced. The filter in the oil reservoir should also be replaced and the lines cleaned at this time. When the soiled filter cartridge is removed, the bottom opening must be closed immediately while removing from the filter support to prevent dirty oil in the filter cartridge running back into the reservoir and entering the oil circuit.

**6. Recommended Inspection :**

The ZF hydraulic ball and nut steering with pump should be inspected in the installed condition, corresponding to the intervals laid down in the following table, and also depending on the vehicle application, by an inspector in the workshops of the vehicle company.

Apart from installing a new filter this inspection also entails a functional test of the entire unit and the necessary replacement of new parts.

Operating instructions can be obtained from ZF service department.

It is not necessary to remove the steering unit and pump from the vehicle for the first and second inspection, unless defects have been established, which then, of course, necessitate the removal of the steering unit or the pump.

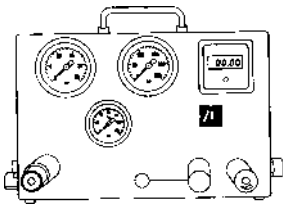
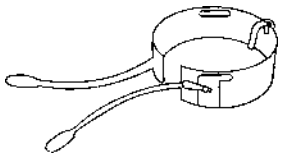
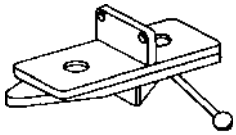
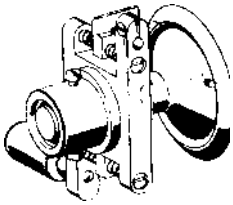
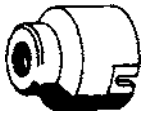
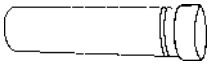
In the case of the third inspection we recommend, due to traffic safety reasons, that the steering unit and pump should be checked for correct function and wear.

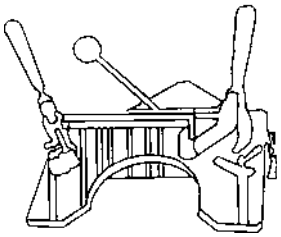
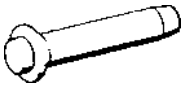
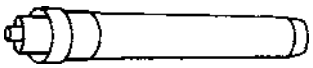
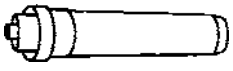
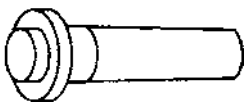
For this purpose they must be removed from the vehicle, dismantled and the mechanical transmission parts should be checked for cracks.

***Note:*** *If oil loss is apparent, check for leaks and repair if necessary. Repairs to the steering gear must only be carried out in authorised service stations.*

| | Long distance traveling | Various and short distance traveling | Traveling on building sites and cross-country |
|---|---|---|---|
| I. Inspection | 100000 km | 100000 km | 80 000 km |
| II. Inspection | 200 000 km | 175000 km | 50 000 km |
| III. Inspection | 300 000 km | 250 000 km | 200 000 km |

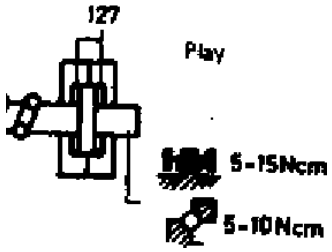
**DISMANTLING AND ASSEMBLING TOOLS**

| 8033 & M033 | 8036 8037 | 8038 | 8042 | 8043 8044 | 8045 | 8046 |
|---|---|---|---|---|---|---|
| **Tool No.1** Servo Tester  | | | 7418798570 | | | |
| **Tool No.2** Tong for Piston Assly.  | | | 3W06 040 004 | | | |
| **Tool No.3** Assembly vice for steering gear  | | | 7418798654 | | | |
| **Tool No.4** Torque measuring device (without insert)  | | | 7470798703 | | | |
| **Tool** No.5 Insert for torque measuring device 7470 798 703 Cylinder serrated gearing: a) 1 x 54 notches b) 1 x 79 notches c) 3/4" x 48 notches  | | 7840 798 551 | 7419798551 | | | |
| **Tool No.6** Sleeve for shaft Sealing ring.  | | | 7404798001 | | | |
| **Tool No.7** Entry bush for shaft seal right (129) - steering spindle Cylinder serrated gearing: a) 1 x 54 notches b) 1 x 79 notches c) 3/4" x 48 notches  | | 7832 798 001 | 7418798006 | | | |

| | 8033 &M033 | 8036 8037 | 8038 | 8042 | 8043 8044 | 8045 | 8046 |
|---|---|---|---|---|---|---|---|
| **Tool** No. **8**<br>Entry bush for oval seal ring (6 and 6.1) - segment shaft  | 8033 798 002 | 8043 798 001 | | | | | |
| **Tool No.9**<br>**Assembly vice for pump (Types -138, 303, 304 & 380)**  | 7633 798 651 | | | | | | |
| **Tool No.10**<br>Press in mandrel for radial shaft seal (303 & 304) of pump  | 7636 798 051 | | | | | | |
| **Tool** No. **11**<br>Holding plier for Assembly / Dismantling of front plate of pump  | 7672 798 652 | | | | | | |
| **Tool** No. **12**<br>Mandrel for Needle Roller of pump (709) -<br>Needle Roller<br>a) 17 x 25 x 16<br>b) 17 x 23 x 12<br>c) 16 x 22 x 12<br>d) 18 x 24 x 16  | 7677 798 051 | | | | | | |
| **Tool** No. **13**<br>Mandrel for Bush of pump Housing (709).  | 7672 978 055 | | | | | | |
| **Tool** No. **14**<br>Mandrel for Shaft Sealing Ring (708) of pump Housing.<br>Shaft sealing ring<br>a) 17 x 28 x 8(6)<br>b) 19 x 05 x 33 x 33 x 7.93.<br>c) 20 x 42 x 7  | 7672 978 052 | | | | | | |

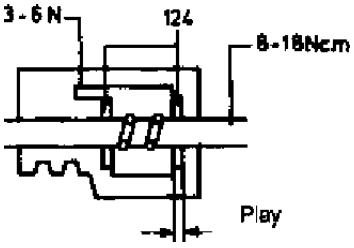
## TECHNICAL DATA AND SET VALUES - ZF HYDRAULIC BALL NUT POWER STEERING UNIT, TYPES

**Worm:**

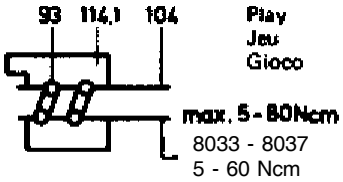



| | | |
|---|---|---|
| Bearing disks (127)- Worm bearing | Thickness : Gradations: | 1.95 to 2.35 0.01 mm |
| Friction torque worm bearing | | |
| Version : threaded ring | Loctite ident No. 222 | 5 to 10 Ncm, with seal ring (123) Without shaft seal ring (129) |
| Version : intermedediate cover | | 5 to 15 Ncm,without seal ring (123), without shaft seal ring (129) |

**Piston**

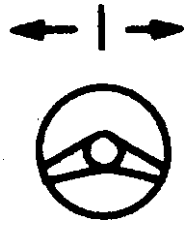



| | | |
|---|---|---|
| Friction torque - steering nut bearing | Loctite ident No. 222 | 8 to 18 Ncm, corresponds to 3 to 6 N (300 to 600 g) displacement force at the valve piston |

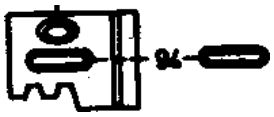



| | | |
|---|---|---|
| Ball types - circulating bore part | Diameter 14 gradation | 7.989 to 8.015 mm from 0.002 to 0.002 mm |
| | Diameter 16 gradation | 7.989 to 8.015 mn from 0.002 to 0.022 mm |

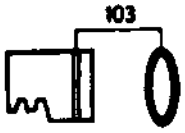
| | | |
|---|---|---|
| Frictin torque of the ball circulation section | New : when worn | 30 to 50 Ncm. 5 Ncm.Max 80 Ncm at the thread start or end |



| | | |
|---|---|---|
| Adjustment - hydraulic medium | | |
| Version with centering sprig | Adjustment with air | Value higher on gerared side 1/2 |
| Version with leaf spring | Adjustment with air | Values equal on both piston sides |
| Version with deflection rod | Adjustment with oil | Values equal on both piston sides -test stand |

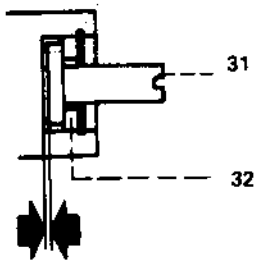



| | | |
|---|---|---|
| Seals'(94)- longitudinal piston groove | | |
| with supporting plate | Thickness : | $2.2^{+0.1}$ and $2.0^{+01}$ mm (94.1) |

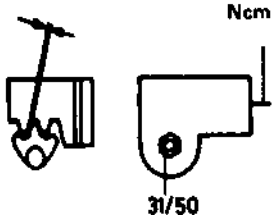



| | | |
|---|---|---|
| Piston ring (103) | Ultramid (Transperent to Ulramid yellowish translucent and lateral recesses) | |
| | or | |
| | Teflon, (deep Wite) | |

**segment shaft :**




| | | |
|---|---|---|
| Guide washer ( 32) | Thickness 14 gradations : | 2.950 - 3.28-275 mm from 0.025 to 0.025 mm |
| Axial play- adjustment screw (31) | | max.0.05 mm |
| Fricion torque increase no-play contact of the segment shaft : | 40 to 60 Ncm | |

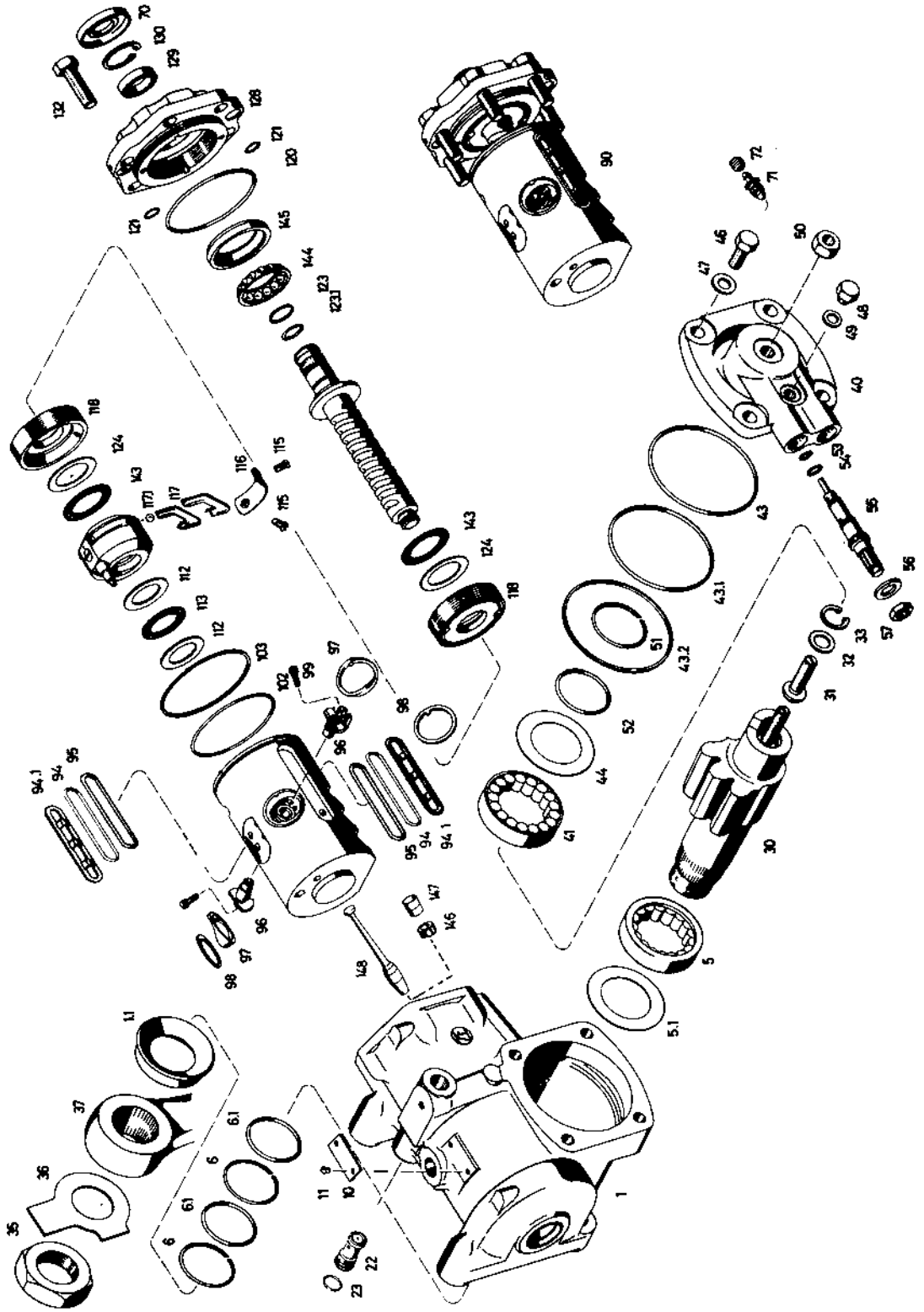



| | | |
|---|---|---|
| Friction moment outside the play free contact of the segment shaft (Steering fully assembled) | Without angle driver<br>100-200 Ncm | With angle driver<br>180-280 Ncm |

| **Tightening torques :** | | | |
|---|---|---|---|
| Hexagon bolts (132) - cover (128) | M10<br>M12 x 1.5<br>M14 x 1.5 | =<br>=<br>= | 6.2 mKg<br>11.5 mKg<br>19.0 mKg |
| Hexagon bolts (46) - housing cover | M10<br>M12 x 1.5<br>M14 x 1.5<br>M16 x 1.5 | =<br>=<br>=<br>= | 6.2 mKg<br>11.5 mKg<br>19.0 mKg<br>28.5 mKg |
| Countersunk screw (115) - circulation tube (117) | 0.6 mKg (M5), Loctite ident. No. 270 | | |
| Countersunk screw (114.3) - dogs (114.2)<br>Version with centering spring or deflection rod | 0.6 mKg (M5), Loctite ident. No. 270 | | |
| Machine screws (153) - dogs (114.2) version with leaf spring | 0.5 to 0.7 mKg | | |
| Threaded ring (146) -deflestion rod | 3.0 mKg | | |
| Machine screws (99) - feedback pistion (96) | 0.4 mKg (M5), Loctite ident. No. 270 | | |
| Valve insert (92) in the case of non-adjustable steering limitation in the piston cap | 5.0 to 6.0 mKg, Loctite ident. No. 270 | | |
| Pressure limiting valve (22) | 3.0 mKg | | |
| Sealing nut (50) - adjustment screw (31) | 9.0 mKg | | |
| Hexagon nut (57) steering limiting valve | 2.5 to 3.5 mKg | | |
| Slot nut (151) - threaded stud (15),<br>version with left spring | 1.2 mKg | | |
| Drop arm nut -65 | 50.0 mKg | | |

**Key to item numbers and exploded view** (Refer exploded view on next page)
**Housing Group**

| Sr. No. | Description | Exploded View No. | Sr. No. | Description | Exploded View No. |
|---|---|---|---|---|---|
| | **Housing Group Carter** | | 39 | Securing Plate / Spring Ring | 36 |
| 1 | Housing | 1 | 40 | Steering Drop Arm | 37 |
| 2 | Dust seal on the steering drop arm | 1.1 | | **Housing Cover Group** | |
| 3 | Threaded stud, long | 1.2 | 41 | Housing Cover | 40 |
| 4 | Threaded stud, short | 1.3 | 42 | Needle Sleeve / Roller Bearing | 41 |
| 5 | Dowel Pin | 1.4 | 43 | Round Seal Ring, Small | 42 |
| 6 | Round seal ring | 2 | 44 | Round Seal, Ring, Large | 42.1 |
| 7 | Circlip | 3 | 45 | Round Seal Ring | 43 |
| 8 | Cap plug | 4 | 46 | Round Seal Ring | 43.1 |
| 9 | Needle sleeve / roller bearing | 5 | 47 | Seal Ring | 43.2 |
| 10 | Washer | 5.1 | 48 | Supporting Washer / Ring | 44 |
| 11 | Shaft Seal Ring / seal supporting | 6 | 49 | Profile Seal Ring | 45 |
| 12 | Round Seal Ring / oval Seal Ring | 6.1 | 50 | Hexagon Bolt, Short | 46 |
| 13 | Circlip | 7 | 51 | Threaded Stud / Hexagon Bolt Long | 46.1 |
| 14 | Supporting Washer | 8 | 52 | Hexagon Nut | 46.2 |
| 15 | Pre Seal Ring | 9 | 53 | Hexagon Bolt | 46.3 |
| 16 | Type Plate | 10 | 54 | Washer | 47 |
| 17 | Half round dowel pin | 11 | 55 | Threaded Plug | 48 |
| 18 | Valve Body | 12 | 56 | Sealing Nut | 50 |
| 19 | Valve Spring | 13 | 57 | Seal/Supporting Ring | 51 |
| 20 | Round Seal Ring | 14 | 58 | Round Seal Ring / Oval Seal Ring | 52 |
| 21 | Adjusting Screw | 15 | 59 | Round Seal Ring | 53 |
| 22 | Valve Guide | 16 | 60 | Round Seal Ring | 54 |
| 23 | Round Seal Ring | 17 | 61 | Valve | 55 |
| 24 | Distance Piece | 18 | 62 | Washer | 56 |
| 25 | Seal Ring | 19 | 63 | Hexagon Nut | 57 |
| 26 | Threaded Plug | 20 | 64 | Round seal ring | 58 |
| 27 | Choke | 21 | | **Fittings and Small Parts Group** | |
| 28 | Clamping Sleeve, Large | 21. | 65 | Protective cap | 70 |
| 29 | Clamping Sleeve, Small | 21.2 | 66 | Bleeding Screw | 71 |
| 30 | Pressure Limiting Valve | 22 | 67 | Cap Plug | 72 |
| 31 | Round Seal Ring | 23 | 68 | Bleeding Unit | 73 |
| 32 | Mesh Filter | 24 | 69 | Seal Ring | 74 |
| | **Segment Shaft Group** | | 70 | Threaded Plug | 75 |
| 33 | Segment Shaft | 30 | | **Piston Group** | |
| 34 | Adjustment Screw | 31 | 71 | Complete Piston | 90 |
| 35 | Guide Washer / Wear Washer | 32 | 72 | Piston Assembled | 91 |
| 36 | Circlip / Threaded Ring | 33 | 73 | Valve Insert | 92 |
| 37 | Split spin | 34 | 74 | Ball | 93 |
| 38 | Castle nut / Hexagon Nut | 35 | 75 | Seal | 94 |



POWER STEERING GEAR - TYPE - 8043

*Fig. 7*

| Sr. No. | Description | Exploded View No. | Sr. No. | Description | Exploded View No. |
|---|---|---|---|---|---|
| 76 | Seal | 95 | 117 | Round Seal Ring | 126 |
| 77 | Feedback Piston | 96 | 118 | Bearing Disk | 127 |
| 78 | Piston | 96.2 | 119 | Cover | 128 |
| 77 | Seal/Round Seal Ring | 97 | 120 | Shaft Seal Ring | 129 |
| 78 | Seal | 98 | 121 | Circlip | 130 |
| 79 | Machine Screw | 99 | 122 | Washer | 131 |
| 80 | Threaded Stud | 100 | 123 | Hexagon Bolt | 132 |
| 81 | Slot Nut | 101 | 124 | Hexagon Bolt | 132.1 |
| 82 | Round Seal Ring | 102 | 125 | Round Seal Ring | 133 |
| 83 | Piston Ring | 103 | 126 | Round Seal Ring | 134 |
| 84 | Worm Assembled | 104 | 127 | Cap Plug | 135 |
| 85 | Clamping Sleeve | 105 | 128 | Round Seal Ring | 136 |
| 86 | Clamping Sleeve | 106 | 129 | Seal Ring | 136.1 |
| 87 | Circlip | 107 | 130 | Guide Tube | 137 |
| 89 | Wear Disk | 108 | 131 | Round Seal Ring | 138 |
| 90 | Needle Cage | 109 | 132 | Seal Ring | 139 |
| 91 | Bearing Ring | 110 | 133 | Sleeve | 140 |
| 92 | Wear Disk | 111 | 134 | Ball | 141 |
| 93 | Bearing Disk | 112 | 135 | Valve Insert | 142 |
| 94 | Axial Needle Cage | 113 | 136 | Axial Needle cage | 143 |
| 95 | Steering Nut Assembled | 114 | 137 | Axial Needle cage/Ball Holder | 144 |
| 96 | Steering Nut | 114.1 | 138 | Bearing Ring Outer | 145 |
| 97 | Dog | 114.2 | 139 | Clamping Ring | 146 |
| 98 | Counter Sunk | 114.3 | 140 | Clamping Ring | 147 |
| 99 | Bearing Needle | 114.4 | 141 | Deflection Rod | 148 |
| 100 | Centering Spring | 114.5 | 142 | Ball | 149 |
| 101 | Spring Plates | 114.6 | 143 | Threaded Stud | 150 |
| 102 | Countersunk Screw | 115 | 144 | Slot Nut | 151 |
| 103 | Covering Plate | 116 | 145 | Leaf Spring | 152 |
| 104 | Half Circulation Tube | 117 | 146 | Machine Screw | 153 |
| 105 | Ball Set | 117.1 | | **Pressure Limiting Valve Group** | |
| 106 | Threaded Ring | 118 | 147 | Threaded Plug | 201 |
| 107 | Threaded Ring | 118.1 | 148 | Sleeve | 202 |
| 108 | Grooved Nut | 119 | 149 | Valve Piston | 203 |
| 109 | Round Seal Ring | 120 | 150 | Round Seal Ring | 204 |
| 110 | Round Seal Ring | 121 | 151 | Pressure Spring | 205 |
| 111 | Intermediate Cover | 122 | 152 | Washer | 206 |
| 112 | Round Seal Ring | 122.1 | 153 | Spring Plate | 207 |
| 113 | Seal Ring | 123 | 154 | Valve Body | 208 |
| 114 | Round Seal Ring | 123.1 | 155 | Washer | 209 |
| 115 | Axial Disk | 124 | 156 | Thrust Element | 210 |
| 116 | Needle Sleeve | 125 | | | |

**REMOVING THE STEERING UNIT FROM THE VEHICLE**

1. Thoroughly clean the steering unit and the area around it paying particular attention to the line connection.
2. Drain the oil by opening one of the inlet/outlet connections. Turn the steering so that the piston is shifted upwards up to the stop. Then briefly, maximum 10 seconds, crank the engine until the oil is sucked out of the pump and oil reservoir. After switching off the engine turn the steering several times both up to the left and right stops so that the oil remaining in the cylinder chambers is pumped out. .
3. Disconnect the pressure and return lines from the steering.
4. Plug all openings, to prevent dirt entering the system.
5. Remove the steering drop arm with a suitable pulling device. Under no circumstances must the steering drop arm be removed by driving a wedge between the neck of the housing and the steering drop arm or with hammer blows since this may, cause serious damages within the steering gear.
6. Valid for steering units with universal joints:
   a) Loosen the universal joint or flexible coupling between the steering gear and steering column.
   b) Remove the securing bolts on the housing and withdraw the steering unit.

**DISMANTLING THE STEERING UNIT**

**A) Removing and dismantling the housing cover**

1. Clamp the steering unit in the assembly vice 1 or between the soft jaws of a commercially available vice. Loosen the hexagonal nut (57) and screw out the steering limiting valves (55) (Figure 8). Remove the sealing nut (50) from the housing cover.
2. Remove the hexagonal bolts (46) and also remove the housing cover (40) by turning the adjustment screw (31) in a clockwise direction (Figure 9.)

2.1 For steering versions with roller bearing

*Note: The rollers of the roller bearing (5 and 41) have been sorted into certain tolerance groups by the manufacturers. Therefore, the rollers removed from the bearings external ring on the cover side must not be interchanged with the rollers removed from the housing side.*

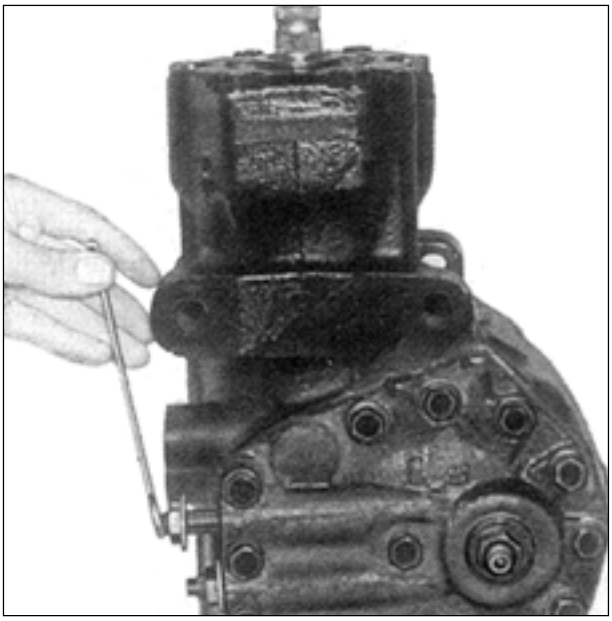


*Fig. 8*

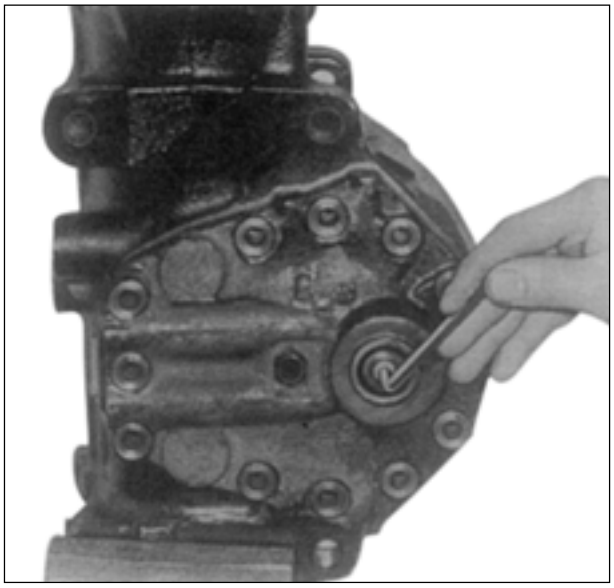


*Fig. 9*

**B) Removing sector shaft**

Withdraw the sector shaft (30) in the centre position of the gearing, upwards out of the housing (Figure 10).

Further dismantling in ZF factory or ZF authorised dealers only. Remove the circlip (33) from the sector shaft and withdraw the adjustment screw (31) with the guide washer (32).

**C) Removing the piston**

1. Remove the protective cap (70) from the worm end. Screw out the securing bolts (132) (Fig. 11). A burr (ridge) may have formed on the side of the piston gearing depending on the service duty of the steering unit, and this will damage the piston running surface when the piston is removed from the housing. This can be avoided if the unit is dismantled horizontally overhead (gearing uppermost). Fig. 12 shows dismantling in an unfavorable position.

1.2 For steering version with threaded ring

Withdraw the piston with the worm and cover (128) from the housing.

2. Remove the seal parts

(94,94.1,95,97,98, 102, 103, 120 and 121)

**D) Removing and dismantling pressure limiting valve if applicable**

*Note: In some steering versions, the pressure limiting valve for the maximum oil pressure of the steering pump is built into the housing (1) of the steering unit. Such steering systems can be recognized by the pressure specifications stamped onto the type plate of the steering unit. This should be observed especially for fault finding.*

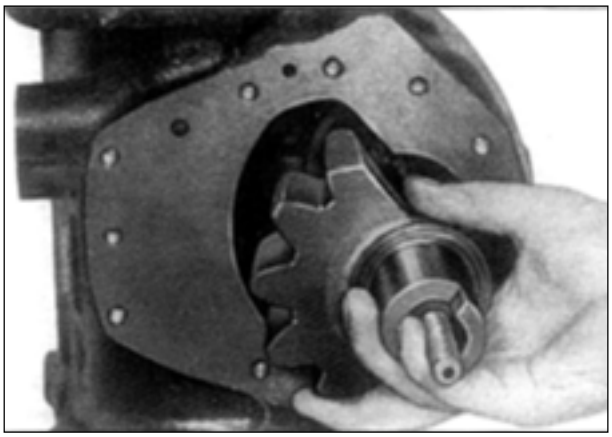


*Fig. 10*

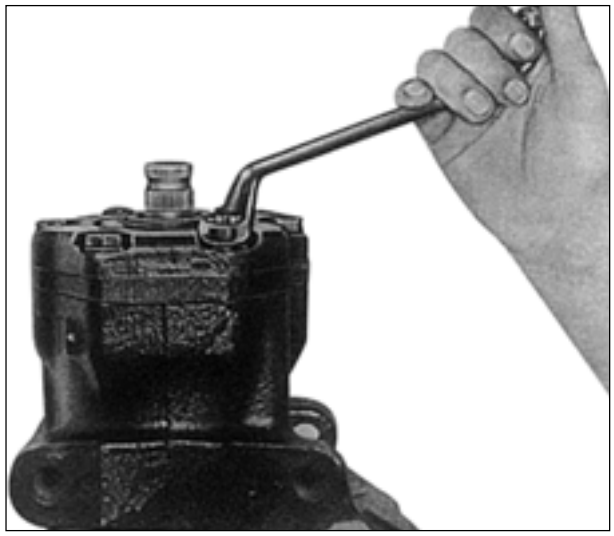


*Fig. 11*



*Fig. 12*

**E) Dismantling housing**

Removal and fitment of seals 6 & 6.1 is allowed. Further dismantling of rollers and bearing race is permissible in ZF factory only.

**F) Dismantling of piston**

(Permissible in ZF factory only)

1. Remove spring element

1.1 For steering version with centering spring

Loosen the slot nut (101) with special tool, and turn out of the piston with the threaded stud (100) (Figure 13).

Screw out the second threaded stud with the slot nut.

2 Removing the steering nut and valve piston

Permissible in ZF factory only:

2.1 Strike open the caulking at the grooves at the threaded ring (118) and unscrew the threaded ring with special tool (Fig. 14). The ring is sealed with Loctite; it can only be removed by heating up to a temperature of approx. 125°C Heating must be carried out in a suitable oven. In this case. It is recommended to immediately loosen the two machine screw (99) and then the two countersunk screws (115) after removing the steering nuts (these are also fitted with Loctite.)

It is only necessary to remove the valve seat (92), also fitted with Loctite, for the steering version with nonadjustable steering limitation when oil has leaked into the ball seats.



*Fig. 13*

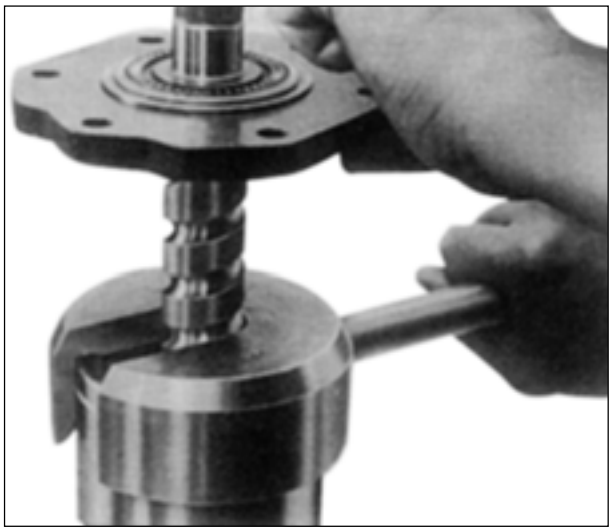


*Fig. 14*

2.2 Withdraw the worm with the steering nut (114) from the piston (Figure 15).

2.3 Screw the two machine screws (99) and withdraw the feedback (96) out of the valve piston.

2.4 Mark the position of the valve piston and then slide out the valve bush.



*Fig. 15*

3. **Dismantling steering nut:**

Unscrew the two countersunk screws (115) on the cover plate (116) (Figure 16). Remove the cover plate; shake the ball circulation tube (117) and the balls out of the steering nut (114). Remove the steering nut, needle cage (143), axial disk (124), threaded ring 118), intermediate cover (122) axial disk (124) and the needle cage (144) from the worm.

4. **Dismantling the spring element:**

Permissible in ZF Factory only:

4.1 For steering version with centering spring

Unscrew the countersunk screw (114.3) and press the finger (114.2) out of the groove of the steering nut. Remove the two spring plates (114.6) and the centering spring (114.5) from the finger.

4.2 For steering version with leaf spring

Unscrew the Allen screw (153). Remove the leaf spring (152).

4.3 For steering version with deflection rod

Unscrew the threaded bush (146) with special tool) and loosen the deflection rod (148) by lightly tapping a screwdriver or drift, made from round steel with a dia. of 8 mm., with a hammer. Slide the clamping high (147) together with the deflection rod out of the piston from the upper side of the piston.

**G) Removing worm bearing mounting for steering version threaded ring in the cover**

Permissible in ZF Factory only:

1. Clamp the cover (128) in the vice with the worm thread pointing upwards. Knock open the caulking of the two grooves of the threaded ring (118.1) and unscrew the threaded ring with special tool (Figure 17). The threaded ring is sealed with Loctite (see Section F).

1.1 For steering version with angular ball bearing

Remove the axial disk (124), axial needle cage (143), worm, ball holder (144) and bearing ring (145) one after another (Figure 18). Remove the circlip (130) and the shaft seal ring (129).

1.2 For steering version with axial needle bearing

Remove the axial disk (124), axial needle cage (123), worm, second axial needle cage (123), second axial disk (124) and bearing ring (145) one after another. Remove circlip (130) and shaft seal ring (129).

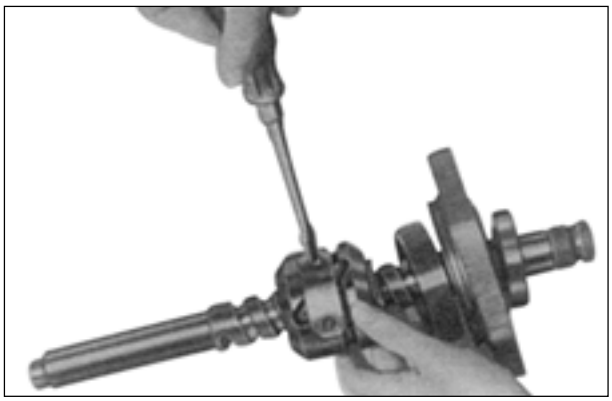


*Fig. 16*

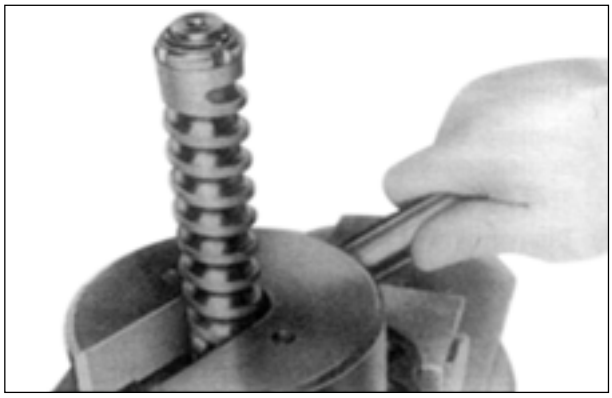


*Fig. 17*



*Fig. 18*

## CHECKING THE STEERING PARTS

***Note:*** *Thoroughly wash all parts in a cleaning fluid. Clean Loctite residue from the threads. The seal rings and other rubber parts must not be cleaned in trichloroethylene but with a suitable washing liquid, such as P 3 or Pril, which is completely soluble in water.*

**Checking**

Check all parts for wear, damage or other defects in order to establish whether the parts can be used again. Only new parts suitable for the type of steering and corresponding to the spare parts list should be used, see type plate e.g. 8043955302.

***Important***

*The test requires detailed specialist knowledge and conscientiousness. The fitter must be responsible for the decision as to whether the parts needed changing or not.*

1. **Housing and housing cover**

1.1 Cylinder bore. Max. wear dimensions of the bore diameters for honing:

1.2 Threads

2. **Piston***

2.1 External diameter

2.2 Gearing (crack testing longitudinally and laterally with a suitable testing procedure such as ferra flux). Scrap all parts with cracks. Remove any burr (ridges) on the sides of the gearing. Permissible in ZF factory only.

3. **Worm and steering nut**

(Permissible in ZF factory only)

3.1 Ball circulation channel (coefficient of friction in the center range of the channel, min. 5 Ncm)

3.2 Running surfaces of the needle cages and of the shaft seal ring.

3.3 Cylindrical parts of the steering finger.

3.4 Serrated gearing of the worm

3.5 Crack testing. longitudinal and lateral (with suitable testing procedure, ferro flux). Scrap all parts with cracks.

3.6 Play between the bending bar and the longitudinal groove of the steering, maximum 0.2 mm.

*The piston (90), valve piston, finger (114.2), steering nut (114.1) and worm (104) must all be changed if one of the parts is damaged since they are selected and mated at the factory to keep play to a minimum.

4. **Sector shaft**

4.1 Teeth (crack testing, longitudinally and laterally, with suitable testing procedure, e.g. ferry flux.) Scrap all parts with cracks.

4.2 Running surfaces of the needle sleeves and the shaft seal ring.

5. **Needle bearing and ball bearing**

The relevant bearings should be changed in the case of indentation or wear on the running surfaces of the steering parts.

**ASSEMBLY OF THE STEERING UNIT AND FUNCTION TESTING**

Before assembly, all traces of paint and damages must be removed from the face surfaces of the housing and cover. In addition, all parts must be thoroughly cleaned, lightly oiled and all sealing parts must be renewed. The measuring and adjusting tools used must be regularly checked for accuracy.

Permissible in ZF factory only.

Apply Loctite to the threaded rings (118 and 118.1), machine screws (99) and countersunk screws (115). This requires that the parts are dry, oil and grease free. That the oil Loctite deposits are removed and that the sprayed activator is ventilated. Pretreating the contact surfaces with activator T accelerates the initial hardening time. The Loctite should be applied so that no excess loctite drips onto the parts after they have been joint together. Hardened Loctite drops may lead to functional disturbances. Loctite joints should only be separated after the Loctite has fully hardened and then refitted together. The use of Loctite is not dealt with in any further detail in the repair instructions, except for the fact that care should be taken to select the correct identification number of the type of the Loctite to be used.

**Hardening times for loctite identification No. 222 and 270 arm room temperature.**

| | |
|---|---|
| After two hours, | it can be transported, adjustment of the hydraulic medium possible with air. |
| After six to eight hours, | Completely hardened. adjustment of the hydraulic medium possible with oil or final testing on the testing rig. |

**A) Pre-assembly of Housing**

1 Clamp the housing in the assembly vice.

For steering version with roller bearing

***Note:*** *The rollers of the roller bearings* (5 *and* 41) *have been sorted out in certain tolerance groups by the manufacturer. Therefore, the rollers removed from the bearing outer ring on the cover side must be interchanged with the rollers from the housing side.*

Permissible in ZF factory only.

1.1 Place the housing on the workbench with the housing neck facing downwards. Plate the supporting disk (5.1) in the bearing neck bore hole.

For roller bearings without roller cage.

Press the outer ring of the roller bearing (5), without the roller, into the housing until it reaches the collar using tool 18, and lock in position by making 10 notches around the circumference. Fit the rollers with grease (Fig. 19) and place the polymide filler piece in a roller gap; this provides protection which the parts are stored and remains in the steering unit. Then place the fitted rollers in the outer ring of the bearing by inserting the sector (segment) shaft; this is important for installing the segment shaft seater with fitted seal rings (6.1 and 6). Remove the sector (segment) shaft.

Press the roller bearing into the housing until it reaches the collar with the open cage side first, and lock in position by making 6 notches around the circumference.

Mount the additionally fitted needle sleeve (5) as described in 1.1.1 for the steering unit version with long bearing neck.

1.2 Place one round seal ring (6.1) and one seal ring (6) in each of the two radial grooves of the housing neck. Special care must be taken to ensure that the polyamide rings with the beveled surface lie on the same inclined surface of the groove (Figure 20).

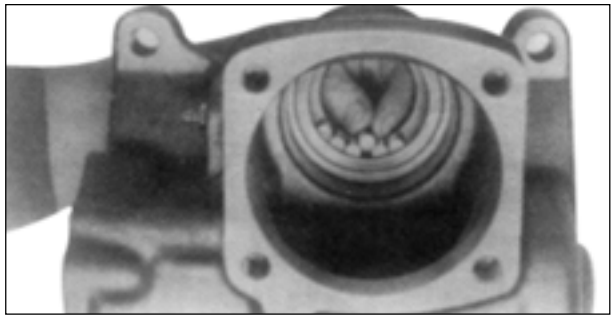


*Fig. 19*



*Fig. 20*

**B) Preassembling the segment shaft**

Fit the adjustment screw (31), guide washer (32) and circlip (33) in the segment shaft with the punched curve outwards (Fig. 21). The adjustment screw should be fitted play - free but must not jam. (Refer to technical data)

**C) Preassembling the piston and adjusting the hydraulic reaction.**

Permissible in ZF factory only.

**D) Fitting the piston**

1. Fit the seals (95) in he longitudinal grooves of the piston and then fit the seals (94) (Fig. 22). A support plate (94.1) must also be fitted in he longitudinal recesses in the case of steering types 8043, 44 and 46. There are two sizes of seals (94) which differ in their overall heights (refer to the technical data).

   The piston must be dismantled once again and the seal with a smaller overall height must be fitted if a larger value than is given in the technical data is obtained outside the pressure point in the test of the frictional forces of the complete assembled steering. The friction force is determined by evenly turning the worm with the torque measuring device 4 and insert 5.

2. The pair of seals (97 and 98) are also fitted with the inner seal (97) first and then the outer seal (98). Place the round seal ring (102) in the recess of the piston and then fit the piston ring (103). Special care must be taken when passing the seal over the piston to ensure that no damage is caused by the edges of the piston The small round seal rings (121) must be adhered to the recess of the intermediate cover (122) or the Cover (128) by means of grease. Lubricate the cylinder path well with oil.

**E) End Cover**

1. Slide in the preassembled piston up to the shoulder of the end cover. In order that the seal parts are not damaged the piston should be fitted in its final position, i.e. gearing parallel to housing neck (Figure 23).

   For steering version with threaded ring in the cover: screw in and tighten the hexagon bolts (132) with the washers (131).

2. For steering version with threaded ring in the cover and long R dimension.

   Only use the washers (131) in conjunction with the bolt lengths given in the parts list.



*Fig. 21*

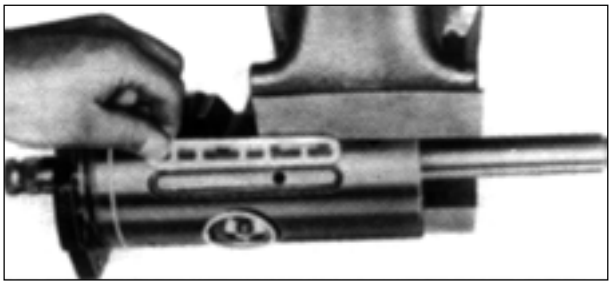


*Fig. 22*

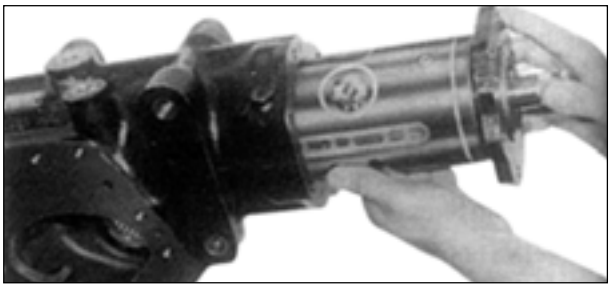


*Fig. 23*

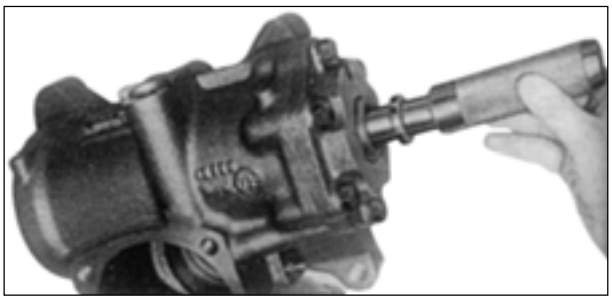


*Fig. 24*

3. Slide the entry bush over the serrated gearing of the steering spindle (Fig. 24), press the shaft seal ring (129) with the sleeve so deep that the circlip (130) can just be fitted in its groove (sealing lip pointing towards the inside of the housing. Fill the space between the sealing lip and the dust lip with hot bearing grease) fit the circlip (130).

   Refer to the technical data for tightening torques.

**F**) Pressure relief valve

If the rated pressure is not obtained, the valve inserts should be replaced.

**G) Housing Cover**

1. Clean the parts thoroughly whereby the rubber or plastic parts must not come in contact with trichloroethylene. Clean the bore holes with compressed air.
2. Fit the round seal ring (52) and the seal ring (51) in the radial groove. Special care must be taken to ensure that chamfered area of the polyamide ring lies in the same chamfered surface of the groove (Fig. 25).

**H) Fitting the segment shaft**

1. Bring the piston to the center position by turning the end of the steering shaft. This center point is found by first determining the total number of turns of the worm then turning back the piston from one stop by half the total number of turns.

1.2 For steering version with roller bearing

Slide the entry bush over the tapered serrated gearing of the segment shaft (30). Insert the segment shaft into the housing, taking care not to damage the sealing parts.

Push the dust seal (1.1) onto the segment shaft up to the shoulder and apply HTR2 grease or similar between the dust seal and housing.

**I) Fitting the housing cover**

1. For steering version with roller bearing :

   Fit the round seal ring (43) and the round seal ring (43.1) together with the seal ring (43.2) in the two radial grooves. The round seal ring (43.1) is fitted together with the seal ring (43.2) in the radial recess on the inside of the housing.
2. Fit the housing cover (Fig. 26). Position the housing cover by turning the adjusting screw (31) on the front surface of the housing in a counter - clockwise direction and screw on the sealing nut (50) temporarily.



*Fig. 25*



*Fig. 26*

Screw in and tighten the hexagon bolts (46) with washers (47).

Screw in the threaded plug (48) and tighten (refer to the technical data for the tightening torque).

**J) Setting the pressure Point**

1. Place the torque measuring unit 4 and insert 5 on the worm.
2. Turn the steering from the one end position to the other. Measure the frictional force outside the pressure point and determine the total turn of the steering wheel.

3. Then set the frictional force in the area of the pressure point (mid position; half of the total turn of the steering wheel). The torque measuring desire is turned both to the left and right of the centre position by one and half turn from ahead position and the adjusting screw should be screwed out so far until an increase in the friction torque of 40-60 Ncm compared to the value measured in point 2 is set (Figure 27).
4. Tighten the sealing nut (50) (refer to the technical data of the tightening torque), while holding the adjusting screw in a fixed position. Check the set torque once again. Fit the protective cap (70).

**K) Fitting the steering limiting valve**

Fit the round seal rings (53 and 54) in the radial groove of the two valves. Turn the valves into the housing cover 9 (Figure 28). Turn the hexagon nuts (57) with the washers (56) onto the threads and tighten slightly.

**L) Checking the frictional torque of the completely assembled steering unit**

Place the torque measuring device 4 and insert 5 on the worm. Turn the steering unit from one end position to the other. Measure that frictional torque outside the pressure point in a horizontal position (refer to the technical data.) If the frictional torque is above this value, this may be due to excessive initial tension of the seal (94) in the piston (see Section D).

**Functional test:**

Clamp the completely assembled steering unit on the steering test rig according to the instructions given in section VIII after Final hardening time for loctite. Bleed the steering unit (see section III) and increase the oil temperature to approximately 50° C.

The adjustment values given in section VIII are valid the for setting pressure point of the steering system after completion of the repairs on the workbench. There is no oil in the steering unit.

1. **Testing the maximum pressure:**

Block the steering unit in the mid position (steering units without hydraulic steering limiting system can also be turned to the stop). Turn the steering wheel until the maximum pressure has built up on one side of the cylinder. For this purpose it is necessary to apply a force of 100 - 200 N (10 - 20 mkg) to the periphery of the steering wheel so that the maximum path of the valve is utilized.

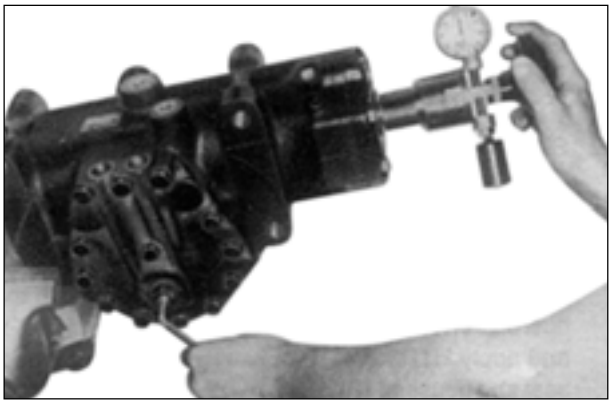


*Fig. 27*

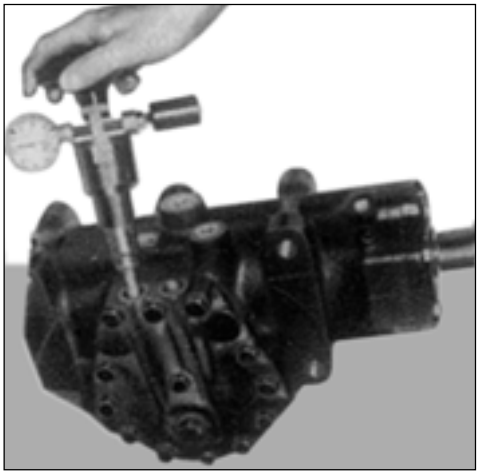


*Fig. 28*

If the steering unit is fitted with a pressure limiting valve a maximum pressure must be built up which corresponds to the specifications given on the type plate (tolerance + 10%). If the steering unit has no pressure limiting valve then the pressure limiting valve built into the testing rig must be set to the rated pressure which is predetermined for the steering unit (this would correspond to the rated pressure which is given on the type plate of the pump.)

The same measurements are now carried out in the opposite direction of the steering wheel. If the maximum pressure is not reached within the specified tolerance, the oil leakage in the steering system is either too great or the pressure limiting valve, if applicable, is incorrectly adjusted. The latter can also be the reason for too high maximum pressure.

2. **Adjusting the maximum pressure for steering systems with built-in pressure limiting valves:**

   The pressure must agree with the specifications given on the type plate of the steering unit (tolerance + 10%). Valve inserts from the date of manufacture 12/76 cannot be adjusted and must be changed completely in the case of pressure deviations. The valve can, however, be dismantled for cleaning purposes.

3. **Checking for oil leaks :**

   The control valve must be fully activated in order to be able to determine the leakage oil in the steering system, For this reason a minimum of approx. 200 N (20 mkg) must be applied to the steering wheel. The test is carried out with the pump running and a pressure is set on the steering testing rig which lies approximately 20 bar below the maximum pressure given on the type plate.

   The maximum permissible leakage oil under these conditions is :

   2.0 LPM for type 8043

   The test can be carried out with blocked steering drop arm or in the end positions of the cylinder. Repeat the leakage oil check at a pressure of 20 - 30 bar.

4. **Checking the valve setting:**

   The pump is running and the oil circulates through the hydraulic system of the steering unit. No counter force is set on the steering shaft in the steering test rig. The hydraulic steering is turned slowly to both sides up to the stops in each case and the torque measuring device is released several times during this process. The steering must not move in any direction on its own. The difference in the torques when steering to left and right must not exceed 30% in respect of the low value up to a pressure of 3 bar compared with the flow pressure when the steering drop arm is blocked.

5. **Checking control valve:**

   Close the control valve by turning the steering wheel then build up the maximum pump pressure. The steering wheel should then be slowly released. The valve should then return to the 0 position, i.e. the oil pressure must fall to the flow pressure.

6. **Setting the hydraulic steering limiter:**

   Turn the steering wheel in one direction until the deflection of the steering drop arm as given in the parts list for the switch - off point of the hydraulic steering limiting system is reached. Then adjust the setting turning the valve (55) in or out according to section II, paragraph B) until the oil pressure drops. This can be felt immediately in that the steering wheel can be turned only with increasing force. The adjustment should also be carried out in the opposite direction of the steering drop arm. Finally lock the hexagon nut (57) with a torque of 25 to 35 Nm.

7. **Checking the seals:**

   No leaks should be visible on the hydraulic steering unit after running for 10 minutes in the neutral position of the steering valve.

   Tightness at high pressure must be determined during the test in accordance with points 2 to 4 of this section. Place the dust seal (1.1) on the segment shaft up to the shoulder, applying HTR2 grease or equivalent between the dust seal and housing, and place the protective cap (70) on the steering spindle end, applying HTR2 grease or equivalent between the protective cap and valve housing.

**FITTING THE STEERING UNIT IN THE VEHICLE**

*Note: In order to ensure perfect functioning of the ZF hydraulic ball & nut steering, special emphasis must be paid to cleanliness when fitting all the relevant units of the system and when laying the oil lines. In order that faults can be avoided due to foreign bodies or dirt in the oil steering circuit the cap plugs on the line connections of the steering unit, oil pump, working cylinder, valves etc. should only be removed when connecting on the lines. Connection lines and securing elements must be carefully cleaned and deburred.*

1. Clean any paint or dirt from the contact faces of the mounting brackets.
2. Insert the steering gear in the mounting bkts and tighten the bolts with the corresponding torque.
3. Stresses which may occur during the assembly of the steering gear / bearing block due to the position of the dash board or on the instrument panel must be avoided under all circumstances when securing the steering column tube and steering spindle.

   Stresses can cause bending forces especially in the steering spindle which, depending on size and frequency, may lead to fractures or impair the easy movement of the steering gear.

The check whether the steering unit has been installed correctly should be carried out as follows:

3.1 Check the movement of the steering gear at the mounting bracket, steering drop arm and drag links (s).

Fit the universal joint or the flexible coupling between the steering column and the steering gear. The angled fork section must be at right angles to the markings on the steering spindle and steering columns tube or valve housing in straight ahead position. The angle should be the same if two joints are used and the joint forks must be arranged in one plane. If it is not possible to fit them in this way, synchronization can be achieved by positioning the forks on the serrated gearing in respect of each other.

Hammer blows on the joints must be avoided in the case of aluminium universal joints because this might lead to destruction or stiffness. Connect them by inserting the fit bolts and tightening the nuts. (Refer to the technical data for the tightening torques).

4. Bring the steered wheels of the vehicle to the straight ahead position. This positions is reached when the steered wheels are flush or parallel to the second pair of wheels (place the measuring bar on the front and rear wheel).

5. Slide the steering drop arm onto the sector shaft (30), whereby the markings of the steering drop arm and the segment shaft must coincide. Tighten the hexagon nut (35) temporarily and turn the steering clockwise until the wheel stop. Remove the steering drop arm and establish whether there is steering reserve in the steering unit by continuing to turn the steering wheel. Repeat the measurement in clockwise direction. Tighten the hexagon nut (35) with torque given below and secure with the split pin (34) or the securing plate (36). Hook on and tighten the drag link.

6. Secure the hydraulic pump on the bearing block and adjust the necessary tension of the V - belt. Thumb test.

7. Connect the pressure and return lines between the pump, steering and working cylinders. If the lines have to be bent then this must be carried out in a cold condition so that the risk of combustion is eliminated.

8. Commissioning the steering unit

In order to prevent dirt particles which still could be in the oil line system, from entering the pressure limiting valve during first commissioning, we recommend that the oil is allowed to flow through the system for several minutes, with changing engine speed and without turning the steering wheel. The steering should then be turned several times in both directions without completely reaching the stops of the steering system at a medium engine speed (until the operating temperature is reached). It is advantageous for steering units with a built-in pressure limiting. Finally bleed the steering unit (see page no. 10).

9. Refer to page no. 7 for adjustment of the hydraulic steering limiting.

## VANE PUMP

## MAINTENANCE INSTRUCTION AND FUNCTIONAL DESCRIPTION

### Maintenance and oils

**1. Checks**

The pump is lubricated by the hydraulic oil, meaning that no additional servicing of the bearings is necessary. On the other hand, it is important that the oil level in the tank be checked at regular intervals. We recommended that this check be carried out at least every 5000 kilometers travelled.

The possibility of air being trapped at various points within the oil circuit and the fact that very small air bubbles still remain in the oil even after air bleeding make it necessary for the oil level to be checked while the pump is running.

The trapped air is then under operation pressure, subsequently expanding under normal atmospheric pressure when the pump has been shut down.

Experience has shown that this causes the oil level to rise approximately 1 to 2 cm in the oil tank when the pump has been shut down.

It is recommended to check the oil level in the oil tank prior to starting the pump and, if necessary, to top up the oil level until it is approximately 2 cm above the upper mark when the pump is at a standstill. Only then should the pump be started. If the oil level then drops excessively (in other words more than 1 to 2 cm), the entire hydraulic system must be bled. Refer to the section entitled “Oil filling and air bleeding” in our inspection documents for hydraulic steering units.

In order to prevent the intake of air, all screw connections and pump lines should be checked for tightness and, if necessary, retightened when the vehicle involved is in for general servicing.

**2. Filter change**

For every 72,000 Kms run, the filter must be changed.

The filter in the oil tank should also be changed when repairs are performed on the pump or the steering unit should also be changed at the same time as the main steering unit inspection (refer to the inspection instructions from the oil reservoir.)

**3. Type of oil**

Oil to be changed at every 72,000 Kms run.

A suitable hydraulic oil must be used in order to ensure perfect functioning of the pump. The hydraulic oil also lubricates the pump, meaning that only one type of oil is required for the entire system.

The unit should be filled with suitable ATF oils having a viscosity of approximately 26 mm2/s (cSt) at 50$^{O}$C, a setting point below -35$^{O}$C and a low foaming tendency. Oils of higher viscosity may result in an excessive under pressure in the inlet line, thus possibly causing pump noise and destruction through. Some of the types of oil recommended by us for the first filling of pumps are listed on the oil - tank.

### Functional description

ZF vane pumps have been specifically designed to supply pressure oil to hydraulic - assisted steering systems. The low number of moving parts (drive shaft, rotor and vanes) and the minimum possible face - end play of these elements with respect to the drive - side and cover - side faceplate ensure high efficiency and, consequently, the best possible utilization of power. This efficiency is also partially the result of the pairs of two opposite suction and pressure lines, a design whereby the ten pump cells each convey twice their own cell volume per revolution. The double arrangement of the suction and pressure lines results in mutual cancellation of the hydraulic radial forces acting upon the rotor.

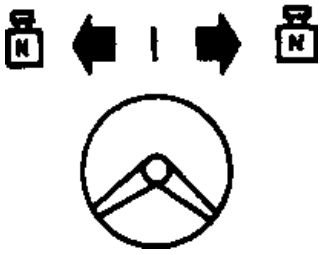
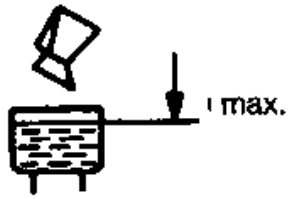
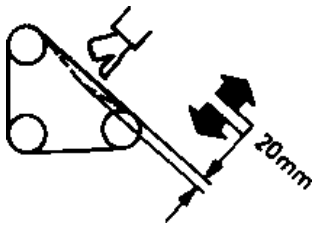
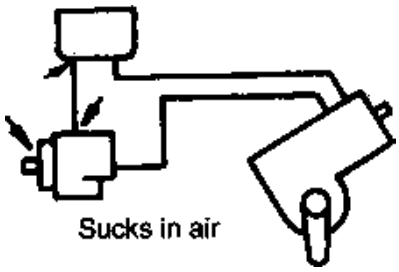
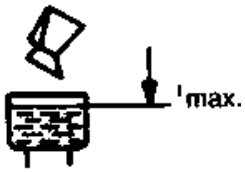
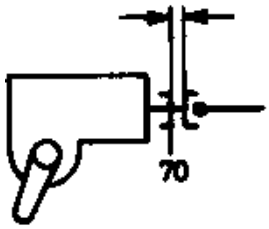
When turning the drive shaft and the rotor connected to it, the vanes guided therein are also driven. Centrifugal force and pressure oil which can pass via bores and grooves from the pressure chamber on the inside faces of the rotor, force the vanes against the track of the cam ring. The pump cells are thus separated from each other, causing intake as the volume rises and discharge as the volume decreases. The oil passes from the two pressure chambers into the space between the cover and the cover - side faceplate, which is thus forced against the cam ring at operation pressure, and also to the flow -limiting valve and, via throttle to the discharge line.

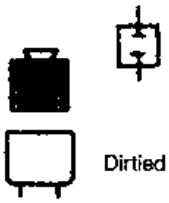
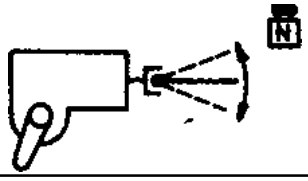
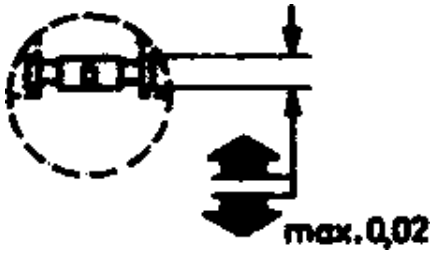
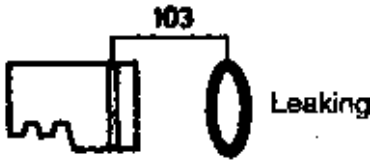
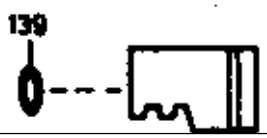
An increase in speed and or increase flow results in an increasing pressure drop downstream of the choke and, consequently, on the spring side of the valve piston. As soon as the hydraulic force (pressure difference x piston area) exceeds the spring force, the piston moves against the spring, with the result that the superfluous conveyed oil can pass into the inlet channel of the pump via the bypass bore which is then opened. Consequently, an almost constant oil flow delivered for the steering unit over the entire speed range. The maximum pressure in the pump is controlled by a spring - loaded valve in the flow - limiting piston.

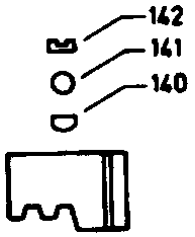
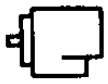
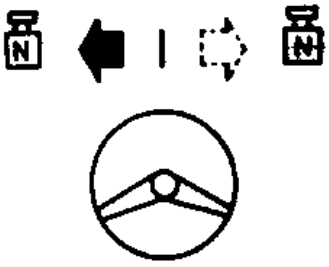
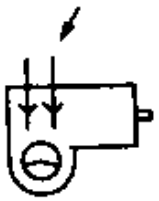
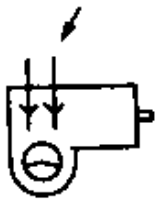
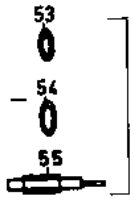
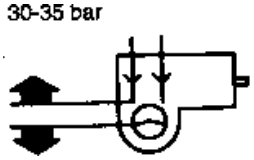
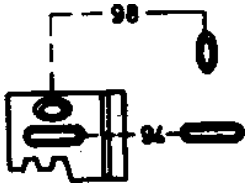
**FAULTS AND REMEDIES**

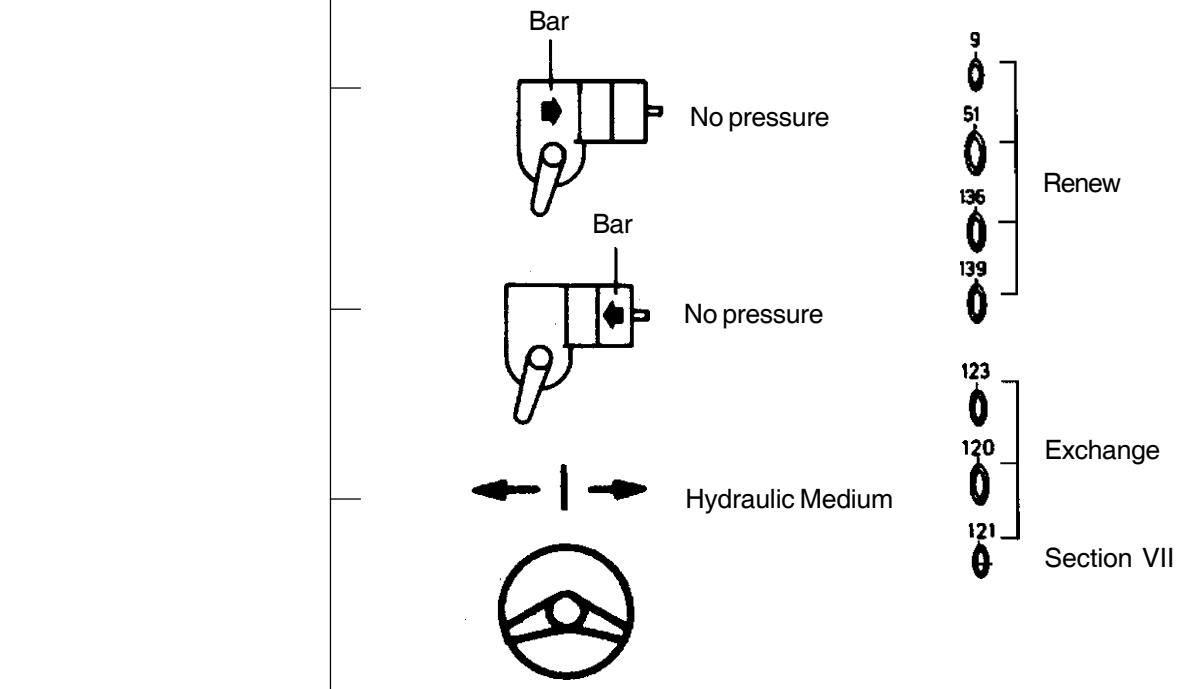
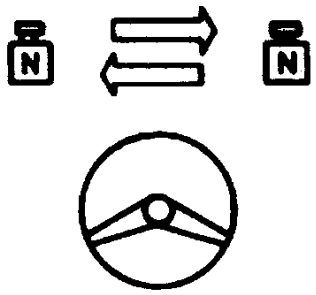
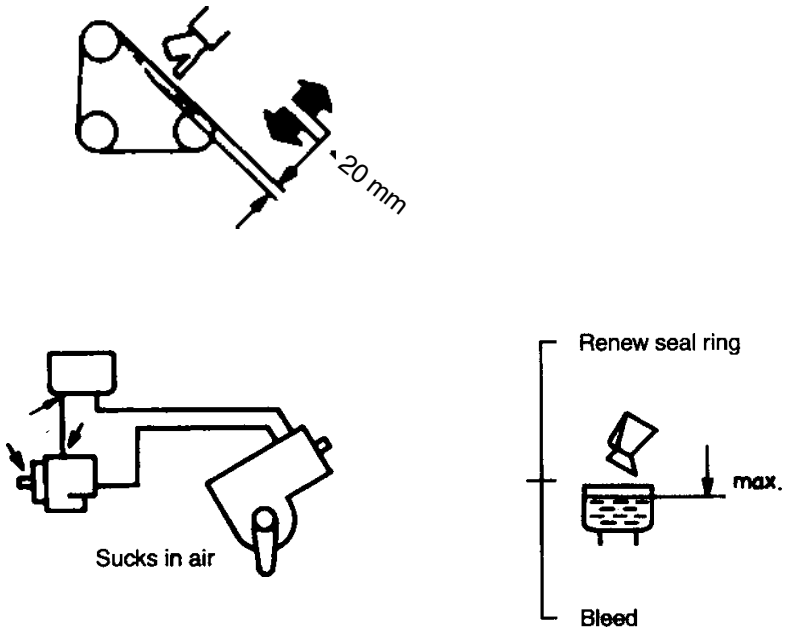
The ZF hydraulic ball nut steering system in short form is designed to meet exacting requirements. The unit is designed in such a way that no faults can occur in the case of correct maintenance and normal operation.

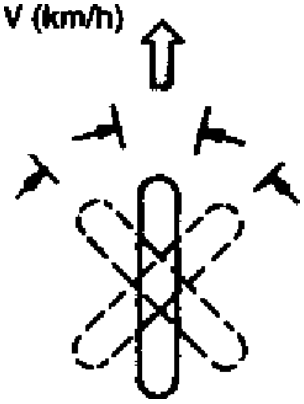
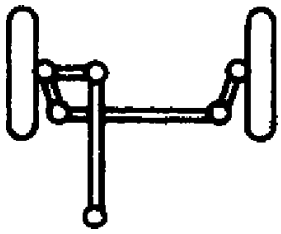
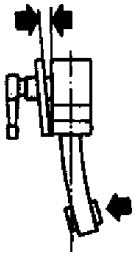
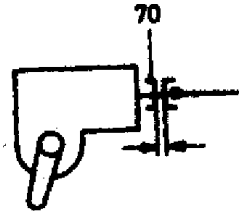
However, if a fault should occur the following information should contribute to establishing and rectifying the fault. Before the steering unit is checked for the individual faults, the oil level must first be checked with the engine running. The oil filling procedure is described in section III. We would also like to draw your attention to the fact that the use of heavily foaming oil may lead to faults, since such oil only release air with great difficulty or not at all, once it has entered the steering system.

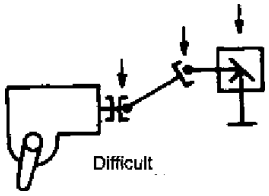
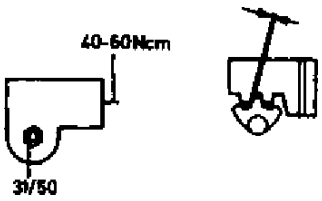
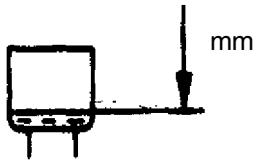
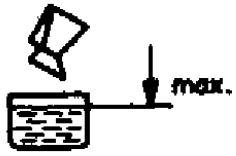
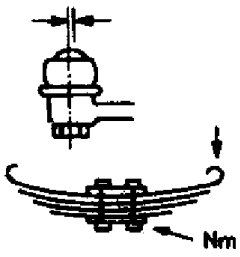
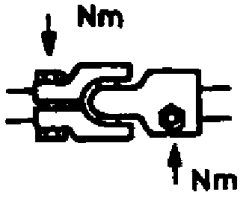
| Fault | Cause | Remedy |
|---|---|---|
| Difficult on both sides   |   | Repair leaks   |
| |   | |
| |  Sucks in air | Renew seal rings   Bleed |
| |   Conveying flow too low | Regrind / renew |
| |   | Dismantle, clean, ensure easy movment |

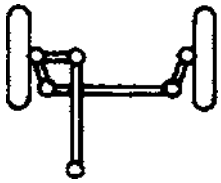
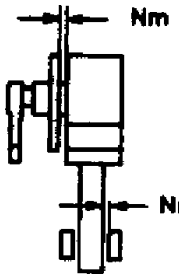
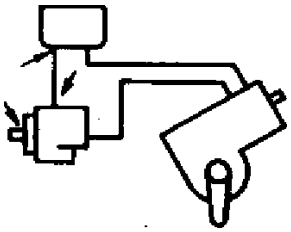
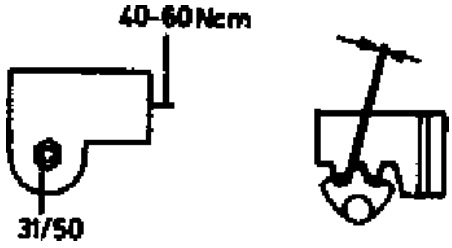
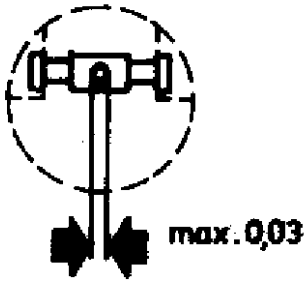
| Fault | Cause | Remedy |
|---|---|---|
| |  | Renew, regulating valve<br>Clean inlet line |
| |  | Renew |
| |  | Ensure easy movement or replace |
| **B** | Internal faults - ZF servise division | |
| |  | Check or exchange |
| |  | Remove foreign bodies |
| |  | Renew |
| |  | |

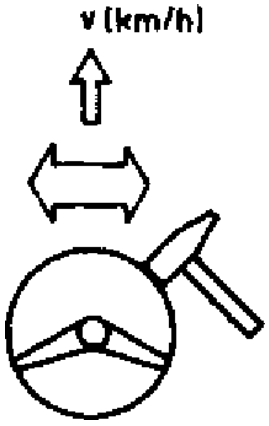
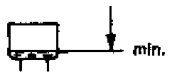
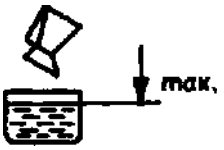
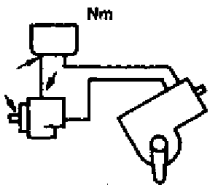
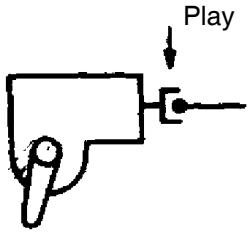
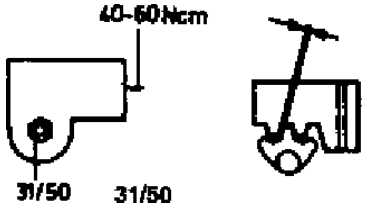
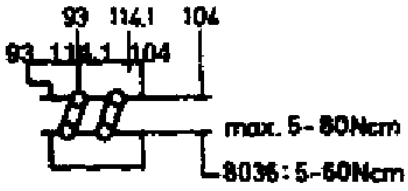
| Fault | Cause | Remedy |
|---|---|---|
| |  Leaking | - Renew |
| |  Covering flow too low | - Exchange |
|  | **A** Internal faults - maintenance work | |
| |  Leaking | - Renew |
| |  Leaking  | Check or exchange |
| |  | |
| | **B** Internal faults - ZF servise division | |
| |  Leaking | - Renew |

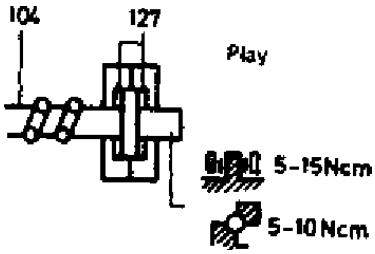
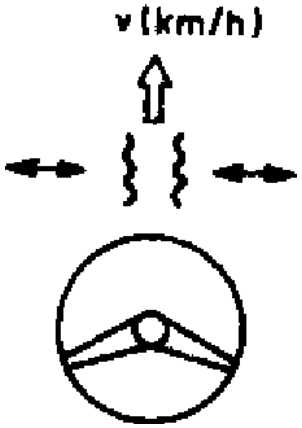
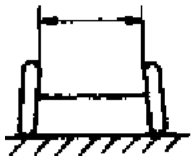
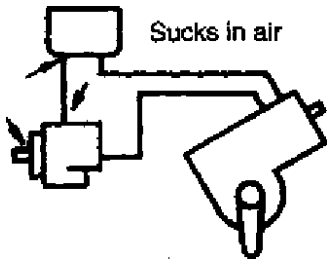
| Fault | Cause | Remedy |
|---|---|---|
| |  | |
| Difficult for fast steering<br> | **A** External faults - maintenance work | |
| |  | |

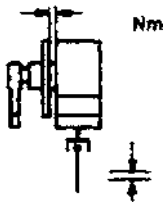
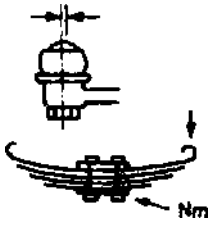
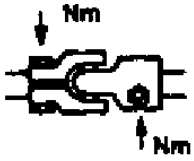
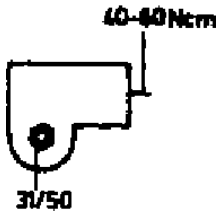
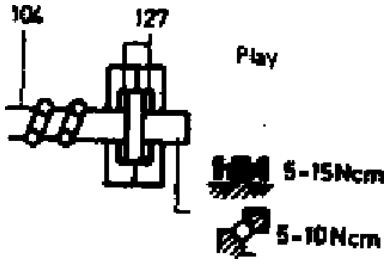
| Fault | Cause | Remedy |
|---|---|---|
| | Conveying flow too low   | Renew |
| | **B** Internal faults - ZF servise division | |
| | Conveying flow too low  | Exchange |
| Return line obstruction   | **A** External faults - maintenance work | |
| | Difficult  | Lubricate |
| |  | Streesed - Release tension |
| |   | Jamming - Regrind / renew |

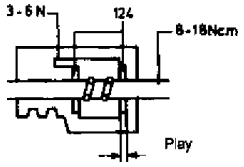
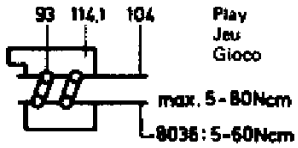
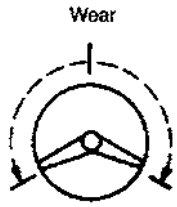
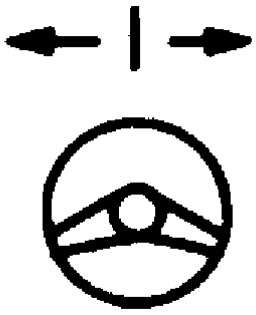
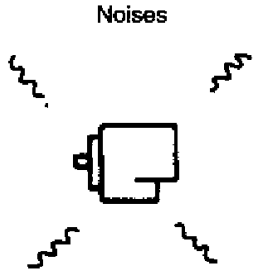
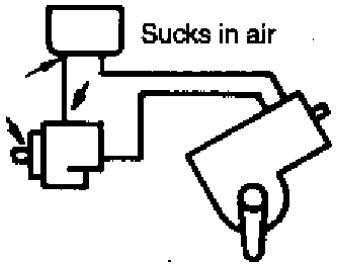
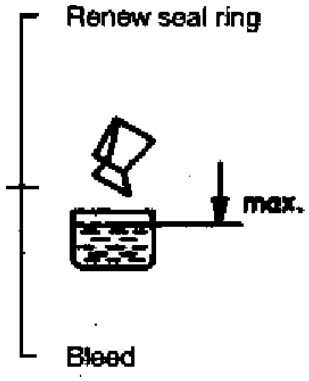
| Fault | Cause | Remedy |
|---|---|---|
| |  | Lubricate |
| |  | Section VII |
| Not excact V (Km/h)  | **A** External faults - maintenance work | |
| |  | Repair leak |
| |  | Bleed |
| |  | |
| |  | Tighten / Replace |

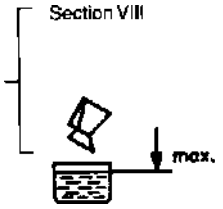
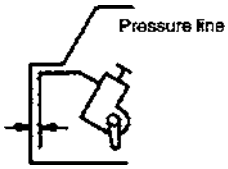
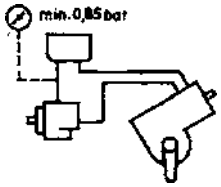
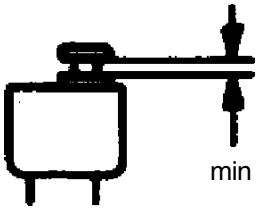
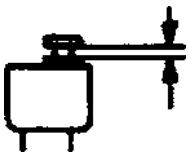
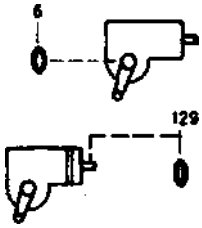
| Fault | Cause | Remedy |
|---|---|---|
| |  | Lubricate |
| |  | Tighten |
| |  | Renew seal rings<br>Bleed |
| |  | Repair leak<br>Section VII<br>mm. |
| | **B** Internal faults - ZF Servise division | |
| |  | Test or replace |

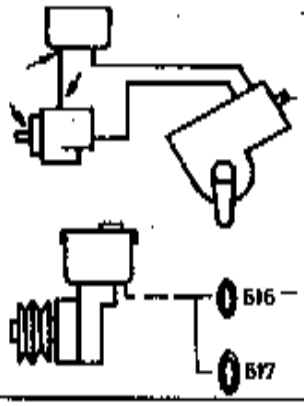
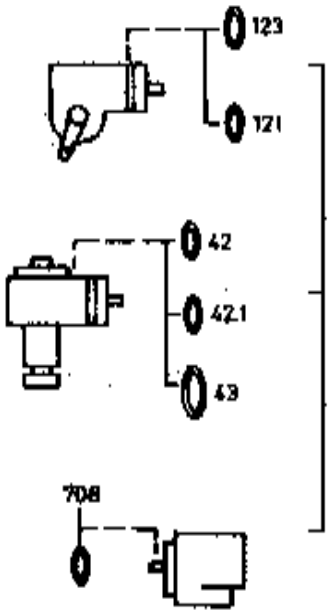
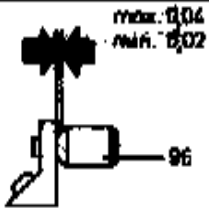
| Fault | Cause | Remedy |
|---|---|---|
|  | **A** External faults - maintenance work | |
| |  | Repair leaks |
| |  | |
| |  Nm | Renew seal rings |
| |  | Bleed<br>Play |
| | | Repair leak |
| |  | Section VII<br>Max. |
| | **B** Internal faults - ZF Servise division | |
| |  | — Section VII |

| Fault | Cause | Remedy |
|---|---|---|
| |  | — Section VII |
| | **A** External faults - maintenance work | |
| Turning vibrations  |   | — Balance |
| |   | — Adjust |
| |  | — Renew seal rings<br>— Bleed |

| Fault | Cause | Remedy |
|---|---|---|
| Steering wheel play   | **A** External faults - maintenance work | |
| |         | Tighten / replace<br>— Section VII  |
| | **B** Internal faults - ZF Servise division | |
| |   | — Section VII |

| Fault | Cause | Remedy |
|---|---|---|
| |  | Section VII |
| |  | Section VII |
|  | **B** Internal faults - ZF Servise division | |
| |  | Section VII |
|  | **A** External faults - maintenance work | |
| |  |  |

| Fault | Cause | Remedy |
|---|---|---|
| |   |   |
| |   | Rubber mounts |
| Wear | **B** | Internal faults - maintenance work |
| |   | Installation instructions |
| Oil loss   | **A** | External faults - maintenance work |
| |  | Close |
| |   | Renew |

| Fault | Cause | Remedy |
|---|---|---|
| |  | Tighten lines |
| |  | 516 — Renew<br>517 |
| | B | Internal faults - ZF service division |
| |  | 123<br>121<br>42<br>42.1<br>43<br>708<br>Renew |
| | B | Internal faults - ZF service division |
| Noises  |  | max. 0,04<br>min. 0,02<br>96<br>— Renew |

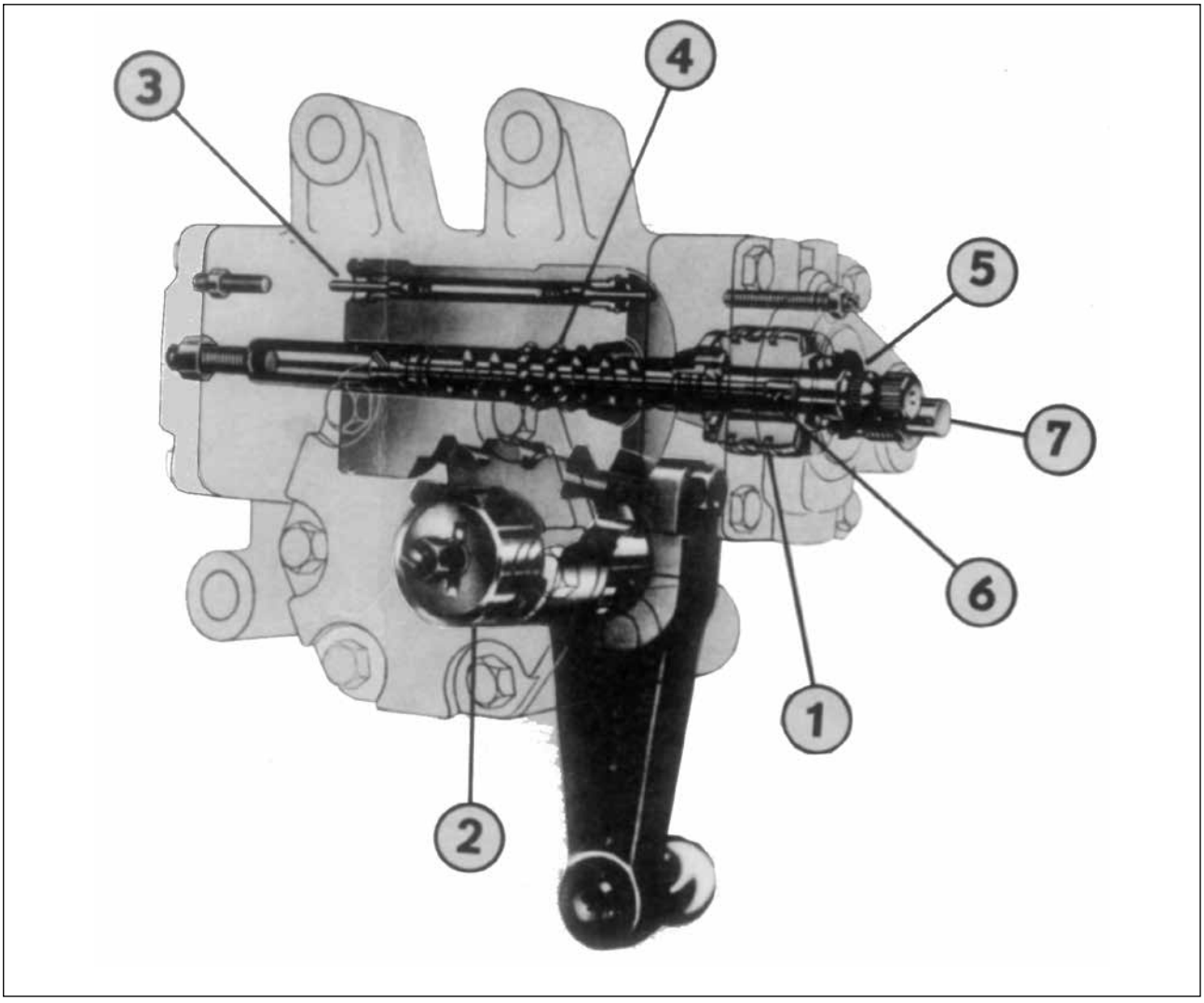
# Rane Power Steering 46

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**INTRODUCTION**

HFB64 Integral Hydraulic Power Steering Gear was specifically designed for motor trucks with new design features.




**DESIGN FEATURES**

1. **Design Valve** - this provides responsive steering control.
2. **DU bushing and or Roller Bearings** - Allow the steering gear to operate with high efficiency and reversibility.
3. **Unloading Valves** - Furnish power steering pump protection and reduce pressure to unload steering linkage at the ends of steering gear travel (optional).
4. **Recirculating Balls-** Combines high mechanical efficiency with smooth operation
5. **Dirt and Water Seals -** Lip type seals on both input and output shafts
6. **Torsion bar-** Provides positive valve centering with definitive “feel of the road”
7. **Relief valves-** Furnish pump protection by limiting maximum pressure (optional)

**HFB64 : GENERAL DESIGN AND OPERATION**

**SPECIFICATIONS**

| | | |
|---|---|---|
| TORQUE OUTPUT AT 90% EFFICIENCY | : | 213 kgm at 69 bar<br>426 kgm at 138 bar |
| NO. OF STG. WHEEL TURNS FOR $95^0$ OF DROP ARM MOVEMENT | : | 5.4 MAX. |
| RECOMMENDED WORKING TRAVEL | : | ± 45° of drop arm movement |
| HYDRAULIC STG. LIMITER | : | Adjustable to suit vehicle installation |
| FLOW REQUIRED FOR 1.5 STG. WHEEL TURNS/SEC. | : | 11. 53 Litres/min. |
| MAX. OPERATING PRESSURE | : | 138 Bar |
| APPROXIMATE WEIGHT OF STEERING GEAR; (LESS DROP ARM) | : | 35 Kg |
| GEAR RATIO | : | 20.4 : 1 |

**Integral power steering**

The HFB64 Power steering gear is the latest design in the family of integral hydraulic power steering gears. Integral hydraulic power steering means that the gear box contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder, all in a single compact package.

**Rotary control valve**

The rotary control valve combines simplicity of construction with desirable performance characteristics. The speed at which the driver can turn the steering wheel with power assist is dependent upon the pump flow (measured in gallons per minute gpm or litres / Min.) directed to a cylinder cavity.

The pressure (measured in pounds per square inch-psi or bar) required for the gear to steer the vehicle is created by the power steering pump to overcome resistance at the steered wheels. The control valve senses these requirements and directs fluid to the cylinder cavity at the proper flow rate and pressure.

**Pressure means Work, Flow means Speed**

The higher pressure a gear can withstand, the more work it can perform. The HFB64 can steer a vehicle with a front-end weight rating of about 12,000 pounds (5443 Kg) through a turn at low vehicle speed and engine idle. As the driver turns the steering wheel faster or slower, more or less fluid will be required by the gear in the minute. For the HFB64. Maximum operating pressure is 2000 PSI (137.9 bar). **The recommended minimum flow at 11/2 hand wheel turns/second must be no less than 2.9 gpm (11.0 Litres/Min.). If the HFB64 steering gear is controlling an auxiliary cylinder, increased minimum flow is required based on the size of the Auxiliary cylinder and 'vehicle' Steering geometry.**

**OPERATION**

**What happens during a steering manoeuver**

When the driver turns the steering wheel, he transmits force from the wheel to the steering gear input shaft. A torsion bar, pinned at its one end to the input shaft and at its other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force, the worm shaft, acting through the recirculating ball mechanism, tries, to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

**Shock loads to the gear**

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston, and onto the worm shaft. The internal geometery of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents objectionable kickback at the steering wheel.

**Unloading (Poppet) valves**

HFB64 gears are equipped with two unloading valves, one at each end of the rack piston. One valve or the other depending on the direction of turn, will trip as the steered wheels approach the axle stops (which must be set according to manufacturer's specification). The tripped valve reduces pressure in the gear and helps to reduce heat generated by the pump. At the same time, the valves also reduce forces on the steering linkage.

**Relief valve**

Some HFB64 gears, are also supplied with a relief valve. The relief valve limits maximum supply pressure to protect the power steering pump, but it does not reduce pressure as the steered wheels approach the axle stops.

**Air bleeding**

HFB64 gears with the hydraulic connections located at the input end, does not need separate bleeding arrangement in all installations which are almost vertical. It is self bleeding.

On installation that are near horizontal, separate bleed screws can be provided to suit the installation. Procedure for bleeding is described under "Filling

## OPERATION

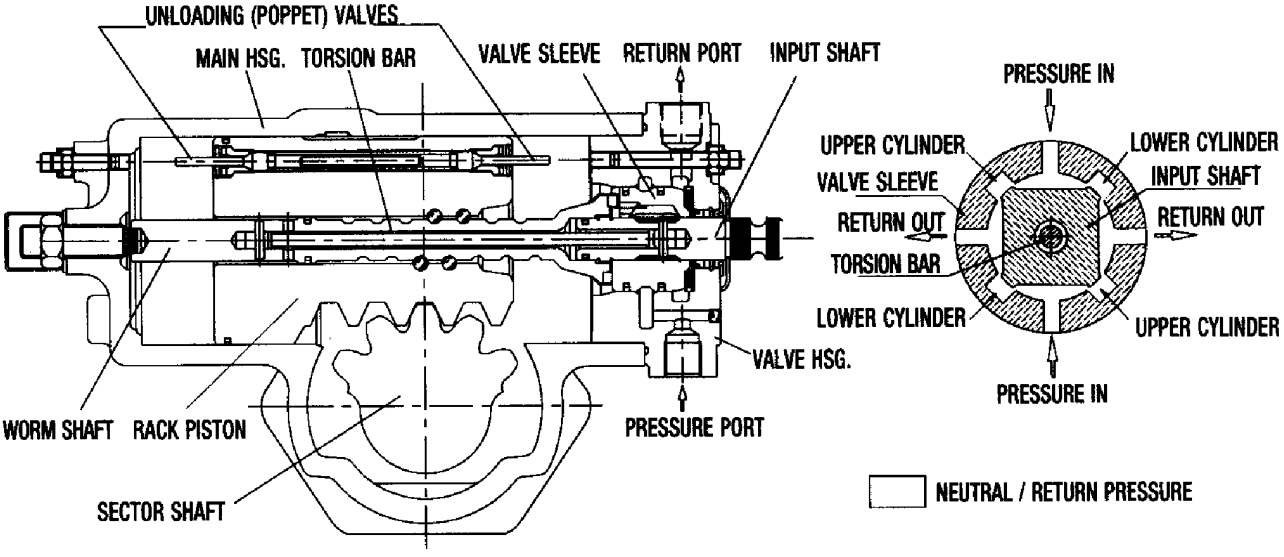
### Normal Operation

When the drivers turn the steering wheel, he activates the steering gear input shaft. A torsion bar pinned at it's one end to the input shaft and the other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force the worm shaft acting through the re-circulating ball mechanism, tries to move the rack piston axially through the gear housing cylinder bore.

### Hydraulic Power Assistance

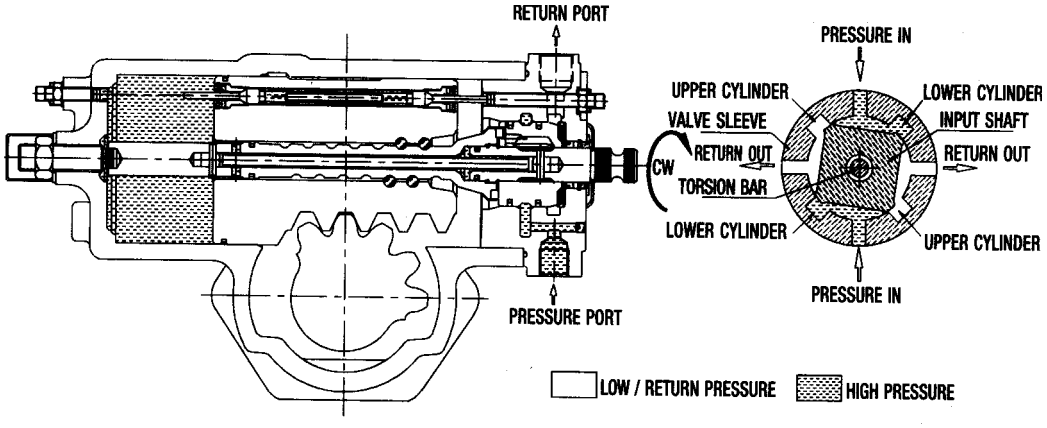
The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkages to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurised fluid directed by the control valve assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle to the desired direction.

### Neutral Condition




The rotary control valve mechanism, Which is the heart of power steering system comprise of input shaft, worm shaft, Torsion bar and valve sleeve. When all these components assembled together this become "valve assembly". The input has four lands and the valve sleeve has four packets assembled in neutral condition. The valve sleeve has keyed connection with the worm shaft, diagonally apposite pockets connect the oil to the lower or upper cylinder. Always the valve will be in neutral condition. In this condition the oil flows to both sides of the cylinder and return back to the reservoir.

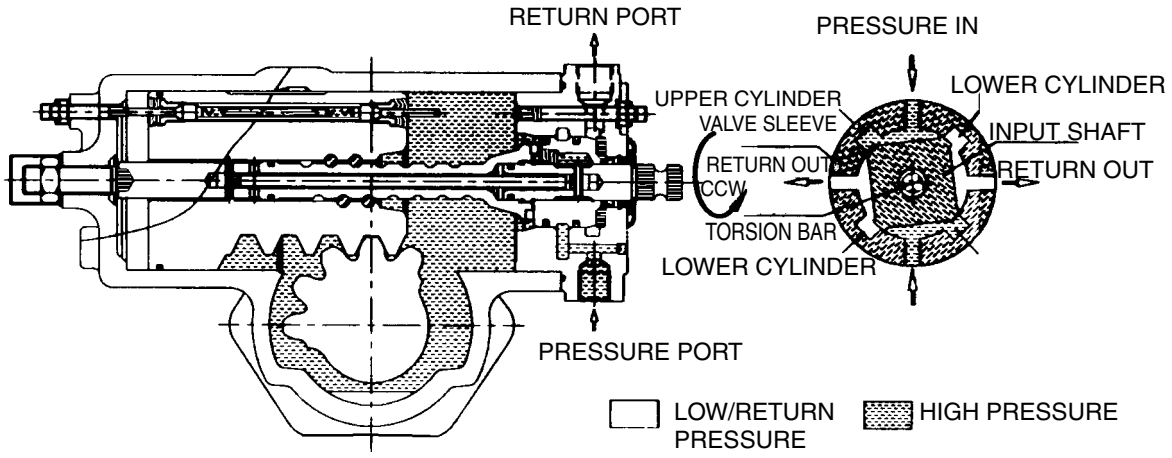
**Right Turn**




When the driver rotates the input shaft to the right through the Steering wheel. Because of the road resistances the torsion bar get twisted and the input shaft alone will twist to the right and disturbs the valve neutral position, thereby causing all the oil to flow to the lower cylinder and pushes the rack piston towards top. Once the driver stops rotating the steering wheel the torsion bar will gain its original position, as the worm shaft rotates and bring back the valve sleeve to the neutral position.

When the driver rotates the input shaft to the left

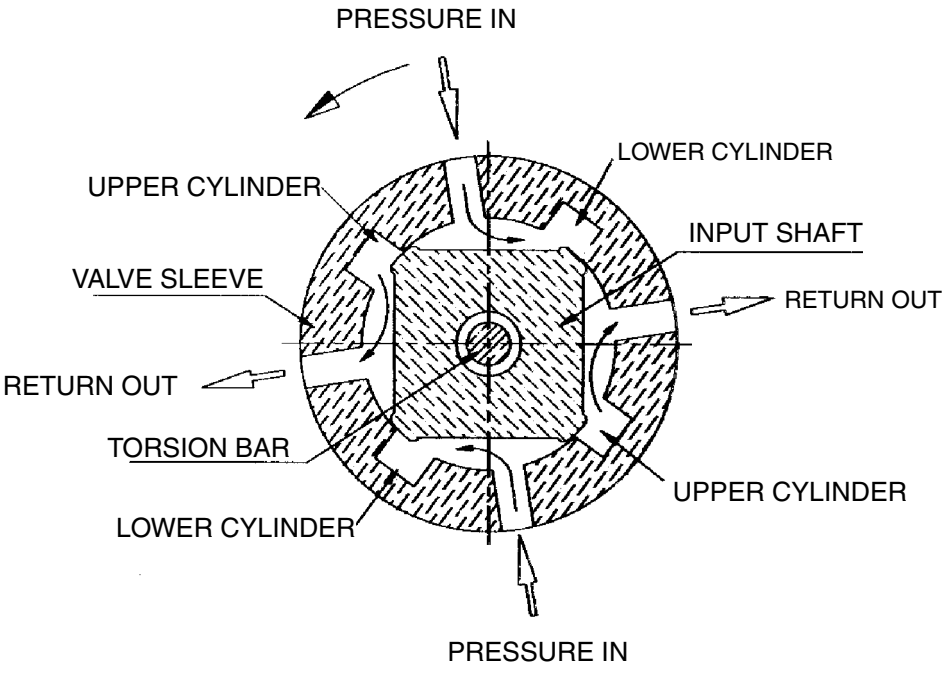
**Left Turn**




through the steering wheel. Because of the road resistance the torsion bar gets twisted and the input shaft alone will rotate to the left and disturbs the valve neutral position, thereby causing all the oil to flow to the upper cylinder and pushes the rack piston towards bottom. Once the driver stops rotating the steering wheel the torsion bar gain its original position, as the worm shaft rotates and bring back the valve sleeve to the neutral position.

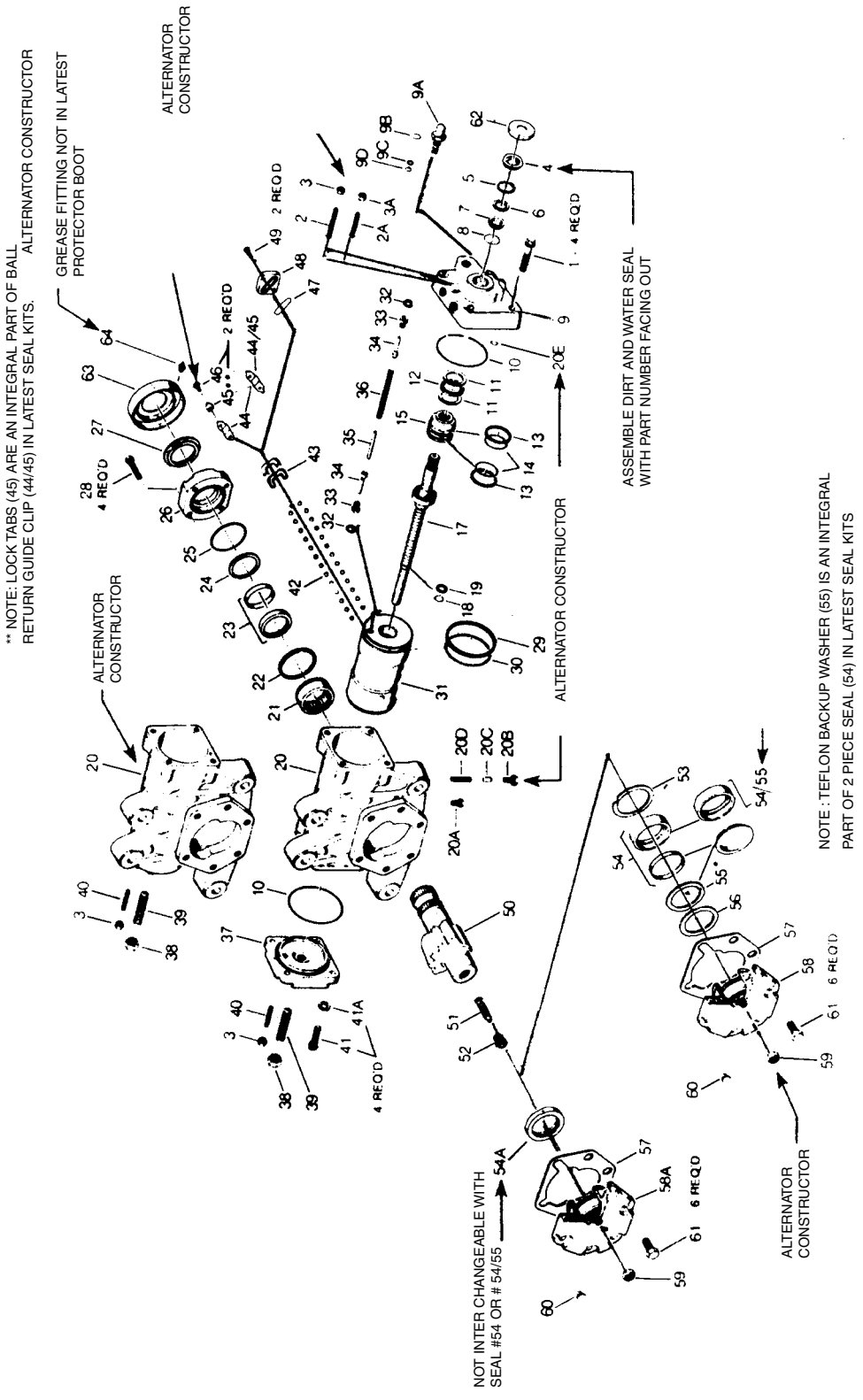
**Valve in Shock Absorption**

**SHOCK ABSORPTION**




In general during the turns the driver disturbs the valve neutral position, causing the oil to flow to the respective cylinder. During shock Absorption the road shocks force the worm shaft tom rotating causing the valve sleeve to move from neutral condition. Thereby causing the neutral condition disturb and the oil flow on the opposite side resisting the rack piston's movement, thus the oil absorbs all the road shocks and prevent shocks getting transmitted to the driver.

## HFB64 EXPLODED ASSEMBLY VIEW



| Item No. | Description | Item No. | Description |
|---|---|---|---|
| 1. | Valve housing bolts (4) | 30. | Rack piston backup O-ring |
| 2. | Poppet adjusting screw | 31. | Rack piston |
| 2A. | Allen head hex poppet adjusting screw | 32. | Poppet retaining rings (2) |
| 3. | Poppet adjusting screw sealing nut | 33. | Poppet seats (2) |
| 3A. | Poppet adjusting screw sealing nut | 34. | Poppets (2) |
| 4. | Dirt and water seal | 35. | Nylon spacer rod |
| 5. | Retaining ring | 36. | Poppet spring |
| 6. | Steel backup washer | 37. | End cover |
| 7. | Input shaft seal | 38. | Worm shaft adjusting screw sealing nut |
| 8. | Input shaft O-ring | 39. | Worm shaft adjusting screw |
| 9. | Valve housing | 40. | Poppet adjusting screw |
| 9A. | Relief valve | 41. | End cover bolts (4) |
| 9B. | Large O-ring | 41A. | Washer (4) |
| 9C. | Teflon seal ring | 42. | Steel balls (27) |
| 9D. | Small O-ring | 43. | Ball return guides (2) |
| 10. | Seal rings (2) | 44. | Ball return guide clip |
| 11. | Thrust washers (2) | 45.** | Lock tabs (2) |
| 12. | Thrust bearing | 46. | Hex head bolts (2) |
| 13. | Teflon seal rings (2) | 47. | Ball return guide cap seal |
| 14. | Backup O-rings (2) | 48. | Ball return guide cap |
| 15. | Valve sleeve | 49. | Allen head screws (2) |
| 17. | Worm shaft/input shaft | 50. | Sector shaft |
| 18. | Worm shaft backup O-ring | 51. | Sector shaft adjusting screw |
| 19. | Teflon worm shaft seal ring | 52. | Retainer |
| 20. | Gear housing | 53. | Side cover retaining ring (alt.) |
| 20A. | Manual bleed screw | 54. | Two-piece side cover seal (alt.) |
| 20B. | Automatic bleed screw | 54A. | Seal |
| 20C. | Special pin | 55.* | Teflon backup washer (alt.) |
| 20D. | Spring | 56. | Steel backup washer (alt.) |
| 20E. | Automatic Bleed passage way seal | 57. | Side cover gasket |
| 21. | Housing bearing | 58. | Side cover (alt.) |
| 22. | Retaining ring | 58A. | Side cover |
| 23. | Two-piece sector shaft seal | 59. | Sector shaft adjusting screw jam nut |
| 24. | Teflon backup washer | 60. | Vent plug |
| 25. | Trunnion cover seal ring | 61. | Special bolts (b) |
| 26. | Trunnion cover | 62. | Seal protector |
| 27. | Dirt and water seal | 63. | Seal protector boot |
| 28. | Trunnion cover bolts (4) | 64. | Grease fitting |
| 29. | Teflon rack piston seal ring | | |

and Air Bleeding" in this manual.

**DISASSEMBLY**

**Preparation**

- THOROUGHLY CLEAN OFF ALL OUTSIDE DIRT, ESPECIALLY FROM AROUND FITTINGS AND HOSE CONNECTIONS, BEFORE YOU REMOVE THE GEAR
- Drain the steering gear assembly.
- Remove input and output shaft connections.
- Remove the supply and return lines from the gear, and immediately plug all port holes and fluid lines.

***WARNING:*** *THIS STEERING GEAR WEIGHS APPROXIMATELY 80 POUNDS 36 KG DRY. EXERCISE CAUTION WHEN YOU REMOVE, LIFT, OR CARRY IT. DO NOT POUND THE UNIVERSAL JOINT OR INPUT SHAFT COUPLING ON OR OFF THE INPUT SHAFT. INTERNAL DAMAGE TO THE STEERING GEAR CAN RESULT.*

- Remove the steering gear from the vehicle and take it to a clean surface (a piece of wrapping paper makes an excellent disposable top).
- Clean and dry the gear before you start to disassemble it.
- As you disassemble the gear, clean all parts in clean, petroleum-based solvent, and blow them dry only.

***WARNING : SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.***

***WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.***

***CAUTION: Never steam clean or high-pressure wash hydraulic steering components. Do not force or abuse closely fitted parts.***

- Keep each part separate to avoid nicks and burrs.
- Discard all seals, O-rings, and gaskets removed from the gear. Replace them with new parts only.

**Disassembly**

1. Position the steering gear firmly in a vise with the gear's worm shaft/input shaft (17) in a horizontal direction. Prepare for fluid drainage and unplug fluid line ports. Rotate worm shaft/input shaft with a special lever having 3/4" x 48 serration socket through the gear travel several times to purge hydraulic fluid from the unit. Then position the timing mark located on the end of the sector shaft to a vertical direction *See Figure* 1.

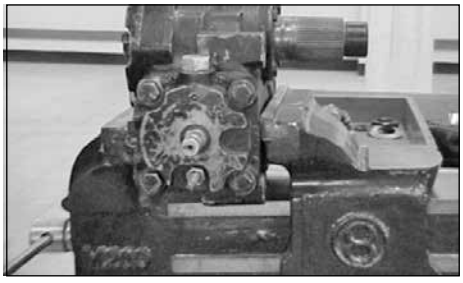


*Figure 1*

2. Remove the seal protector boot (63) and the dirt and water seal (27) from the trunnion cover (26). *See Figure* 2. Discard protector boot and seal.



*Figure 2*

3. Remove any paint or corrosion from the non-serrated area of the sector shaft (50) and loosen the sector shaft adjusting screw jam nut (59).
4. Remove the four trunnion cover, bolts (28). *See Figure* 3.



*Figure 3*

5. Remove the trunnion cover (26). Remove and discard the seal ring (25), the two piece sector shaft seal (23) and the Teflon back-up washer (24) from the trunnion cover. *See Figure* 4.



*Figure 4*

6. Tape the serrations of the sector shaft (50) with one layer of masking tape to prevent loose bearing rolls from “hanging up” the sector shaft during its removal. The tape should not extend on to the sector shaft bearing diameter.
7. Prepare for fluid to drain, and remove the six special bolls (61) from the side cover (58). *See Figure* 5.

   *NOTE : These bolts are special because they are equipped with washer design on the underside of the head. See. Figure 6. If you replace one or more bolts, you must use bolts of the SAME SPECIAL TYPE AND LENGTH AS THOSE YOU REMOVED. Do not use a substitute. You can get these bolts through your OEM parts distributor.*



*Figure 5*



*Figure 6*

8. Begin to remove the side cover (58) and sector shaft (50) as an assembly. *See Figure* 7. Stop removal when the bearing rolls in the housing bearing (21) are half exposed. Coat the bearing rolls with wheel bearing grease. As a means of starting the removal of the side cover and sector shaft assembly, you may use a soft hammer or wooden hammer handle.

   *NOTE: When the bearing rolls are half exposed and it is evident that the unit has a caged bearing (rolls retained) the following two notes do not apply.*

   *NOTE: Take care to remove this assembly slowly, or it may come out too quickly for you to retain the bearing rolls in the housing bearing rolls in the housing bearing race. Follow the shaft end with dummy shaft to retain the rolls, or when the rolls are half exposed, be sure to coat them with grease to retain them in the housing bearing.*

   *CAUTION: If one or more of the rolls Is lost, you must replace the entire bearing (see disassembly step 38).*



*Figure 7*

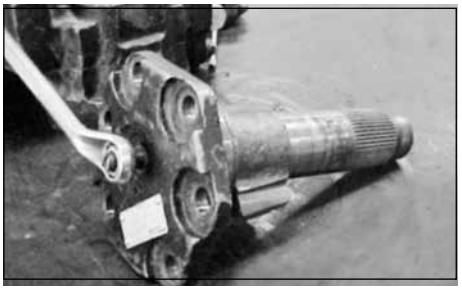


*Figure 8*

9. Finish removing the side cover (58) and sector shaft (50) as an assembly. Remove side cover gasket (57) and discard.
10. If the housing bearing has loose rolls, remove the bearing rolls from the bearing (21) race, count them and put them aside as a set for cleaning, inspecting and reassembly.
11. Remove the sector adjusting screw jam nut (59). *See Figure* 8.
12. Screw the sector shaft adjusting screw (51) through the side cover (58) *See Figure* 9. Place the side cover exterior side down and lift the sector shaft out vertically. *See Figure 10.*



*Figure 9*



*Figure 10*

*Note: If the side cover bearing assembly has uncaged (loose) rolls, the vertical position will allow the side cover bearing rolls to fall Into the side cover, where you may easily collect and count them.*

*CAUTION: The part number of the bearing In the side cover may not be visible on the surface. Take care not to lose any rollers during disassembly and assembly, or you will have to replace the complete side cover assembly.*

*WARNING: IF THE BEARING IS THE UNCAGED (LOOSE) ROLL TYPE, DO NOT MIX THE ROLLS FROM THE SIDE COVER WITH THE ROLLS FROM THE HOUSING BEARING. THE BEARING RACE AND ROLLS ARE A MATCHED SET. INTERCHANGING THE ROLLS COULD RESULT IN PREMATURE BEARING OR SEAL FAILURE, WHICH COULD CAUSE A LOSS OF POWER STEERING.*

13. Remove the side cover retaining ring (53), the two-piece side cover seal (54), the Teflon backup washer (55), and the steel backup washer (56) from the side cover (58). *See Figures* 11 & 12. Discard the two-piece seal and the Teflon backup washer.

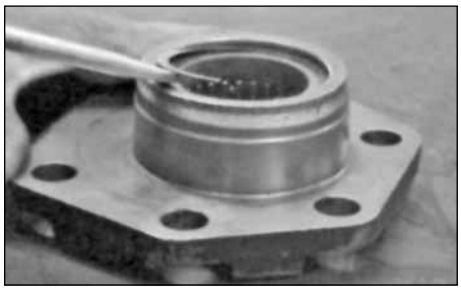


*Figure 11*



*Figure 12*

14. Only if replacement of the retainer (52) and or adjusting screw (51) is required (see inspection procedure 8 page 23) place the sector shaft (50) firmly in a soft jawed vise and unstake the retainer using a suitable chisel. Turn the retainer out of the sector shaft pocket and remove the adjusting screw. Discard the retainer. *See Figure* 13.

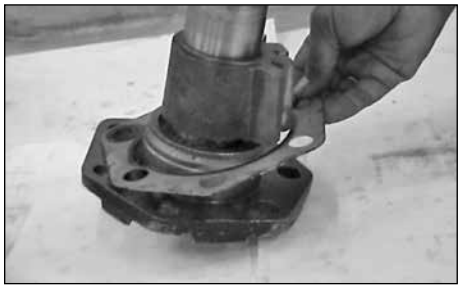


*Figure 13*

15. Loosen the worm shaft preload adjusting screw sealing nut (38) and loosen the worm shaft preload adjusting screw (39) about two turns. *See Figure* 14. If your gear is equipped with poppets, loosen the poppet adjusting screw sealing nut (3) and the poppet adjusting screw (40) about two turns.

    *NOTE: The worm shaft adjusting screw and sealing nut and poppet adjusting screws and sealing nuts do not have to be removed unless apparent fluid leaks at the adjusting screw or damage Indicate the sealing nuts and or screws be replaced.*



*Figure 14*

16. If your gear is equipped with a removable end cover (37), remove the four end cover bolts (41) and washers (41A). Then prepare for fluid to drain and remove the end cover. *See Figure* 15.

17. Remove the end cover seal ring (10) from the groove in the end cover (37).

    *NOTE: Gears with the closed end housing do not have an end cover seal ring, end cover bolts or washers.*

18. Remove and discard seal protector (62) from worm shaft/input shaft (17). Clean any paint or foreign matter from the exposed non-serrated area of the input shaft with a fine grade of emery paper.

19. If your gear is so equipped';' loosen the other poppet adjusting screw sealing nut (3) and the other poppet adjusting screw (2) in the valve housing (9) about two turns.

    *NOTE: It is recommended that a line be scribed across the edge of valve housing (9) and gear housing (20) before disassembly of valve housing for correct positioning at reassembly.*

20. Remove the four valve housing bolts (1). Prepare for some fluid to drain, and remove the valve housing (9) *See Figure 16A* & 168.

    *NOTE: The valve sleeve (15) will probably remain in the valve housing. See Figure 168.*

    *WARNING: Do not disassemble the worm shaft/input shaft assembly (17) which includes the worm shaft, input shaft, torsion bar, torsion bar pins, drive ring and drive ring retainer, and Insert. Do not unbend the drive ring retainer tangs that hold the drive ring in place. See Figure 17. Doing either will alter the valve timing, which could cause the vehicle to pull to one side or the other.*

21. Remove the valve sleeve (15) from the valve housing (9), *See Figure* 18.

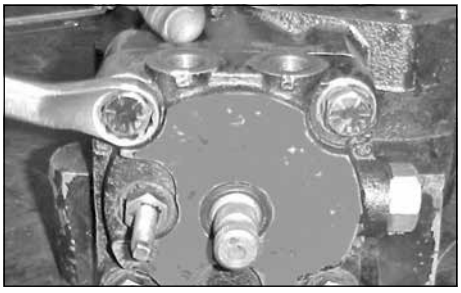


*Figure 15*

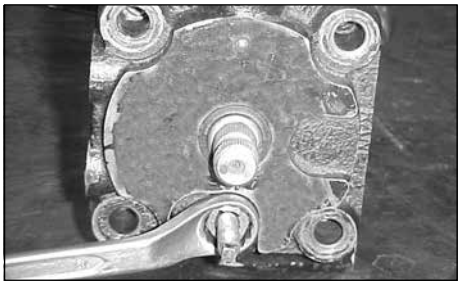


*Figure 16A*

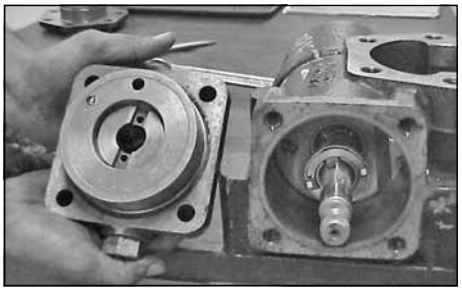


*Figure 16B*

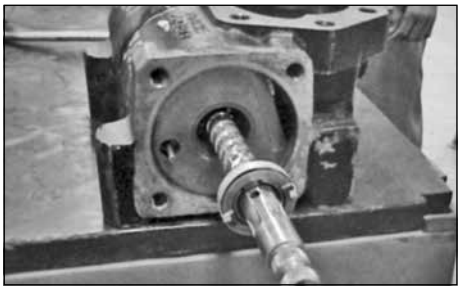


*Figure 17*

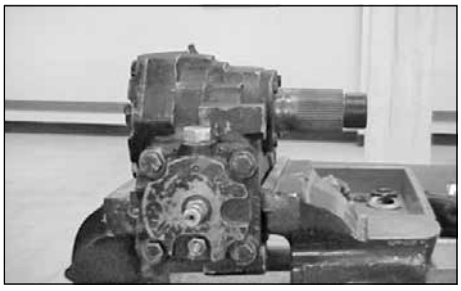


*Figure 18*

22. Remove the first thrust washer (11), the thrust bearing (12), and the second thrust washer (11) from the valve housing (9) *See Figure* 19.

    *NOTE: The first thrust washer may stay on the end of the valve sleeve. If so, remove It from the sleeve.*

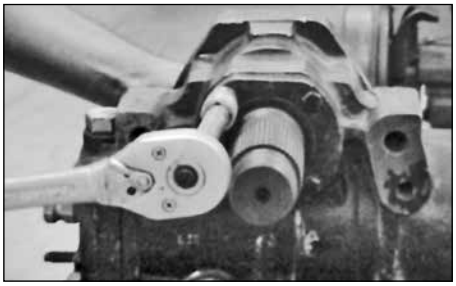


*Figure 19*

23. Remove and discard the two Teflon seal rings (13) from the valve sleeve (15) *See Figure 20.*

24. Remove and discard the two backup 'O' rings (14) from the grooves in the valve sleeve (15).

25. Remove and discard seal ring (10) from valve housing (9).

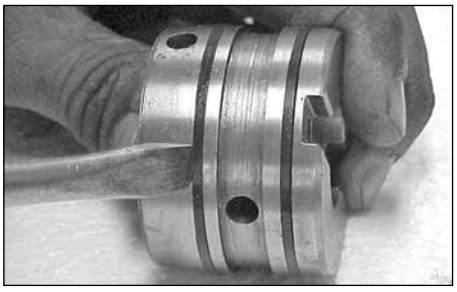


*Figure 20*

26. Remove and discard the dirt and water seal (4). *See figure* 21.

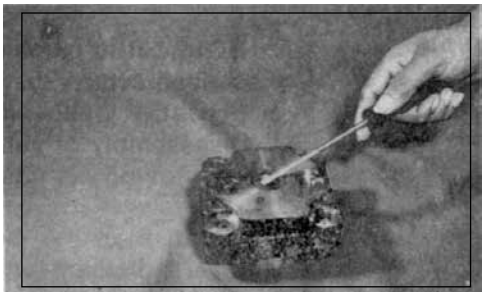


*Figure 21*

27. Remove the retaining ring (5). *See Figure* 22.



*Figure 22*

28. Remove the steel backup washer (6), the input shaft seal (7), and the input shaft a-ring (8) *front* the valve housing (9). Discard the seal and a-ring *See Figure* 23.



*Figure 23*

29. Remove poppet adjusting screw (2) and nut (3) if replacement is required.

30. Remove the rack piston (31) and worm shaft/ input shaft (17) from the gear housing (2) as an assembly. *See Figure* 24. Set the rack piston and worm shaft assembly on a clean rag to keep the piston from rolling.

    *NOTE: The worm shaft part of the assembly will be inside the rack piston, with the Input shaft part of the worm protruding from the rack. Take care when you remove this assembly from the housing. To prevent the Teflon rack piston seal (29) from getting caught In the sector shaft cavity, remove the assembly from the long end of the housing, if the housing Is open on both ends.*

    *NOTE: To prevent the Teflon rack piston seal ring (29) from "hanging up" as it exits the housing sector shaft cavity in housings that are closed at the long end of the rack piston bore, cut and remove the seal ring from the rack piston when it is exposed in the sector shaft cavity of the housing, during the removal of worm shaft input shaft, rack piston assembly.*

31. For rack pistons with the ball return guide clip (44), bend the tangs down on the two locking tabs (45). *See Figure* 25. Remove the two hex head bolts (46), tabs and clip. Discard locking tabs. *See Figure* 26.

32. Remove the halves of the ball return guide' (43). *See Figure* 27. Next, remove the 27 steel balls (42) from the rack piston (31) by rotating the worm shaft/input shaft (17) until the balls fall out. *See Figure* 28.

    *NOTE: The ball return guide Is closely fitted with the rack piston, and you may have to remove the halves by carefully inserting a screwdriver between the rack and the guide.*

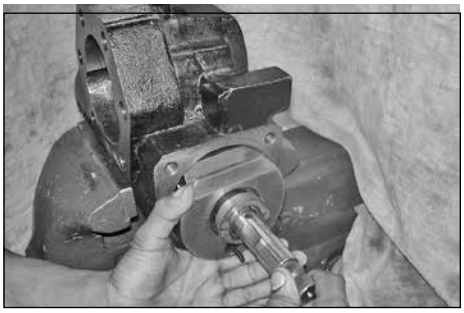


*Figure 24*



*Figure 25*

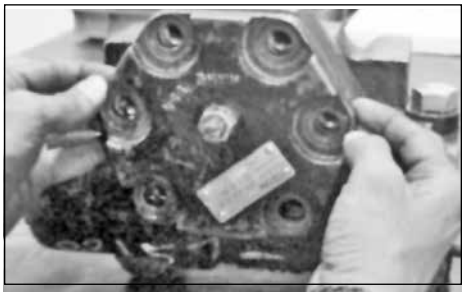


*Figure 26*

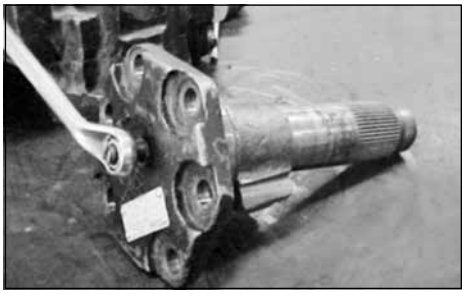


*Figure 27*

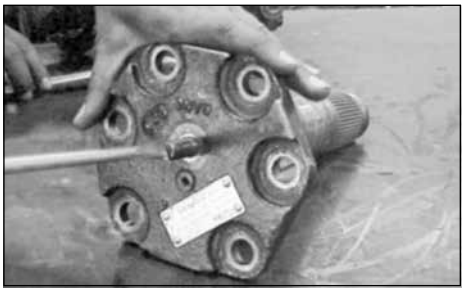


*Figure 28*

*CAUTION: The 27 steel balls are a matched set. Take care not to lose any of them. If you lose any of the balls, you must replace them with a complete, new set.*

*WARNING: INCORRECT MATCHING OF BALLS, WORMS CREW AND RACK PISTON CAN RESULT IN LOSS OF STEERING, WHICH COULD RESULT IN AN ACCIDENT.*

33. Remove the worm shaft/input shaft (17) from the rack piston (31). *See Figure* 29.

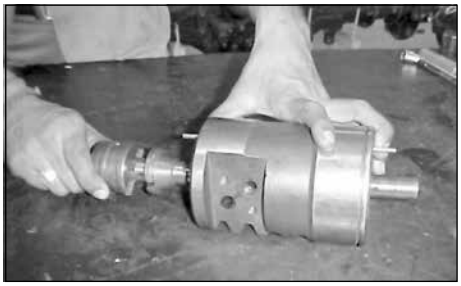


*Figure 29*

34. Remove and discard the Teflon rack piston seal ring (29) and backup O-ring (30). *See Figure 30.*



*Figure 30*

35. Remove and discard the Teflon worm shaft seal ring (19) and O-ring (18). *See Figure* 31.

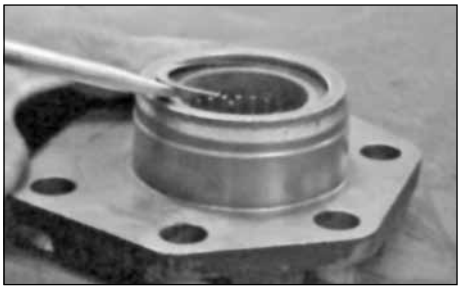


*Figure 31*

36. If your gear is equipped with poppets, they will usually not require servicing. If it is necessary, however, position the rack piston (31) in a soft-jawed vice. Then, remove two poppet retaining rings (32), two poppet seats (33), two poppets (34), the nylon spacer rod (35), and the poppet spring (36). *See Figure* 32 & 33.



*Figure 32*



*Figure 33*

37. The housing bearing assembly (21) or race should only be removed if you determine that only the bearing must be replaced after following inspection procedures 4, 5 and 6 on page 22. Remove the bearing in the following manner. Apply pressure from the side cover opening and press the bearing out through the trunnion cover opening. *See Figure 34.* Maintain a good, square contact between the housing and press base to avoid damaging the housing bearing bore. Remove retaining ring (22) from bearing. Discard bearing.

    *CAUTION: If the bearing is cocked while you press It out, It will burnish the bore, causing It to become oversized. You will then have to replace the gear housing.*

    This completes disassembly of the HFB64 steering gear.

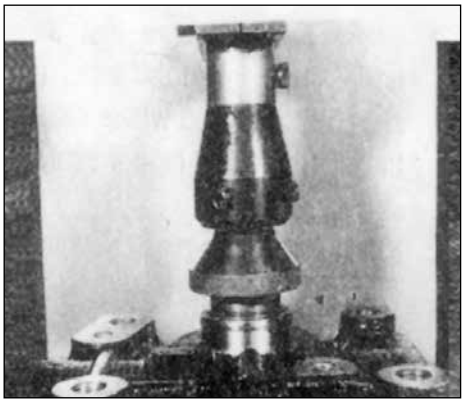


*Figure 34*

**INSPECTION**

- Check to make sure that all sealing surfaces and seal cavities are free from nicks and corrosion. If any part is nicked or corroded where sealing occurs, you must replace the part to insure proper sealing.
- Wash all parts in clean petroleum-based solvent. Blow them dry only. CAUSE INJURY OR DEATH.

  *WARNING : SINCE THEY ARE FLAMMABLE, BE EXTERNALLY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.*

  *WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.*

1. Inspect the rack piston (31) teeth for cracks and wear. If you can detect a step by running your fingernail horizontally across the teeth surface, you must replace both the rack piston and sector shaft (50) and set of 27 balls (42). *See Figure* 35.
2. Inspect the rack piston internal ball-track grooves for brinelling (dents) or spalling (flaking). *See Figure* 36. If either condition exists, you must replace the following parts; the rack piston (31), the worm shaft/input shaft (17), the valve sleeve (15), and set of 27 balls (42).
3. Inspect the worm shaft/input shaft assembly (17) ball track grooves for brinelling or spalling. *See Figure* 37. If either condition exists, you must replace all of the following parts; the worm shaft/input shaft assembly (17), the rack piston (31), the valve sleeve (15), the set of 27 balls (42). Visually inspect the upper shaft seal area near the input shaft serrations for nicks, and run your fingernail edge across the sealing surface to detect steps. *See Figure* 38. Visually inspect the sleeve contact area of the worm shaft/input shaft for discoloration from excess heat. If either of these conditions exist you must replace the worm shaft/input shaft assembly (17) and valve sleeve (15) as a matched set and the set of 27 balls (42).

   *NOTE: The Input shaft Is pinned to the worm shaft by the torsion bar pin, and the assembly Is flexible and may appear slightly bent at this joint, this slight bend Is normal See Figure 39.*



*Figure 35*

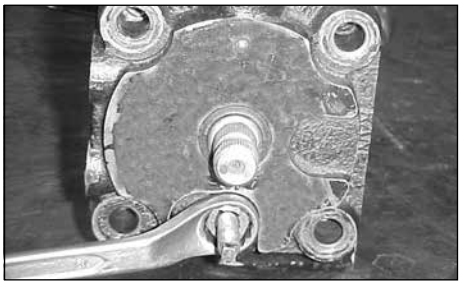


*Figure 36*

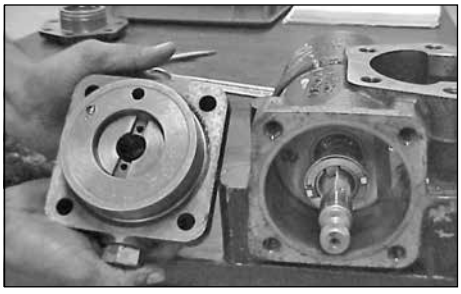


*Figure 37*

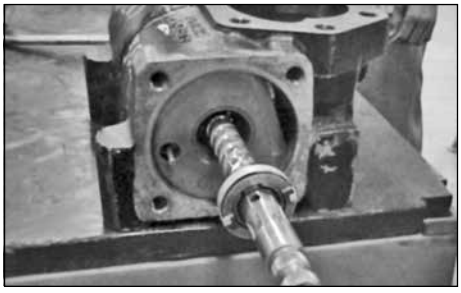


*Figure 38*

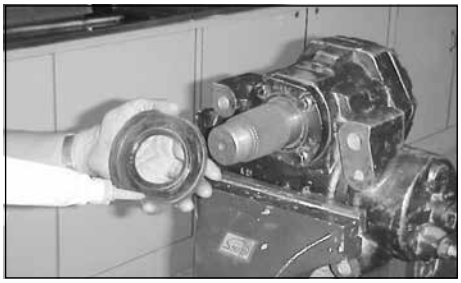


*Figure 39*

4. Inspect the housing cylinder bore. *See Figure 40.* You will probably notice normal scoring marks running lengthwise through the bore. Since this scoring is normal, you should not compare it to the scoring considered detrimental in the cylinder bores of an internal combustion engine. Replace the housing only if you've tested it for internal leakage and you've determined that the scoring, and not damaged seals, is responsible for the excessive internal leakage, greater than 5.7 liters/min.

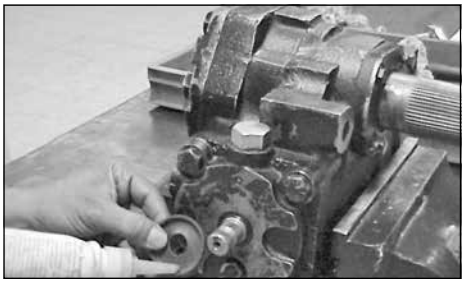


*Figure 40*

*NOTE: In running the Internal leakage test after reassembly of the unit, make sure that internal leakage exceeding 1.0 gpm (3.8 liters/min.) Can only be attributed to the housing and not to the improper assembly of the new seals in the worm shaft, rack piston, and valve assembly, before you replace the housing.*

5. Inspect the housing (20) faces for nicks that would prevent proper sealing. Replace THE gear housing if these nicks are present and cannot be easily removed with a fine-toothed flat file without changing the dimensional characteristics. *See Figure* 41.

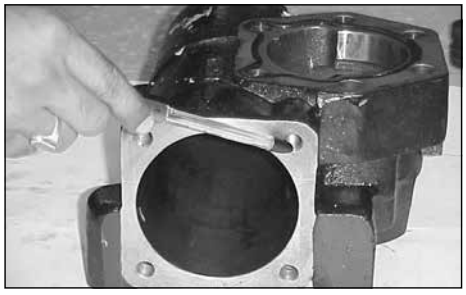


*Figure 41*

6. Inspect the housing roller bearing (21) and the side cover bearing for brinelling or spalling. *See Figures* 42, 43. If either condition exists, replace the damaged housing bearing (21). For the housing bearing, follow disassembly step 37 and assembly step 2, pages 20 and 25. If the side cover roller bearing damaged, replace side cover assembly.

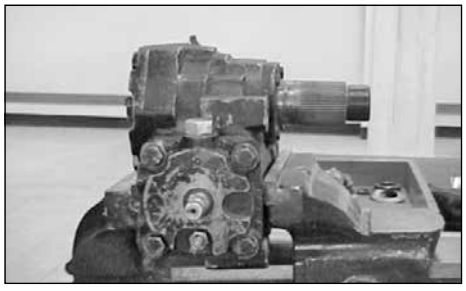


*Figure 42*

*WARNING: FOR BEARING TYPE WITH UNCAGED (LOOSE) ROLLS DO NOT MIX THE ROLLS FROM THE SIDE COVER BEARING WITH THE ROLLS FORM THE HOUSING BEARING. THE BEARING RACE AND ROLLERS ARE A MATCHED SET, INTERCHANGING THE ROLLS COULD RESULT IN PREMATURE BEARING OR SEAL FAILURE, WHICH COULD CAUSE A LOSS OF POWER STEERING.*



*Figure 43*

7. Inspect the sector shaft (50) bearing and sealing areas and sector teeth contact surfaces for brinelling or spalling. *See Figure* 44. Run your fingernail edge across these areas to detect steps. Inspect also for cracks. Remove any masking tape from the shaft serrations and inspect for twisted or otherwise damaged serrations. II any of these conditions exists, replace the sector shaft.

   *NOTE: A service shaft assembly will have the adjusting screw (51) and retainer (52) assembled into it. The- screw (51) and retainer (52) can be serviced separately if required.*

8. Inspect the sector shaft assembly for damaged adjusting screw (51) threads. The staked retainer (52) must be locked in place, and have no cracks. The adjusting screw must rotate by hand with no perceptible end play (lash). Replace adjusting screw, it damaged. Replace the retainer, if damaged, or if the adjusting screw requires replacement or adjustment.

9. Inspect the thrust bearing rollers (12) for any deterioration. Inspect the two thrust washers (11) for brinelling, spalling, or cracks *See Figure* 45. Replace the part if you detect these conditions.

   This completes inspection of the HFB64 steering gear.



*Figure 44*



*Figure 45*

**ASSEMBLY**

**Preparation**

- Wash all part in clean petroleum-based solvent. Blow them dry only.

  *WARNING: SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.*

  *WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.*

- Replace all seals, seat rings, and gaskets with new ones each time you disassemble the gear.
- Rane does provide individual seals, seal rings, and gaskets, as well as complete and partial seal kits. *See Figure* 46. These parts should be available through most OEM parts distributors. (Contact your local dealer for availability).



*Figure 46*

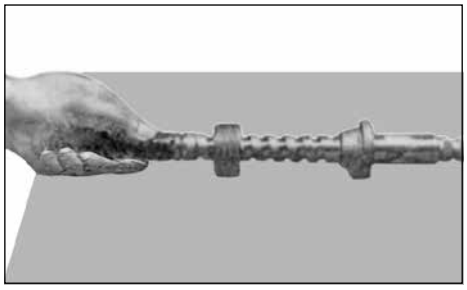


*Figure 47*

1. Slide compression tool, (820501031) small diameter end first, onto the worm end of worm shaft/input shaft (17) until it is beyond the seal ring groove. Using seal installation tool (820601001) assemble the new worm shaft O-ring (18), and then the new seal ring (19). *See Figures* 47 & 48. Next, compress the seal ring by pulling the compression tool back over the seal ring. Allow the worm shaft/input shaft to set with compression tool in place for at least ten minutes. *See Figure* 49.

*CAUTION: Allow for this 10 minutes to insure that the O-ring and seal ring are properly seated when you install the worm shaft Into the rack piston. If you do not allow for this time, the seal may tear or be cut when you place the worm Into the rack.*

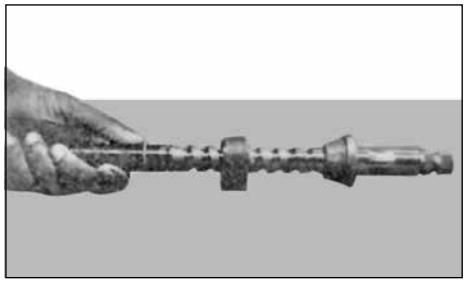


*Figure 48*

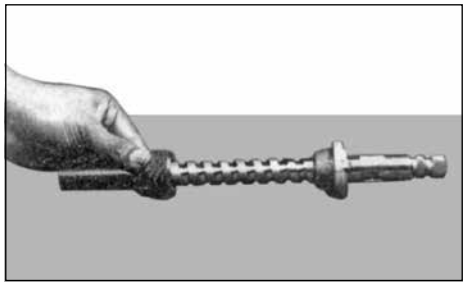


*Figure 49*

2. It you are installing a new housing bearing (21) or using the old housing and bearing assembly, apply a generous amount of clean grease to the bearing race to retain the bearing rolls. Then, place the rolls into the race, being sure you have the correct quantity of rolls for your particular bearing assembly. To install the new bearing assembly (21) into the housing, first install the retaining ring (22) into the groove on the bearing's outside diameter. Then press the bearing into the housing from the trunnion side using bearing mandrel against the lettered end of the bearing shell so that the retaining ring is away from the housing bore. *See Figure 50.* During this procedure be sure that the housing is square with press base and the bearing is not cocked.

   *CAUTION: The bearing rolls must be In place to Insure proper Installation of the bearing. If the rolls are Improperly Installed, the bearing race may collapse and fall. The flange may break, causing premature failure of the bearing. Again, do not mix the housing bearing rolls with the side cover bearing rolls. Be sure the bearing mandrel used is clean.*

3. Install the new rack piston backup 'O' ring (30 and then the new Teflon rack piston seal ring (29). *See Figures* 51 & 52. Do not over stretch these rings as you install them. After you install them, coat them with a liberal amount of grease.

   Slip on compression tool and allow 10 minutes to insure proper seating 01 the seal before installing the piston in the housing.

   *WARNING: DURING STEP 4, YOU SHOULD WEAR EYE PROTECTION, AS THE SPRING LOADED POPPETS COULD EJECT, AND CAUSE EYE INJURY.*

4. If the gear is equipped with poppets and the poppets were removed, then install into the rack piston (31) one poppet seat (33). *See Figure* 53. From the other end of the rack piston install one poppet (34), the spring (36), the nylon spacer rod (35), the other poppet (34), and the other poppet seat (33). Torque both poppet seat to 20-25 Ft. Ibs. (2734 Nm). Install both retaining rings (32). *See Figures* 54.

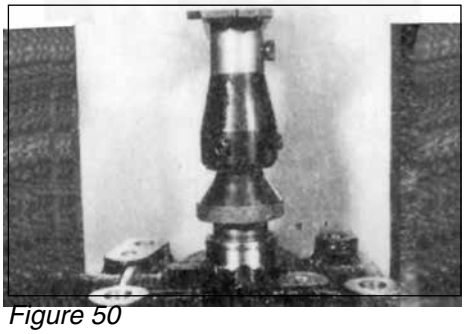


*Figure 50*



*Figure 51*

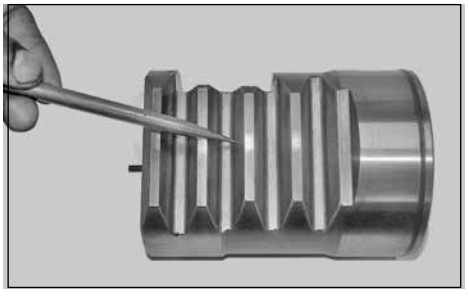


*Figure 52*



*Figure 53*



*Figure 54*

5. When the 10 minute compression time has elapsed, remove the compression tool fro":, the worm shaft/input shaft assembly (17). Grease the worm shaft seal ring (19) and the sealing surface inside the rack piston (31). Install the worm shaft input shaft assembly into the rack piston end that will position the worm seal ring in the rack bore and Position the worm ball track grooves to accept the set of balls through the rack piston ball guide holes. *See Figure* 55.



*Figure 55*

6. Assemble the ball return guide halves (43) into the rack piston (31). Make sure they are correctly seated. *See Figure* 56.

   *WARNING: DO NOT SEAT GUIDES WITH A HAMMER, DAMAGE TO GUIDES CAN RESULT IN SUBSEQUENT LOCKUP OR LOSS OF STEERING.*

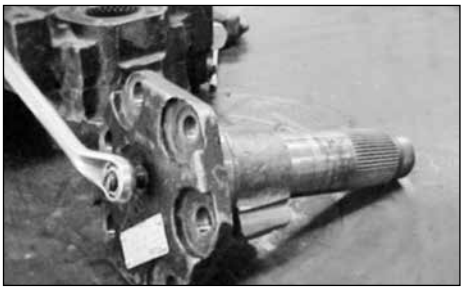


*Figure 56*

7. Assemble 27 steel balls (42) into the ball return guide through the hole provided in the top of the guide. As you drop the balls into the guide, rotate the worm shaft (17) to pull the balls down into the ball track grooves. *See Figure* 57.

   *WARNING: MAKE SURE THE BALL RETURN GUIDE STAYS DOWN IN PLACE AS YOU DROP THE BALLS THROUGH THE HOLE. FAILURE TO HOLD THE GUIDE DOWN MAY RESULT IN A BALL BEING TRAPPED OUTSIDE THE CLOSED LOOP. A TRAPPED 'BALL CAN RESULT IN A STEERING LOCKUP, WHICH COULD CAUSE AN ACCIDENT.*



*Figure 57*

8. If your gear is equipped with the ball return guide clip (44), install it so that both bolt hole faces are in full contact with the rack piston surface. Install two new lock tabs (45) and the two hex head bolts (46). Torque the bolts to 1422 ft. lbs. (19-30 Nm). Finish by bending the locking tabs up against the bolt head flats. *See Figure* 58.

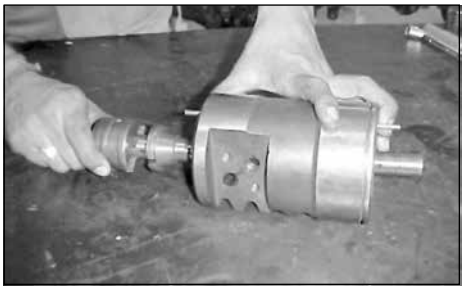


*Figure 58*

*WARNING: ROTATE THE WORM SHAFT FROM ONE END OF TRAVEL TO THE OTHER, TO MAKE CERTAIN THAT YOU HAVE INSTALLED THE. BALLS PROPERLY. SEE FIGURE 59. IF YOU CANNOT ROTATE THE WORM SHAFT, YOU WILL HAVE TO REMOVE THE BALLS AND REASSEMBLE THEM. IF YOU INSTALL A GEAR ON A TRUCK WITH THE WORM SHAFT UNABLE TO ROTATE, THE GEAR WILL NOT FUNCTION CORRECTLY. DAMAGE MAY RESULT.*

9. Position the housing (20) securely in a vise as it was for the disassembly procedures. *See Figure. 1 Page 12.* Apply a generous amount of clean grease to the Teflon rack piston seal ring (29) and to the housing cylinder bore. Install the rack piston (31) and worm shaft/input shaft (17) as an assembly into the long end of the gear housing (20), if the housing rack piston bore is open on both ends, so that the Teflon rack piston seal ring goes in last. *See Figure 60.*

   *CAUTION: Be certain that the seal goes Into the long end of the housing last if the housing bore is open on both ends. Otherwise, a large section of the seal will be cut, and the vehicle will have no power steering assist.*

   *CAUTION: If the housing rack piston bore is open only on one end and the seal ring end of the rack piston must enter the housing first, with a piston guide fitted to the housing. See Fig.61 The rack piston cannot be removed after it is assembled into the housing without destroying the rack piston seal ring.*

   *NOTE: To ease the later assembly of the sector shaft, rotate the rack piston and worm shaft assembly in the housing so that the rack teeth are exposed in the sector shaft cavity of the housing. See Figure 62.*

10. If they were disassembled, assemble the new worm shaft adjusting screw sealing washer (38), Lock nut (38A) onto the non-slotted end of the worm shaft preload adjusting screw (39) so that the sealing washer will face the end cover (37) or closed end of housing. *See Figure* 63. Assemble a new sealing washer (3), Lock Nut (3A) onto poppet adjusting screws (2) and (40) in the same manner.



*Figure 59*



*Figure 60*



*Figure 61*

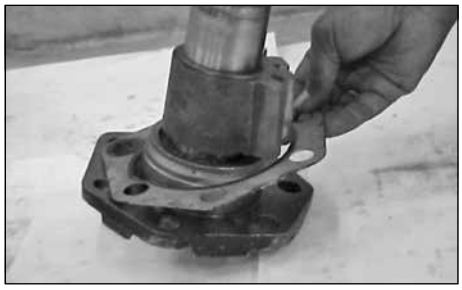


*Figure 62*



*Figure 63*

11. Assemble poppet adjusting screw (40) nut (3) and sealing washer (3A) assembly into end cover (37) or closed end of housing (20) a few turns. Final adjustments will be made later.

    *WARNING: IF SCREWS (2) AND (40) ARE UNEQUAL IN LENGTH, YOU MUST INSTALL THE SHORTER SCREW INTO END COVER OR CLOSED END OF HOUSING. OTHERWISE, THE POPPET ASSEMBLY MAY BREAK AND LOCK UP THE STEERING GEAR, POSSIBLY RESULTING IN AN ACCIDENT.*

12. Install the worm shaft preload adjusting screw (39) and sealing washer (38A) nut (38) into the end cover (37) or closed end of the gear housing (20) a few turns. *See Figure* 64. Final adjustments for worm and poppet adjusting screws will be made later.

13. If your gear is equipped with the removable end cover (37), apply clean grease to the seal ring groove in the end cover. Install the new end cover seal ring (10) into the groove. *See Figure* 65.

    *Note: When Installed, the seal ring will extend slightly above the machined surface of the end cover.*

    *CAUTION: When performing step 14, make sure that the rack piston teeth are fully visible in the sector shaft cavity of the gear housing (20). This will insure proper location of the poppets and Insure also that the poppet adjusting screw will contact the poppet.*

14. If your gear has the removable end cover (37), position it so that the poppet adjusting screw (40) is aligned with the end of the poppet (34). *See Figure* 66. Push the end cover in until it contacts the gear housing.

15. Install the four end cover bolts (41) 35.1 mm long and washers (41 A), and torque the bolts to 142-156 Nm if dry or 102-115 Nm if lubricated. *See Figure* 67.

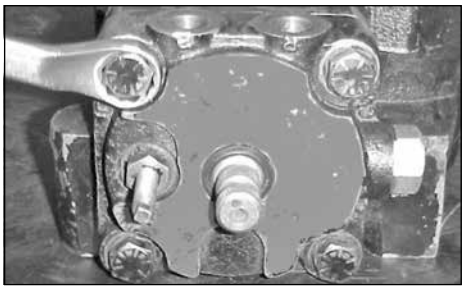


*Figure 64*

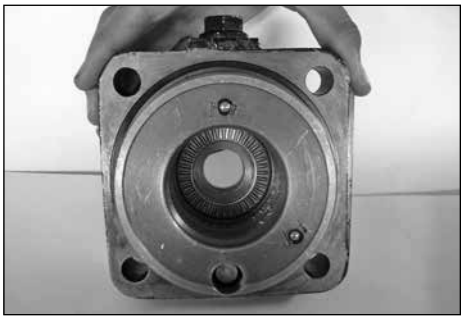


*Figure 65*

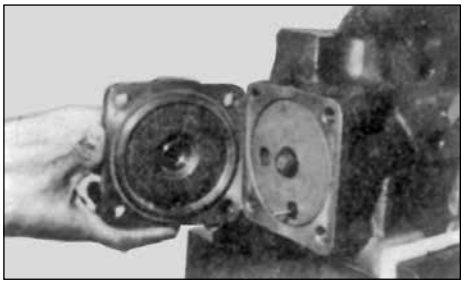


*Figure 66*



*Figure 67*

16. Grease the two new backup O-rings (14) and the two new Teflon seal rings (13). Using seal installation tool (82 0401 001) assemble the backup O-rings and then the seal rings onto the valve sleeve (15). *See Figures* 68 & 69.

    *Note: Assembly each O-ring and seal ring from the end closest to its groove.*

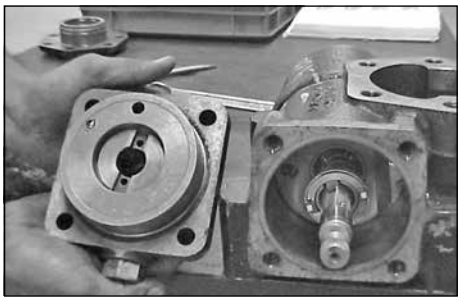


*Figure 68*



*Figure 69*

17. Use the compression tool (82 04 01 041) to compress the teflon seal rings. Leave this compression tool on for 10 minutes. *See Figure 70.*

    *CAUTION: Allow for this at least ten minutes, to ensure that the seals are properly seated. Otherwise, the valve sleeve will be difficult to assemble into the valve housing, and the seal may be cut during installation.*



*Figure 70*

18. If removed, assemble the poppet valve adjusting screw (2) nut (3) and sealing washer (3A) assembly into the valve housing (9) a few turns.

19. Apply clean grease to the seal ring groove in valve housing (9) and install a new seal ring (10) into the groove. *See Figure* 71.

    *NOTE: When installed, the valve housing seal ring should extend slightly above the machined surface of the valve housing.*

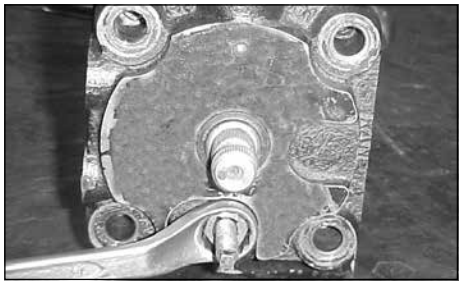


*Figure 71*

20. Apply a generous amount of clean grease to one thrust washer (11), Place the valve housing, exterior side down, on a flat surface and place the thrust washer into the valve housing (9), making sure to center the washer *See Fig.* 72.



*Figure 72*

21. Apply a generous amount of clean grease to the thrust bearing (12). Install the bearing into the valve housing (9) and onto the first thrust washer, making sure to center the bearing on the washer. *See Figure* 73.

    *WARNING: THE THRUST WASHER AND THRUST BEARING MUST BE FLAT AND CENTERED IN THE COUNTER BORE SURFACE OF THE VALVE HOUSING. OTHERWISE, THE THRUST WASHER COULD BREAK WHEN YOU PLACE THE VALVE HOUSING ONTO THE GEAR HOUSING. A BROKEN THRUST WASHER COULD CAUSE UNCONTROLLABLE STEERING, POSSIBLY RESULTING IN AN ACCIDENT.*

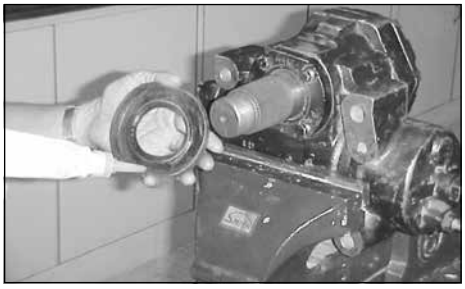


*Figure 73*

22. When the compression time has elapsed, remove the compression tool from the valve sleeve (15). Apply more grease to the valve sleeve seals (13 and 14), and grease the thrust washer face on the end of the valve sleeve without the drive shots. *See Figure* 74 & 75. Place the second thrust washer (11 A) onto this face.

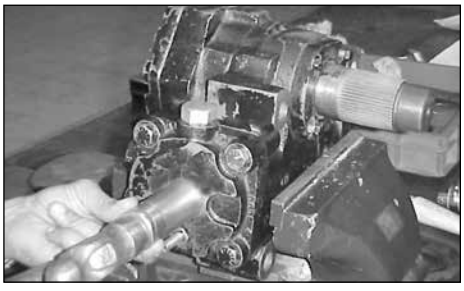


*Figure 74*

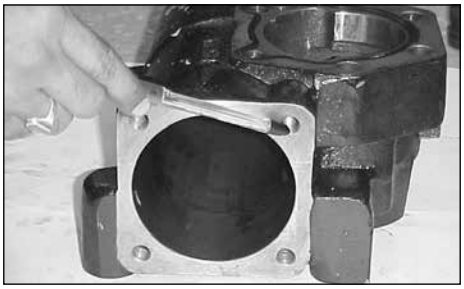


*Figure 75*

**ASSEMBLY**

*WARNING: THIS THRUST WASHER MUST BE SECURELY IN PLACE ON THE VALVE SLEEVE. IF IT IS NOT, IT CAN BREAK AND CAUSE UNCONTROLLABLE STEERING, POSSIBLY RESULTING IN AN ACCIDENT.*



*Figure 76*

23. Locate the timing mark on the valve sleeve (15), R or L punched on the inlet groove. Make a corresponding mark on the front face with a felt marker. *See Figure* 76. Assemble the valve sleeve (15), with the second thrust washer attached, into the valve housing (9), thrust-washer end first. When the valve sleeve is properly in place, the valve sleeve face should measure approximately. 10.2 mm below the face of the valve housing. *See Figure* 77.

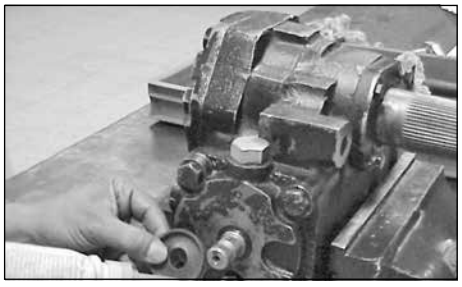


*Figure 77*

*WARNING: DO NOT FORCE THE VALVE SLEEVE DOWN INTO THE VALVE HOUSING MAKE SURE THE VALVE SLEEVE SEAL RINGS ARE COMPRESSED. MISASSEMBLY OR INCORRECT MEASUREMENT MAY CAUSE THE THRUST WASHERS OR THRUST BEARING TO BREAK DURING GEAR OPERATION. THIS WILL RESULT IN UNCONTROLLABLE STEERING.*

24. Position the rack piston (31) so that it is flush with the valve housing end of the gear housing. Rotate the worm shaft (17) until it extends out of the rack piston as far as it will go *See Fig.* 78.

*WARNING: THE WORM SHAFT AND VALVE SLEEVE ASSEMBLY IS ASSEMBLED AND SOLD AS A MATCHED SE~ USE ONLY MATCHED SETS FOR REPLACEMENT. NEVER MATE AN OLD VALVE SLEEVE WITH A NEW WORM SHAFT, OR AN OLD WORM SHAFT WITH A NEW VALVE SLEEVE. TO DO EITHER MAY RESULT IN DAMAGE TO THE GEAR OR INJURY TO THE DRIVER DURING OPERATION.*

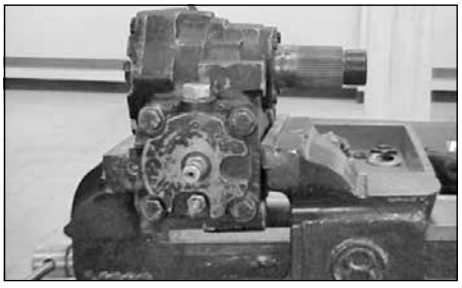


*Figure 78*

25. Locate the scribed timing marks on the worm shaft/input shaft assembly (17) and valve sleeve (15). *See Figure* 79. Next, grasp the valve housing (9) and valve sleeve as an assembly, with your thumbs on the valve housing and your fingers applying pressure on the valve sleeve to keep it in the valve housing. *See Figure 80.* Align the previously located timing marks and place the valve housing and valve sleeve as an assembly onto the input shall end Of the worm shaft/input shaft until the drive lugs on assembly (17) are fully engaged in valve sleeve lug slots. *See Figure* 81.

    *Note: Valve sleeves are identified and matched to a right or left hand lead of the worm screw. If the screw has a right hand thread (that is, goes into the rack piston when turned clockwise), the valve sleeve will have the letter "R" stamped between the seal lands. For a left hand worm lead (which will come out of the rack piston when turned clockwise), the mating valve sleeve has no identifying letter or has the letter "L" stamped between the seal lands.*

    *WARNING: IF YOU PLACE AN INCORRECT VALVE SLEEVE ON A WORM AND ASSEMBLE THIS INTO THE GEAR, THE GEAR WILL NOT FUNCTION PROPERLY. INSTEAD, THE MECHANISM WILL JERK THE STEERING WHEEL WITH SUCH FORCE, THAT IT COULD INJURE THE DRIVER.*

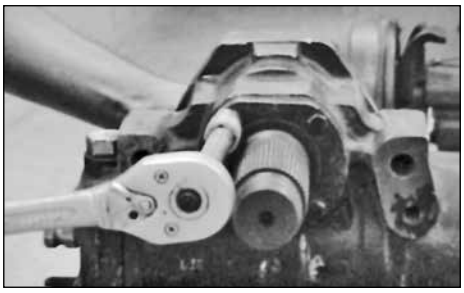


*Figure 79*

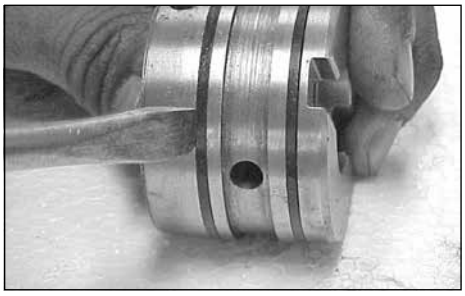


*Figure 80*

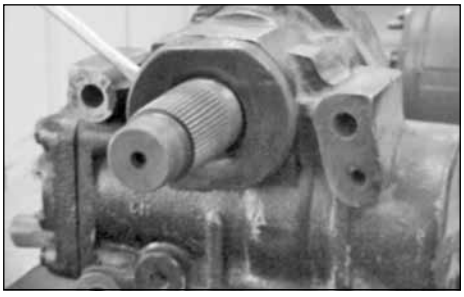


*Figure 81*

26. Maintain pressure on the valve end on the valve housing to insure continued engagement of the drive lugs and thrust bearing package. While maintaining this pressure, rotate the valve housing to align the poppet adjusting screw (it equipped) with the poppet in the rack piston (31). *See Figure* 82. While maintaining pressure, rotate the input shaft to bring the valve housing into contact with the gear housing face.

    *NOTE: If a line was scribed across the valve housing and gear housing before disassembly, as recommended, use the line for correct valve housing positioning.*

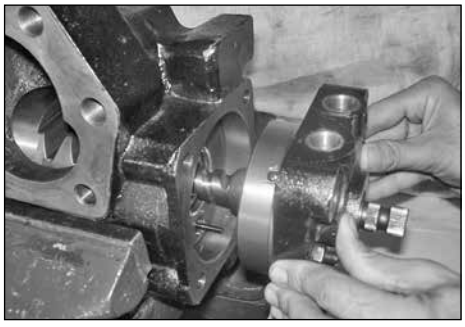


*Figure 82*

27. Install the four valve housing bolts (1) into the valve housing (9). Torque them to 142-156 Nm if dry or 102-115 Nm if lubricated. *See Figure* 83.

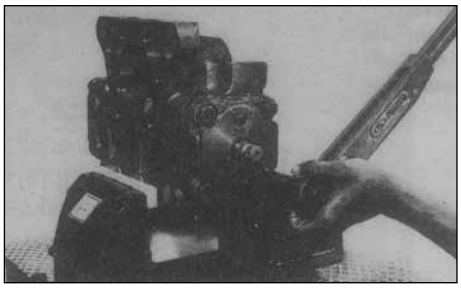


*Figure 83*

28. If the adjusting screw (51) has been removed from the sector shaft (50), clamp the sector shaft into a soft-faced vise by gripping the serrated end. Coat the expanded end of the new adjusting screw with a suitable grade 01 wheel bearing grease and insert into recess in end of sector shaft. Thread a new sector shaft screw retainer (52) into the sector shaft and adjust to permit free rotation of sector shaft adjusting screw by hand without perceptible end play. [.000 to .002 in. (.05 mm) loose]. Stake the new retainer into the two slots provided using a suitable punch and again check freedom of adjusting screw movement and end play. *See Figure* 84.

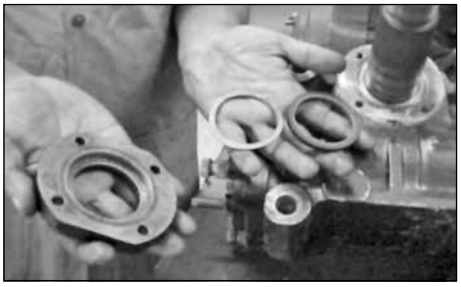


*Figure 84*

*WARNING: USE CARE IN SECURELY STAKING THE RETAINER (52) INTO THE SECTOR SHAFT SLOTS. A RETAINER THAT IS BROKEN OR CRACKED DURING THE STAKING PROCEDURE MUST BE REPLACED AS IT COULD RESULT IN THE SECTOR SHAFT NOT BEING RETAINED AND THE LOSS OF MANUAL AND POWER STEERING CONTROL.*

29. Apply a generous amount of clean wheel bearing grease (do not substitute another type of grease) to the bearing race inside the side cover (58) and to the rolls if they are caged (retained) rolls.

*CAUTION: Use only wheel bearing grease on the roller bearing assembly. This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Without wheel bearing grease, the bearing could wear prematurely.*

30. If the side cover (58) has loose bearing rolls, assemble the bearing rolls into the side cover bearing race. *See Figure* 85.

    *CAUTION: Apply more wheel bearing grease to these rolls to retain them in the bearing race.*



*Figure 85*

31. Assemble the steel backup washer (56) and then the teflon washer (55) into the side cover (58) bearing bore. *See Figure* 86.



*Figure 86*

32. Assemble retaining ring (53) onto the side cover end of sector shaft (50). Assemble the two-piece seal (54) onto the end of the sector shaft about 1 inch (25.4 mm). The words “oil side” on the seal must face toward the sector shaft. *See Figure* 87.

    *CAUTION: Be sure the two-piece seal and the side cover bearing rolls remain correctly assembled and that the vent plug (60) has been removed during these procedures.*



*Figure 87*

33. Be sure the side cover bearing, the sector shaft bearing diameter and steel are well greased, then insert sector shaft (50) assembly into the side cover (58) bearing only until the shaft will retain the loose side cover bearing rolls in place (about 8 turns of adjusting screw). Slowly and carefully work the two-piece seal (54) down the sector shaft and squarely into the side cover until it is past the retaining ring groove. Use an appropriate blunt end punch or punches.. *See Figure* 88. Carefully turn the adjusting screw (51) through side cover until it reaches solid height then back screw one turn, so that the side cover rotates freely on sector shaft.

    *CAUTION: Be sure that one or more bearing rolls do not become dislodged during assembly of sector shaft Into side cover.*



*Figure 88*

34. Install the sector shaft adjusting screw jam nut (59) onto the sector shaft adjusting screw (51) a few threads. Final adjustment will be made later. *See Figure* 89.

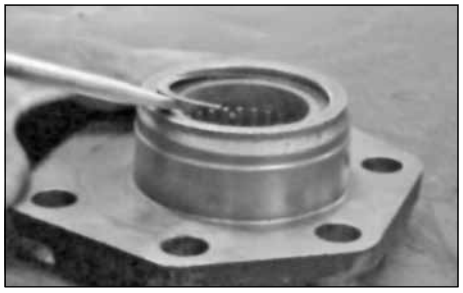


*Figure 89*

35. Press the new vent plug (60) into the hole provided in the side cover (58) until the plug is flush. *See Figure 90.*

    *WARNING: DO NOT WELD OR OTHERWISE PLUG THIS HOLE IN ANY PERMANENT MANNER. THIS IS A SAFETY VENT WHICH FUNCTIONS ONLY IF THE SIDE COVER SEAL FAILS. IF THE SEAL FAILS AND THE PLUG CANNOT VENT, THE STEERING GEAR MAY LOCKUP OR OTHERWISE MALFUNCTION.*



*Figure 90*

36. Apply clean grease to the new side cover gasket (57), and assemble it into the side cover (58). Apply enough grease to hold the gasket in place. *See Figure* 91.



*Figure 91*

37. There are four teeth on the rack piston (31). *See Figure* 92. Position the rack piston so that the tooth space identified by the pencil, it is the space between the second and third teeth, is in the center of the sector shaft opening. *See Figure* 93. This will center the rack piston in the opening.

    *WARNING: IF THE RACK PISTON IS NOT CENTERED WHEN SECTOR SHAFT IS INSTALLED, GEAR TRAVEL WILL BE SEVERALLY LIMITED IN ONE DIRECTION. THIS COULD RESULT IN AN ACCIDENT.*

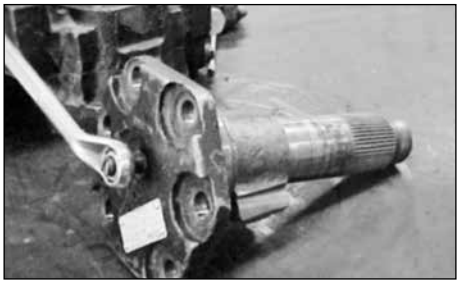


*Figure 92*



*Figure 93*

38. With the rack piston (31) in its center position, torque the worm shaft/input shaft adjusting screw (39) using a 5/ 16 inch Allen wrench socket into solid height (20.3 to 27.1 Nm). Then loosen the adjusting screw 1/4 to 1/2 turn and note torque required to rotate worm shaft/input shaft (17) through 90° each side of center, using an 11/16 inch or 3/4 inch 12 point socket and an appropriate torque wrench. *See Figure* 94. Loosen adjusting screw if noted input shaft torque exceeds 1.7 Nm. Return rack piston to center position.
39. Clean off any old tape on the sector shaft (50) serrations. Retape the serrations and bolt groove with one layer 01 masking tape. Install the sector shaft and side cover (58) into the gear housing (20) as an assembly. Make sure that the center tooth of the sector shaft engages the center space (between the second and third teeth) 01 the rack piston. *See Figure* 95.

    *WARNING: AS YOU PLACE THE SECTOR SHAFT THROUGH THE HOUSING BEARING (21), DO NOT KNOCK ANY OF THE BEARING ROLLS OUT OF THE BEARING RACE. DO NOT PINCH THE SIDE COVER GASKET (57). IF YOU DO EITHER, THE BEARING OR SEAL MAY PREMATURELY FAIL, AND THIS COULD RESULT IN A LOSS OF POWER STEERING ASSIST.*
40. Install the six special side cover bolts (61) into the side cover and torque them to 298-325 Nm if dry or 217-244 Nm if lubricated.
41. Place the trunnion cover (26) exterior lace down on a bench and install the new Teflon backup washer (24). *See Figure* 96
42. Next install the new two-piece sector shalt seal (23) so that the words “oil side” are visible after the seal is in place. *See Figure* 97.

    *WARNING: THE WORDS “OIL SIDE” MUST BE VISIBLE ON THE SEAL AFTER IT IS IN PLACE. IF NOT, THE SEAL WILL NOT FUNCTION, AND A LOSS OF POWER STEERING ASSIST MAY OCCUR.*
43. Grease the new trunnion cover seal ring (25) and install it into the trunnion cover (26) seal ring groove.
44. Visually inspect the housing bearing (21) to make sure that all of the bearing rolls are properly in place. Then install the trunnion cover (26). *See Figure* 98. Install the four trunnion cover bolts



*Figure 94*



*Figure 95*

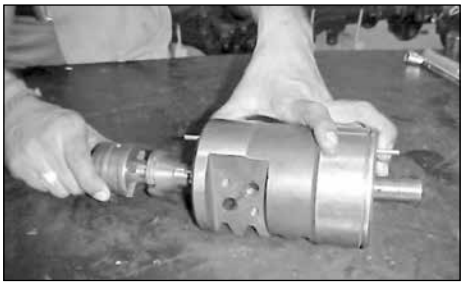


*Figure 96*



*Figure 97*

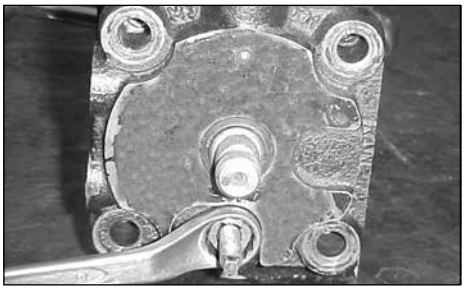


*Figure 98*

(28) and torque them to 20 - 30 Nm if dry or 15-22 Nm if lubricated. *See Figure* 99.



*Figure 99*

45. Pack the cavity around the seal area of sector shaft (50) with clean high temperature industrial grease (shell Retinax A, BP Energrease PR-EP1. Assemble a new dirt and water seal (27) using special tool (82 01 04 001) Apply a generous amount of the same grease inside of the inner ring of protector boot (63). Assemble protector boot (63) over sector shaft (50) and trunnion cover (26), *See Figure 100.*

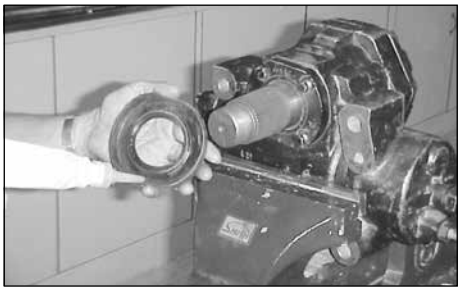


*Figure 100*

46. Apply clean grease to the input shaft seal assembly (7 and 8) and to the input shaft. Install the new two-piece input shaft seal (7 and 8), flat side out, and then the steel backup washer (6), using seal driving tool (82 01 02 001). Install the retaining ring (5). *See Figure 101* & *102*

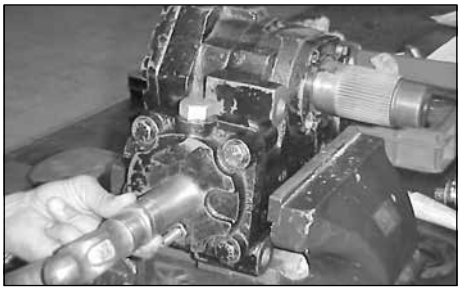


*Figure 101*

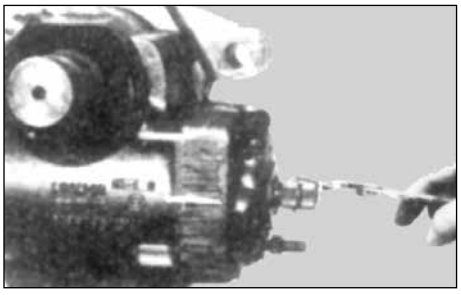


*Figure 102*

47. Pack the area around the input shaft with clean high temperature industrial grease shell retinax A, BP Energrease PR-EP1 and, install the new dirt and water seal (4), with part number lacing out, using seal driving tool (82 01 03 001) or suitable blunt-ended drift. *See Figure. 103.* If the dirt and water seal has a rim, it should be pressed against the valve housing face. If the seal does not have a rim, the seal should be pressed in flush with the valve housing face.

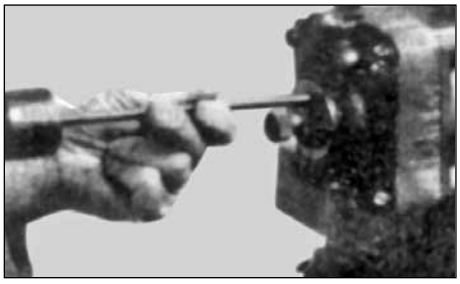


*Figure 103*

48. Apply more of the above grease to the cupped side of the new seal protector (62) and assemble it, cupped side in onto the worm shaft input shaft (17) and into the serration relief groove. *See Figure 104.*

    This complete assembly of the HFB64 steering gear. Before you install the gear into the vehicle, make final adjustments described on this page. All ports should be plugged until unit is installed in the vehicle.

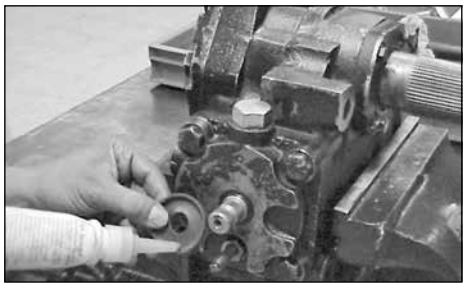


*Figure 104*

**Final Adjustment**

1. To center the steering gear, rotate worm shaft/ input shaft (17) until the timing mark on the end of sector shaft (50) is perpendicular to the worm shaft/ input shaft. *See Figure 105.* A special lever having 3/4" x 48 serration socket is required.

   *NOTE: Initial worm preload adjustment was accomplished In assembly procedure 38, page 36, before assembly of sector shaft (50).*

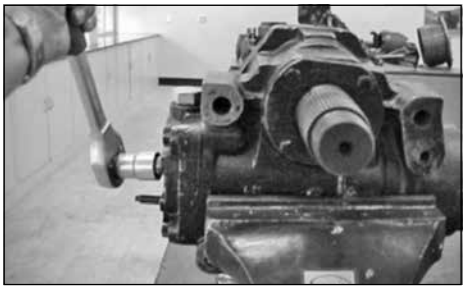


*Figure 105*

2. Tighten sector shaft adjusting screw (51) to provide 2.8 to 3.4 Nm of torque required to rotate the worm shaft/input shaft (17) through *180$^0$* each side of center. *See Figure 106.*

   *NOTE: This procedure will properly mesh and seat the rack piston teeth and sector shaft teeth for final adjustments.*



*Figure 106*

3. Loosen sector shaft adjusting screw (51) one turn and note maximum torque required to rotate the worm shaft/input shaft (17) through 180$^0$ each side of center.
4. Adjust sector shaft adjusting screw (51) to increase maximum torque noted in procedure 3 by 23 to .45 Nm. Torque jam nut (59) using a 3/4 inch socket, to 40 to 45 fl. lbs. (54 to 61 Nm) and check worm shaft input shaft torque again. Readjust if worm shaft/input shaft torque exceeds 20 in. lbs. (2.3 Nm).
5. Adjust worm shaft/input shaft adjusting screw (39), a 5/16 inch Allen wrench or screwdriver required, to increase maximum worm shaft/input shaft (17) torque noted in procedure 4 by 1.1 to 1.7 Nm. Torque sealing nut (38) to 95 - 108 Nm) using a 1-1/16 inch socket and check worm shaft/ input shaft torque again. Readjust if worm shaft/ input shaft torque exceeds 4.0 Nm. *See Figure 107.*

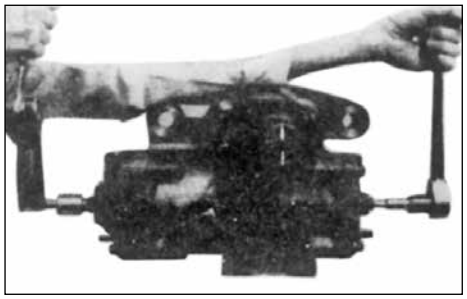


*Figure 107*

This completes the final adjustments of the HFB64 gear to be made before it is installed into the vehicle's steering system. Install the gear by following instructions in the vehicle shop manual. Then follow the succeeding sections of this service manual. (HFB64) on "Hydraulic Fluid" and "Filling and Air Bleeding the System" which also includes instructions for adjustment of the optional adjustable poppet valves.

## ADJUSTMENTS

You can make three adjustments to the gear while it is mounted on the vehicle; the worm shaft preload adjustment, the poppet valve adjustment if your gear is equipped with poppets, and the sector shaft adjustment.

**3. Worm Shaft Preload Adjustment (With vehicle engine off)**

3.1 Back off the worm shaft adjusting screw sealing nut (38) three turns. See Figure. 108 the worm shaft preload adjusting screw (39) one turn. See Figure 109. Inspect the threads between the sealing nut and housing end (or end cover, 37, if equipped) for foreign mailer. Clean the threads and replace the sealing nut if necessary. See Figure. 110. One and 1/16 inch socket required.

*NOTE: HF864 gears are equipped with a housing that has either a closed, non-removable end or a removable end cover (37). The worm shaft preload adjustment described here applies in either case, and you should make the adjustment according to the instructions in this manual.*

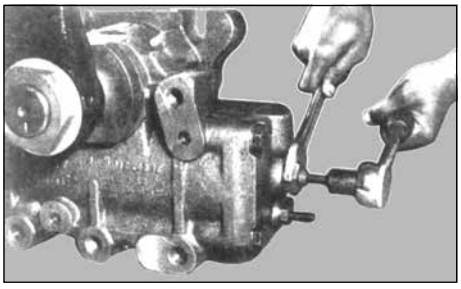


*Figure 108*

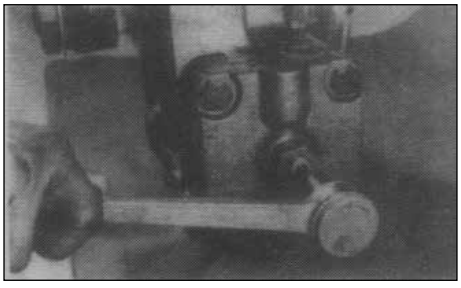


*Figure 109*

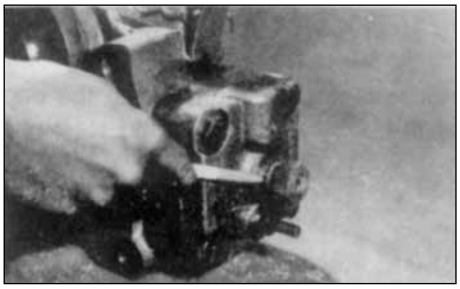


*Figure 110*

3.2 While someone lightly rotates the steering wheel back and forth about one inch local, torque the worm shaft preload adjusting screw (39) to 4.13-4.83 Nm. See Figure 111.

*NOTE: While torquing the adjusting screw, make sure that the worm shaft adjusting screw sealing nut (38) does not, tighten against housing or cover.*

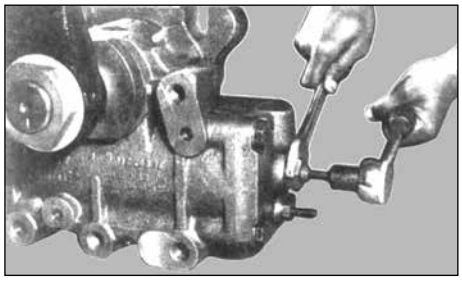


*Figure 111*

3.3 Torque the worm shaft adjusting screw sealing nut (38) to 95-108 Nm, making sure that the worm shaft preload adjusting screw (39) does not move.

*NOTE: If the sealing material In the sealing washer/nut has separated, remove the adjusting screw and replace the sealing washer/ nut with a new one onto the nonslotted end of the adjusting screw. Then, assemble and adjust the assembly as described.*

**4. Poppet Valve Adjustment (With Vehicle engine on)**

*NOTE: This adjustment is for all HFB64 gears equipped with poppet (unloading) valves, whether they are also equipped with a relief valve or not.*

4.1 Before you adjust the poppets, set the axle stops according to the manufacturer's specifications.

4.2 Install a pressure gauge or a flow meter/ pressure gauge package into the supply line from the pump to the gear. Make sure that the flow meter can be pressurized. Bring the fluid temperature to between 51.7°C and 57.2°C, using the method to warm the system up described in the troubleshooting section.

4.3 With the engine at idle, have someone turn the steering wheel to full lock (axle against axle stop), while you observe the rotation of the sector shall (50) See Figure 112. If the sector shall rotates counter-clock wise as shown, adjust the poppet adjusting screw identified in Figure 31. II the sector shall rotates clockwise, adjust the other poppet adjusting screw.

***CAUTION: If relief pressure is reached while the steering wheel Is at full lock (axle against axle stop), release the steering wheel from the position. At no time should relief pressure maintained for longer than 5. Seconds as damage to the pump may result.***

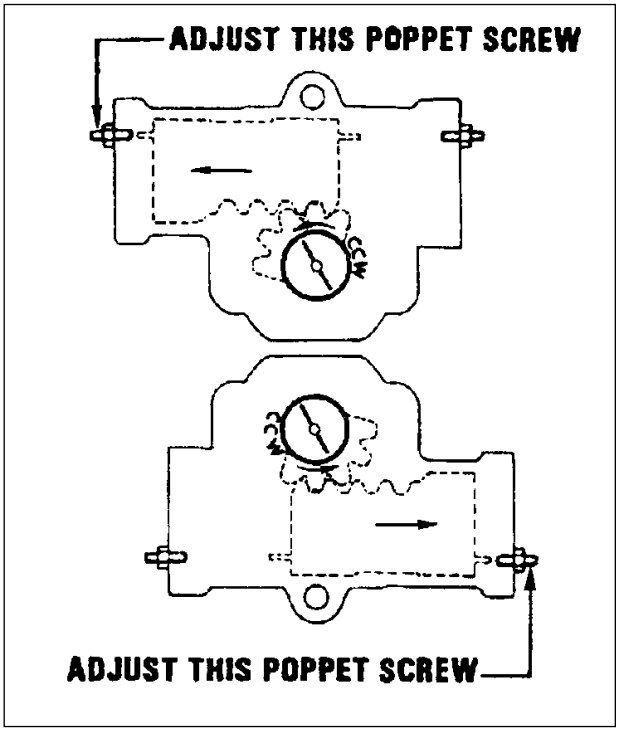



*Figure 112*

***NOTE: You must maintain enough force on the steering wheel to assure that the steering gear control valve is completely closed when reading pressure gauge.***

4.4 Once you have determined which poppet to adjust, loosen the poppet adjusting screw sealing nut (3 or 3A) and the poppet adjusting screw (2, 2A or 40) until the pressure gauge reads maximum system (pump) pressure with steering wheel at full lock. See Figure 113.

***CAUTION: Do not unscrew the adjusting screw more than required, as otherwise it would come out of the gear.***

4.5 Screw-in adjusting screw until the supply pressure drops to 50% of relief pre-setting. Tighten adjusting screw lock nut to 16-24 Nm.

4.6 To adjust the other poppet, repeat these instructions for full lock in the, other direction. See Figure 114 .

5 Cross-shaft or Sector-shaft Adjustment

(With Vehicle engine off).

5.1 If the sector-shaft adjusting screw jam nut (59), located on the side cover, is not accessible, the steering gear must, be removed prior to adjustment.

5.2 If the sector shalt adjusting screw (51) is accessible, remove the drag link from the pitman arm.

*CAUTION: This adjustment must be performed with the sector shaft on its centre of travel.*

*NOTE: Because 01 pitman arm or Internal stops or poppet adjustment the "centre of travel" for this adjustment may not be the centre of sector shaft or hand wheel rotation.*

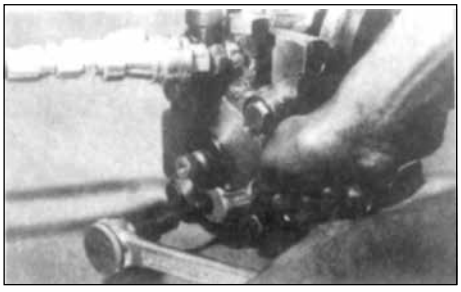


*Figure 113*



*Figure 114*

5.3 To position the sector shaft (50) on centre of travel for this adjustment rotate steering wheel (worm shaft/input shaft) until the timing mark across the end of the sector shaft is perpendicular to the worm shaft  input shaft (17).

5.4 With the sector shaft (50) in the centre position, grasp the pitman arm and gently try to move this arm back and forth in the direction of travel. Finger-tip force is adequate to detect lash of a loose sector shaft. There must be no movement of the input shaft or sector shaft. If no lash is detected, do not adjust.

5.5 If lash is detected, loosen jam nut (59) with a 3/4 inch socket and move the adjusting screw (51) clockwise until the sector shaft and rack piston (31) are in contact. Use no more than 14 Nm of torque. Then, turn the adjusting screw counterclockwise one turn.

5.6 At this point, there should be lash at the pitman arm.

5.7 To adjust, slowly turn the adjusting screw (51) clockwise until no lash is felt at the pitman arm. Hold the adjusting screw in place, and tighten the jam nut (59). Final torque 54-6 Nm.

5.8 Recheck the pitman arm for lash. Turn the steering wheel 1/4 turn each side of center. No lash should be felt. If lash exists, repeat adjustments 5.3-5.8.

5.9 Reconnect drag link to' pitman arm.

## FILLING AND AIR BLEEDING THE SYSTEM

***CAUTION** : For steps 1 and 2, do not turn the steering wheel. Otherwise, air may be induced into the system.*

1. Fill the reservoir nearly full. Crank the engine for 10 seconds if possible without, allowing it to start. If the engine does start, shut it off immediately. Check and refill the reservoir. Repeat at least three times, each time checking and refilling the reservoir.

   ***CAUTION**: Do not allow the fluid to drop significantly or run out of the reservoir. This may induce air into the system.*

2. Start the engine and let it idle for 2 minutes. Shut the engine off and check the fluid level in the reservoir.

3. Start the engine again. Steer the wheel from full left to full right turn several times. Add fluid, as necessary, to the fill line on the dipstick.

   ***NOTE** : Poppets, if equipped on the gear, must be adjusted so that they relieve pressure at full left and right turns to aid in the removing of air from the system. At this time, make sure poppets are properly adjusted. If they are not, adjust them in accordance with section 4 and repeat step 3.*

   The above procedures should remove all air *from* the steering system, unless the gear is mounted horizontal position and is equipped with the manual' bleed screw (20A). If this is so, refer to step 4.

4. Remove the air from a gear mounted in horizontal position and equipped with a manual bleed screw (20A) by following steps 1,2 and 3 above. Then with the engine idling, steer the gear from full left turn to full right turn several[ times. With the steering gear in neutral (no steering action), loosen the manual bleed screw about one turn, allowing air and aerated fluid to "bleed out" around the bleed screw until only clear (non aerated) fluid is bleeding out them close the bleed screw. Torque the manual bleed screw 3.1- 3.7 Nm. 5/16 inch Socket required. Check and refill reservoir.

   Repeat this procedure 3 or 4 times starting with the steering manoeuvre with bleed screw closed, until only clear (non aerated) fluid is discharged when bleed screw is loosened, torque the manual bleed screw 3.1-3.7 Nm. check and refill reservoir.

   ***CAUTION** : Do not turn steering wheel with bleed screw loosened as this could induce air into the system.*

**INSTALLATION OF DIAGNOSTIC GAUGE**

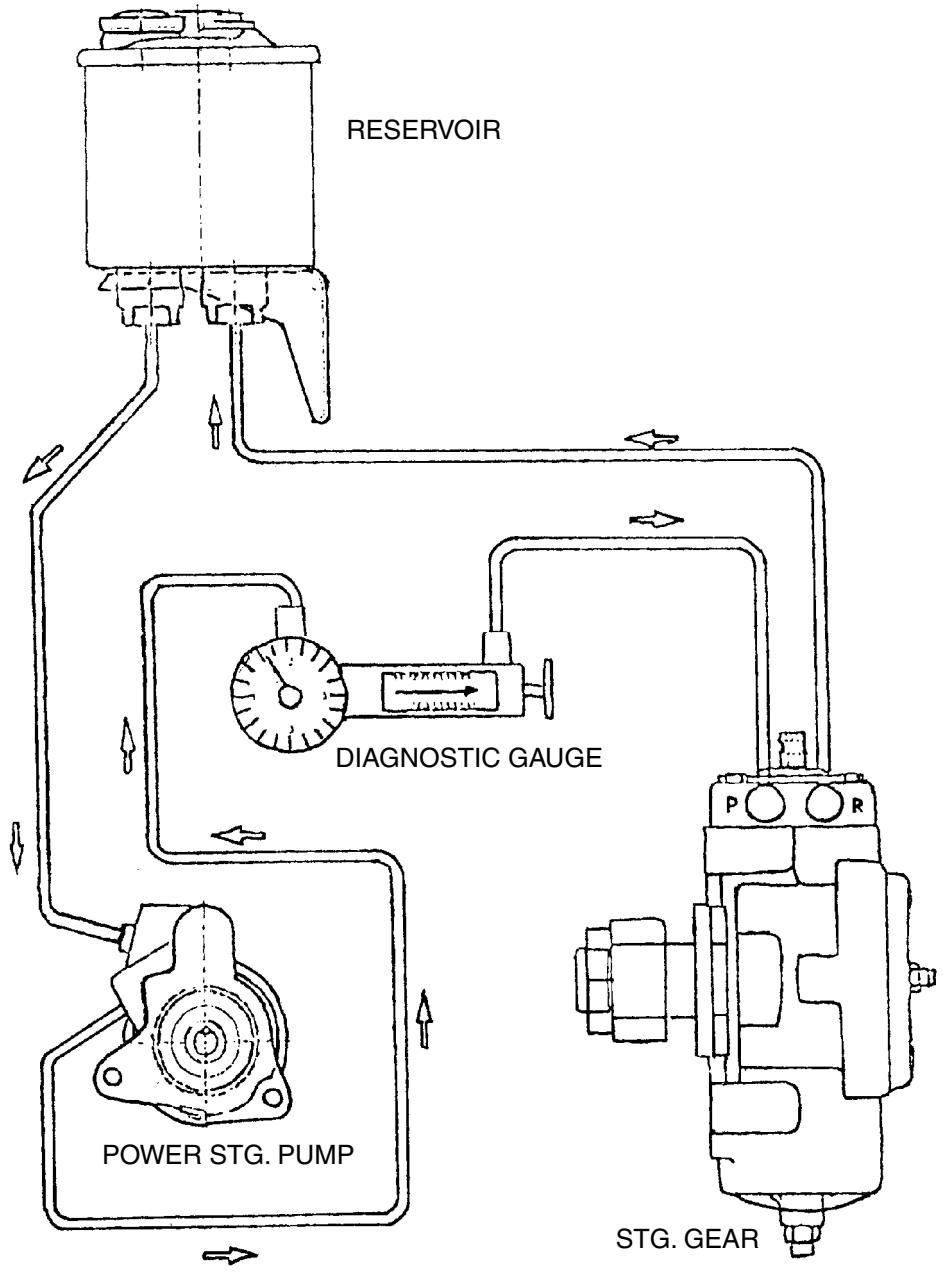



*Figure 115*

## TROUBLESHOOTING INFORMATION

### Preliminary Checks

When a customer comes to you with a problem related to his truck's steering, you can save a lot of time and work if you first verify the problem. Make sure you're both talking the same language about the same problem. If he says the truck's hard to steer, find out exactly what he means. Is it hard steering into a right or left turn? Only when turning the steering wheel while the truck is sitting still? Is there only intermittent power steering? Or is there no power assist at all?

If at all possible, and if it's safe to do so, test drive the truck. If you're not familiar with the rig, let the customer drive it while you sit beside him. Take hold of the wheel while he drives to get a feel for the problem he's talking about. Since most of his driving will be with his truck hauling a load, arrange for a load if one is required to reproduce the steering problem.

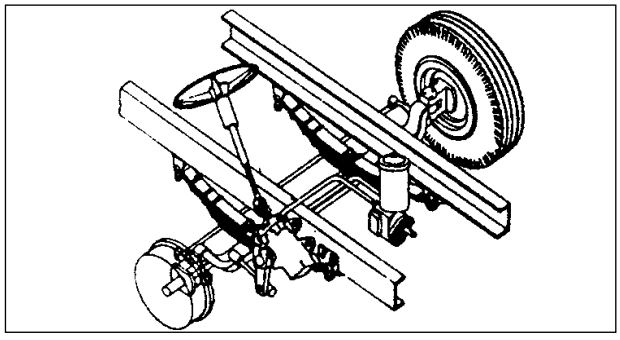


*Fig. 116*

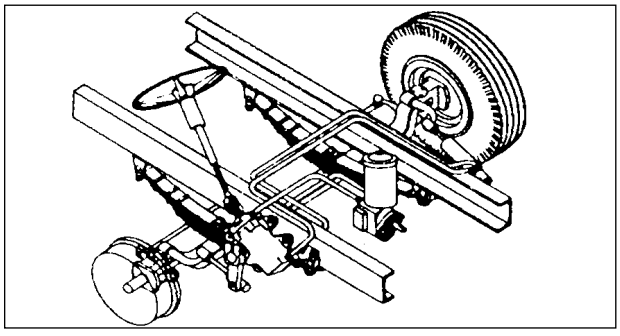


*Fig. 116A*

Once you've determined the problem and its symptoms, don't jump right in to tear the steering gear to pump apart. In most cases, in fact, the gear should be the last component you check. There are many other components in the steering system that could be causing the problem (See Fig. 116 & 116 A). These you should check first.

Begin, then, by checking the steered wheels: make sure that the tires are at correct pressure and equal all around, that they are properly sized, and that, they are not worn or damaged.

Next, have the front-end alignment checked and look for abnormal looseness or tightness in the steering linkage, ball joints, and king pins.
A service replacement or fluid line may be misrouted or may be too small in diameter, or it may be restricted in some other way. Reroute any hose that is kinked or bent sharply. Replace any hoses that are not the same as original equipment.

Continue by checking the power steering fluid reservoir to make sure that oil is up to the correct level. Also, check the pump drive belt, if one is used, to see if it is slipping. The belt may be tight, but it may also be glazed, and a slipping belt doesn't always squeal. If you adjust the belt, check the specifications.

These are just some of the checks you should make before you turn to the steering gear to pump. The Troubleshooting Guide on pages 47 through 49 explains what to diagnose for a particular steering problem. Match the trouble symptom against the chart and follow the recommended troubleshooting sequence. Doing so will most likely save you time and may prevent unnecessary repairs and costs.

### Hydraulic Tests

If the checks described above all prove satisfactory, it is possible that the cause of the steering problem can be traced to a lack of pressure or insufficient flow. In this case, you may have to do more detailed troubleshooting that involves conducting hydraulic tests.

### Preparation for Hydraulic Tests

To conduct the following hydraulic tests, first install a flow meter, pressure gage and load (shut off) valve in the fluid supply line to the steering gear, as indicated by the instructions that come with the flow meter. Steering system analyzers are available with the 3 units integral. Place a thermometer in the reservoir (Fig.117). You must use a flow meter, and it is recommended that you use a thermometer, if you are to troubleshoot the hydraulic system accurately.

Start the engine and warm the hydraulic system up by partially closing the load valve until the pressure gage reads 69.0 Bar. When the fluid temperature, as indicated on the thermometer, reaches between 51.7°C and 57.2°C, open the load valve. The system is warmed up, and you can conduct the tests.

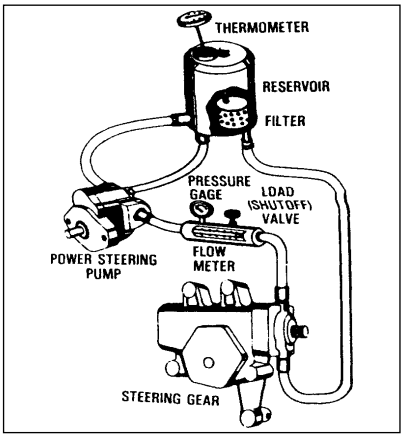



*Fig. 117*

*CAUTION: Do not close the load valve completely and leave it closed, or you may damage the pump. At no lime allow fluid temperature to exceed 82.2°C. Run all the tests at the prescribed temperature range 01-51. 7°C, 57.2"C.*

**Power Steering Pump Pressure Test**

With the engine idling, close the load valve and read the pressure gage. If the pressure reads below the maximum specified by the pump manufacturer, repair or replace the pump.

***CAUTION**: Do not keep the load valve closed for longer than 5 seconds to avoid damaging the pump. Closing the load valve causes the pump to operate at relief pressure and the fluid temperature to increase rapidly. Allow fluid to cool between 51. 7°C and 57.2°C before you resume with the other tests.*

**Power Steering Pump Flow Test**

WARNING: MAXIMUM FLOW RATE FOR THE HFB64 STEERING GEAR IS 22.7 LITRE/MIN. FLOW RATE SHOULD NOT EXCEED 22.7 LITRE MIN. EXCESSIVE FLOW CAN CAUSE DAMAGE TO INTERNAL PARTS OF THE STEERING GEAR, WHICH COULD RESULT IN A LOSS OF POWER STEERING.

*NOTE: If flow specifications and methods of checking flow rate are provided by the vehicle manufacturer, you should follow those instructions rather than the procedure described below.*

With the engine idling and the fluid temperature between 51.7°C and 57.2°C, check the pump manufacturer's specifications for flow rate. Compare these specifications with the flow rate on the flow meter.

Now, fully close the load valve until the pressure gage registers the pressure at which the pump is relieving. When pump relief is reached, flow rate must be zero. IMMEDIATELY OPEN THE LOAD VALVE. The flow rate must instantly return to the original reading. If this rate does not return immediately, the pump is malfunctioning, which can result in intermittent power assist.

Now, set the engine at governed rpm, and fully close the load valve again until pump relief is reached. At pump relief, the flow rate must be zero. IMMEDIATELY OPEN THE LOAD VALVE. The flow rate must instantly return to the original reading. If this rate does not return immediately, the pump is malfunctioning, which can result in intermittent power assist.

*NOTE: Conduct the pump flow test once at idle rpm and three times at governed rpm.*

*CAUTION: Do not allow the fluid temperature to exceed 82.2°C. Run each phase 01 this test between 51.7°C and 57.2°C.*

**Steering Gear Internal Leakage Test**

To test the steering gear for internal leakage, you must first prevent operation of the gear's internal unloading (poppet) valves or relief valve (or both, in some gears). This will allow full pump relief pressure to develop. To prevent operation of the poppets, place an unhardened steel spacer block, about 1 inch thick and long enough to keep your finger clear, between the axle and stop at one wheel (see Fig.3). To prevent operation of the relief valve, remove the relief valve. Install the relief valve plug, special tool J29059, in its place.

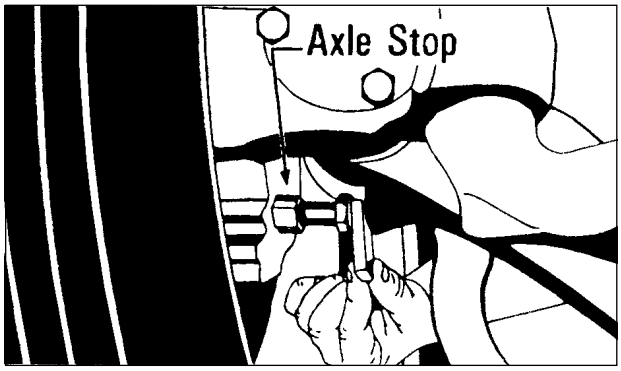



*Figure. 118*

*NOTE: Be sure you reinstall the relief valve, with new seals and O-rings, back onto the gear.*

*With the fluid temperature between 51.7°C and 57.2°C, turn the steering wheel until the axle stops bottom on the spacer block (Fig.3).*

*CAUTION: When running this test, do not hold the*

*steering wheel in the full turn position for longer than 5 to 10 seconds at a time to avoid damaging the pump. WARNING: KEEP YOUR FINGERS CLEAR OF THE AXLE STOPS AND SPACER BLOCK DURING THE TEST. MAKE SURE THAT THE SPACER BLOCK CONTACTS THE AXLE STOP SQUARELY. CONTACT THAT IS NOT SQUARE COULD BREAK THE AXLE STOPS OR DANGEROUSLY THROW OR EJECT THE SPACER BLOCK.*

Apply 9.1 Kg to the rim of the steering wheel during this test to be sure that the steering gear control valve is fully closed. The pressure gage should now read pump relief pressure, as noted during the pump pressure test. You can now read steering gear internal leakage on the flow meter.

**Repeat this test for the opposite direction of turn.**

If internal leakage is greater than 3.8 *Liters* / Min. and there is no auxiliary hydraulic cylinder in the system, repair the gear. If the internal leakage is greater than 5.7 Liters / Min. and there is an auxiliary hydraulic cylinder in the system, controlled by the HFB64 gear, isolate the auxiliary cylinder from the system by disconnecting the auxiliary cylinder hydraulic lines at the HFB64 unit's auxiliary ports. Plug those ports with suitable pressure plugs or caps. Connect the disconnected lines together if a rotary auxiliary cylinder is in the system. Plug the disconnected lines if a linear auxiliary cylinder is in the system and disconnect the linear cylinder from the steering linkage, making sure it will clear the steered axle. Repeat the internal leakage test. If the Internal leakage is less than 3.8 Liters/Min. repair the auxiliary cylinder. II the internal leakage is greater than 3.8 Liters/Min. repair the HFB64 gear.

***NOTE:*** *When hydraulic tests are completed and fluid lines are reconnected. Check fluid level and air bleed the system.*

***NOTE:*** *If all seals as include~ in the complete seal kit have been correctly replaced, and the HFB64 steering gear cannot pass the internal leakage test, or if intermittent loss of power steering occurs. A service worm shalt/input shaft, valve sleeve assembly is required.*

**Troubleshooting Guide**

**I. Normal Noises**

- You or the driver may hear a hissing noise from the control valve when it is actuated during a steering maneuver.
- You or the driver may hear a noise as fluid bypasses through the poppets at full turn.
- You or the driver may hear a noise from the system relief valve when it is required to actuate.
- You or the driver may hear pump growl from some types of power steering pumps.

**II. Abnormal Noises**

- If the power steering pump is belt driven, a squealing noise may indicate that the belts should be tightened or replaced.
- A clicking noise heard during a turn, or when changing detections, may indicate that some component is loose and shifting under load.
- A change in the normal noise of the pump may indicate that air has been induced into the system or that fluid 'level is low.

**III. Possible Steering Problems and Causes**

**Road Wander**

- Tyre pressure incorrect or unequal left to right
- Components in steering linkage loose or worn (Steering wheel to road wheel)
- Wheel bearings improperly adjusted or worn.
- Front end alignment out of specification.
- Dry fifth wheel or poor finish on fifth wheel or trailer plate.

- Steering gear mounting bolts loose on frame.
- Steering gear improperly adjusted.
- Looseness in rear axle assemblies o, trailer bogies.

**No Recovery**

- Tyre pressure low
- Front end components binding
- Front end alignment incorrect Tight front axle king pins
- Dry fifth wheel or poor finish on fifth wheel or trailer plate Steering column binding
- Pump flow insufficient
- Steering gear improperly adjusted
- Steering gear control valve sleeve sticking

**Shimmy**

- Badly worn or unevenly worn Tyre Improperly mounted Tyre or wheel
- Wheel bearings improperly adjusted or worn Components in steering linkage loose or worn
- Wheels or brake drums out of balance Front end alignment incorrect
- Air in the hydraulic system

**External Oil Leakage**

- Finding the location of leak may be difficult, since oil may run away from leak source, the fittings, hoses, pump, or gear to a low point on the gear or chassis.
- A leak from the vent plug at the side cover indicates failure of the sector shaft oil seal inside the side cover.

**Over-steering or Darting**

- Dry fifth wheel or poor finish on fifth wheel or trailer plate Front end components binding or loose.
- Steering column binding Steering gear improperly adjusted.
- Steering gear control valve sleeve sticking.
- Rear axle mounts (rear steer).

**High Steering Effort In One Direction**

- Unequal tire pressure Vehicle overloaded.
- Inadequate hydraulic system pressure.
- Excessive internal leakage in one direction of turn only (verify with internal leakage test).

**High Steering Effort In Both Directions.**

- Low tire pressure Vehicle overloaded
- Low hydraulic fluid level
- Low pressure or flow from pump
- Components of steering system binding

**High Steering Effort in Both Direction**

- Low tire pressure
- Vehicle overloaded
- Low hydraulic fluid level
- Low pressure or flow from pump
- Components of Steering system binding.
- Restrictions return line, or line too small in diameter
- Excessive internal leakage (Verify with internal leakage test)
- Oversize tires (Check manufacturer's specifications)

**Last Motion (Last) at the Steering Wheel**

- Steering wheel loose on the shaft
- Loose connection between the steering gear, intermediate column, and steering column
- Steering gear loose on frame Pitman arm loose on output shaft
- Components in steering linkage loose or worn Steering gear improperly adjusted
- Excessive Heat 56.6°C Over Ambient] Not to Exceed 121°C Continuously
- Excessive pump flow Vehicle overloaded
- Undersized replacement hose or line
- Restricted hose or line that is kinked or severely bent or internally blocked
- Restricted recentering of gear valve caused by column bind or side load on the input shaft Poppet not adjusted properly (only for gears equipped with poppets)
- Prolonged stationary vehicle operation

*WARNING: IF THE HYDRAULIC SYSTEM FLUID BECOMES OVERHEATED, IT CAN CAUSE THE SEALS IN THE STEERING GEAR AND PUMP TO SHRINK, HARDEN, OR CRACK AND LOSE THEIR SEALING ABILITY.*

**RANE POWER STEERING PUMP**

**Design & Operation**

The pump is designed to incorporate the features required to supply a power steering system, whilst minimising weight and size. Ten sliding vanes provide the pumping elements and the motion of these valves are constrained by a rotating carrier (Rotor) and stationary cam ring {See the cross section view). Each vane is performing two pumping cycles per revolution, thereby maintaining the hydraulic pressure forces on the drive shaft in balance. Oil is admitted to and discharged from the pumping cartridges by specially shaped ports at either end of it.

A flow control cum pressure relief valve is also incorporated in the pump. The flow & relief pressure are factory set and should not be altered in the field.

**Recommended Oils**

a) Castrol TQ Automate Transmission fluid type A -castrol

b) Bharat Automatic Transmission Fluid Type A - Bharat Petroleum

**Maximum Temperature**

Recommended working temperature of oil is 65-85 deg.C. Occasional peak not to exceed 120$^0$C.

***CAUTION:*** *Holding the steering for more than 5 secs, against wheel lock under full load and or raising the engine speed to maximum under load would lead to overheated pump and could cause early failure of pump and seals.*

**Specifications**

| | | |
|---|---|---|
| Type | : | Side vane pump |
| Relief Pressure | : | 100bar |
| Controlled flow | : | 12 LPM (min) at 1000 RPM or above |
| Working speed | : | Minimum: 500 RPM<br>Maximum: 3500 RPM |
| Drive | : | From Air Compressor crankshaft. |
| Filtration | : | 25 micron |

1. Service Tools

   No special tools are required.

2. Special Notes

   Thoroughly clean the pump exterior. Plug all ports to prevent dust entry. During disassembly, pay particular attention to identification of parts, especially the cartridge for correct assembly.

3. Disassembly

   Camp the housing in a vice firmly but not too tight and not on ports).

   With cover end up press the cover against the spring.

   Remove cover 'O'. -ring and spring Discard, '*0'* ring.

   Note the position of the rear pressure plate with respect to the dowel pins.

   ***CAUTION:*** *If one or more of the vane is lost, you must replace all vanes.*

**Remove and discard "O" ring**

To remove the pressure & flow control valve clamp the housing in a vice, with shaft end down, and maintaining a downward pressure on the valve plug drive out the split pin.

Slowly release the downward pressure on the plug, the spring will force out the plug and valve.

Discard “O” ring on the plug.

Now, in the housing subassembly, and shaft bushes and oil seal remains is completes dismantling serviceable parts. Inspection:

Wash the metal parts in mineral oil solvent. Blow dry with air.

Check the wearing surfaces, ie. pressure plates, cam ring & rotor/carrier for scoring or excessive wear. Remove light scoring marks by lapping, if possible. Check vanes for burrs wear & excessive play in, the rotor carrier slots. If anyone of the parts is not acceptable, the whole cartridge is to be replaced.

Check, in the housing sub-assembly for excessive radial play of shaft (indicates wear), damages to shaft on pulley mounting area or spline area (carrier driving spline) and damages to valve bore area. If any of the above defects are noticed, replace the housing sub assembly as a whole.

**Assembly:**

*NOTE: Coat all parts with hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amount of petroleum Jelly to hold “O” rings in place during assembly.*

Clamp the housing with shaft end down and assemble the two dowel pins.

Assemble front pressure plate, cam ring rotor/carrier and vanes.

**Install new “O”-ring on rear pressure plate.**

To assemble the rear pressure plate, after ensuring original orientation of the parts with respect to the dowel pins, press the pressure plate into the housing using a hand press.

*NOTE: Apply enough force to ensure proper/firm seating of all the parts. Other wise pump will not function properly.*

Locate cover spring on the pressure plate, assemble new a-ring in the housing (for cover), insert cover carefully & press down uniformly (without tilting) till the retainer groove is exposed. Holding at this position, install the retainer ring. Ensure proper seating.

To assemble valve, begin by inserting the spring, valve and plug (after installing a new “On-ring) ensuring correct orientation of components.

Holding the plug down to expose the split pin hole, insert the split pin flush with the body and release the plug to move back and stop against the split pin.

Rotate shaft by hand, and check for easy and uniform rotation.

**6. Repairs without fully dismantling the pump.**

a) If shaft oil seal leaks and needs replacement, drive it out without damaging the bore & shaft. Clean the bore & shaft and press a new seal (with the lip facing side) firmly against the bore bottom. This can be done without dismantling the pump, using only a screw driver, plier.

If back cover “a.-ring leaks, remove only the cover (follow corresponding dismantling instruction) replace “a” -ring & put back the cover.

c) If valve plug “On-ring leaks, remove only the plug (follow corresponding dismantling instruction) change .O”-ring & refit plug.

UNLESS OTHER WISE SPECIFIED PARTS ARE COMMON FOR ALL AVP 30 SERIES PUMPS

| ILLUS NO. | | QTY. PER ASSY | REMARKS |
|---|---|---|---|
| 10 | Housing | 1 | |
| 20 | Flow Control Spring | 1 | |
| 21 | Flow Control Valve Assy. | 1 | |
| 22 | Seal Washer | 1 | |
| 23 | Plug Sub ASSY. | 1 | |
| - | Shaft Sub Assy. | | |
| | * comprise of | | |
| 4 | Shaft | 1 | |
| 5 | Ball Bearing | 1 | |
| | Retaining Ring (ext) | 1 | |
| 11 | Side Plate | 1 | |
| 14 | Cam | 1 | |
| 13 | Rotor | 1 | |
| 12 | Vanes | 10 | |
| 15 | Pressure Plate | 1 | |
| 8 | Double Lip Seal | 1 | |
| 2 | 0 ring | 1 | |
| 18 | 0 ring | 1 | |
| 17 | Dowel Pin | 2 | |
| 1 | Drive Coupling Disc | 1 | |
| 19 | End Cover | 1 | |
| 16 | M6 Screw | 2 | |
| 3 | Retaining Ring (Ini) | 1 | |
| 7 | Spacer | 1 | |
| 23 | Seal washer | 1 | |
| 22 | Spring Flow Control | 1 | |
| 20 | Spring Flow Control | 1 | |
| 24 | Pressure Banjo Bolt | 1 | |
| 25 | Copper Washer | 2 | |
| 26 | Pressure Banjo Body | 1 | Upward banjo type |
| 27 | Pressure Banjo Body | 1 | Downward banjo type |

**EXPLODED VIEW OF PUMP**

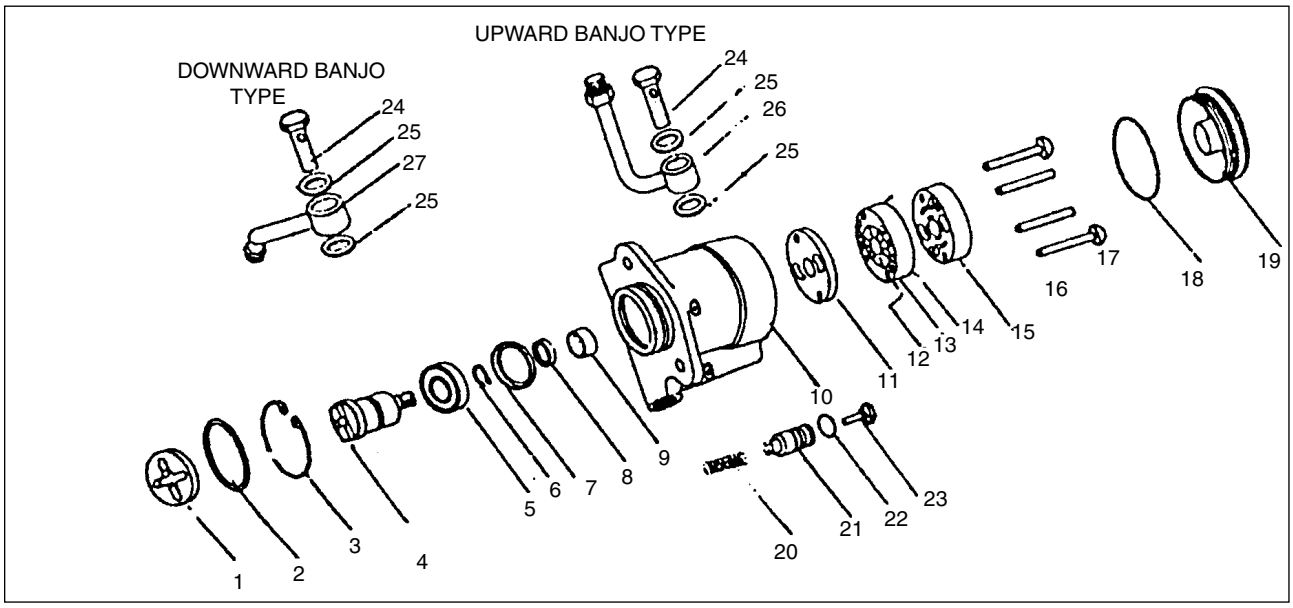



*Figure. 120*

**RANE POWER STEERING RESERVOIR**
**&**
**FILTER ASSEMBLY**

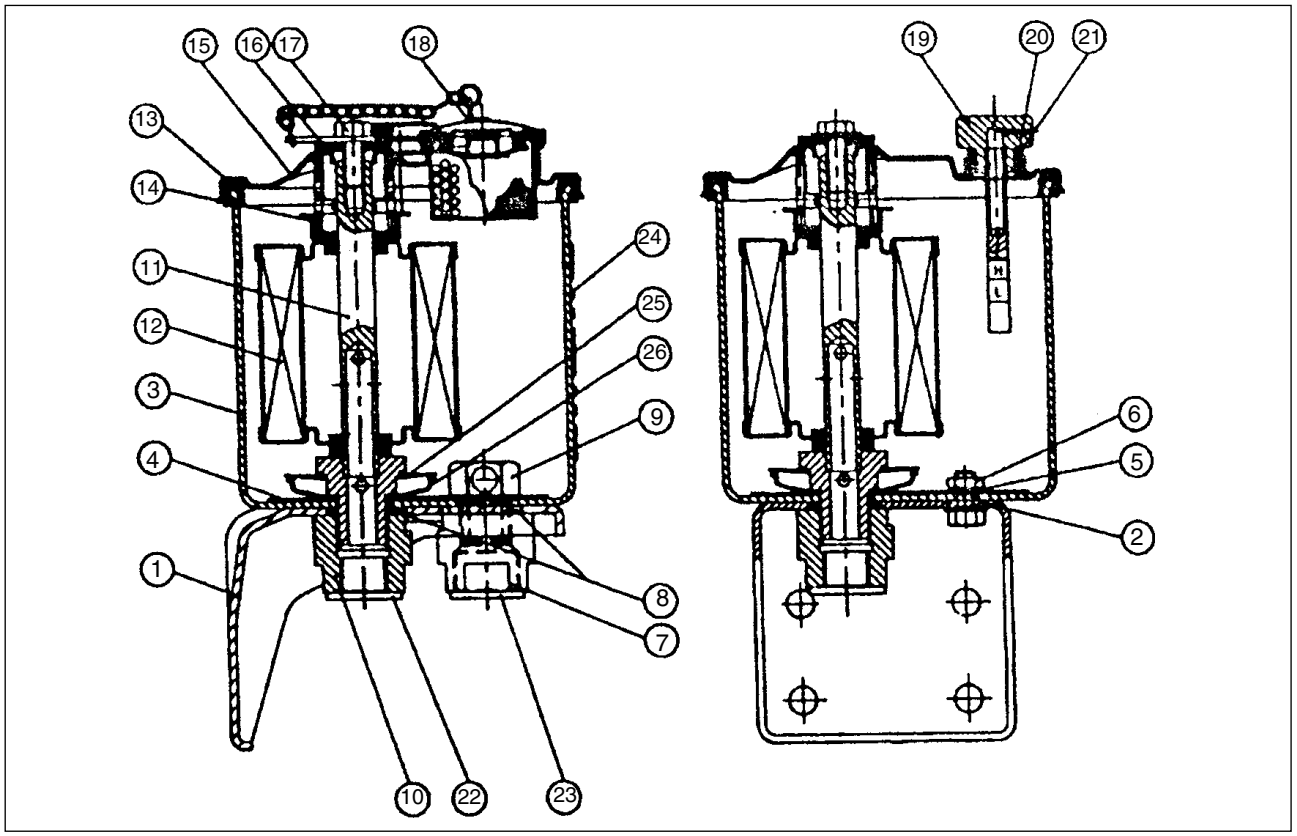



*Figure. 121*

**SERVICEABLE PARTS OF RESERVOIR ASSY.**
**(WITH FILTER ASSY).**

| ILLUS NO | DESCRIPTION | QTY. PER |
|---|---|---|
| 1 | BRACKET (SUB. ASSY.) | 1 |
| 2 | 'O' RING | 2 |
| 3 | TANK BODY | 1 |
| 4 | TANK BODY. SHORTER | 1 |
| 5 | STIFFENER | 1 |
| 6 | WASHER | 2 |
| 7 | NUT | 2 |
| 8 | SUCTION PORT BOSS (M26 x1.5) | 1 |
| 9 | 'O' RING | 2 |
| 10 | SUCTION FITTING | 1 |
| 11 | RETURN PORT BOSS (M26 x1.5) | 1 |
| 12 | CENTER STUD ASSY. | 1 |
| 13 | COVER SEAL | 1 |
| 14 | SPRING | 1 |
| 15 | COVER ASSY. | 1 |
| 16 | STEEL. RUBBER WASHER | 1 |
| 17 | BOLT (COVER FIXING) | 1 |
| 18 | OIL FILLER CAP ASSY. (WITH CHAIN) | 1 |
| 19 | 'O' RING | 1 |
| 20 | '0' RING CUP | 1 |
| 21 | PLUG | 1 |
| 22 | PLUG | 1 |
| 23 | STICKER | 1 |
| 24 | DISC SPRING | 1 |
| 25 | VALVE SEAT | 1 |
| | SERVICE KIT | 1 |

**SPECIAL TOOLS**

| Sl. No. | Description | Part No. |
|---|---|---|
| 1 | Input shaft oil seal mandrel. | 2658 5890 46 01 |
| 2. | Input shaft oil seal pressing tool. | 2658 5890 46 02 |
| 3. | S/shaft oil seal assy. sleeve. | 2658 5890 46 03 |
| 4. | Sector shaft oil seal mandrel. | 2658 5890 46 04 |
| 5. | Sector shaft oil seal pressing tool. | 2658 5890 46 05 |
| 6. | Valve seal mandrel. | 2658 5890 46 06 |
| 7. | Pre-load setting tool. | 2658 5890 46 07 |
| 8. | End cover wrench adaptor (valve/worm). | 2659 5890 46 08 |
| 9. | End cover wrench adaptor (cylinder). | 2658 5890 46 09 |
| 10 | Valve ring compressor. | 2658 5890 46 10 |
| 11. | Cylinder ring compressor. | 2658 5890 46 11 |

# Radiator 50

**Contents**


| Serial No. | Description | Page No. |
|---|---|---|
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| 3. | General | 3 |
| 4. | Removal, inspection and testing of radiator | 4 |
| 5. | Installation of radiator | 8 |
| 6. | Expansion volume radiator | 9 |
| 7. | Aluminium radiator | 12 |

**Specification / Repair data**

| | | |
|---|---|---|
| Type | : | Copper fins over brass tubes Straight fins |
| Number of tube rows | : | 4 |
| Number of tubes | : | 249 |
| Core Depth | : | 74 mm |
| Width | : | 550mm |
| Height | : | 520mm |
| Capacity | : | 9 Lit. |
| Working pressure | : | 0.5bar |
| Leakage testing pressure | : | 1.0 bar |

**Radiator cap :**

| | | |
|---|---|---|
| Main valve opening pressure | : | 0.5 $\pm$ 0.08 bar |
| Vacum valve opening pressure (suction) | : | 0.1 bar max. |

### Construction and Mounting

The radiator core is of corrugated tubes surrounded by fins and is connected to the upper tank and bottom tank.

Fins are provided over tubes to increase the surface area for better heat desipation.

The radiator is mounted on the chassis frame in such a way that it is not subjected to any kind of stress. This is achieved by rubber buffer mountings at the bottom and rubber fastenings with stay rod.

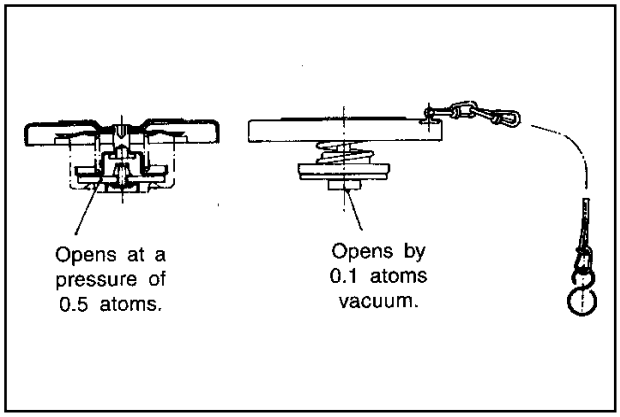



*Fig. 1 Radiator cap*

### General

The engine cooling system is pressurised to operate at 0.5 kg/sq. cm. The advantage of a pressurised cooling system is that the boiling temperature of the cooling water is increased. This helps engine operation at high altitudes without overheating.

The radiator cap is of special design.

The pressure in the cooling system is created by valves incorporated in the radiator cap. For details see fig. 4. It is important to ensure that the rubber gasket of the radiator cap is intact and that the cap is fitted firmly on the radiator filler neck.

The thermostat fitted in the engine is a vital component. Its function is to bring the temperature of the cooling water to the correct operating temperature in the shortest possible time.

### 3. Removal of radiator from vehicle

Before proceeding for radiator removal ensure that cooling system is at room temperature.

1. Unlock and swing open center face panel (radiator grills).
2. Remove mounting screws for oil filler and dipstick brackets from radiator support frame. Keep both the brackets suitably aside.
3. Turn open the radiator cap.
4. Drain cooling water through drain cock provided at the bottom of radiator.
5. Fit back radiator cap and close drain cock.
6. Loosen hose clips and disconnect inlet and outlet hoses from radiator.
7. Unscrew nyloc nuts of radiator upper (center) mounting. Remove plain washers, rubber buffers and short spacer tubes at radiator end. Fig. 2
8. Unscrew nuts of radiator lower mountings (2 numbers). Remove screws, plain washers, rubber buffers and spacer tubes . Fig. 3
9. Remove radiator along with mounting frame taking care that fan blades and radiator fins are not damaged.

### Inspection, Repair and testing of radiator

1. Check radiator and cap for any damage, clogging etc. Repair/replace if necessary. Fig.4.
2. Check frame for cracks, damage etc. Repair/replace, if necessary.

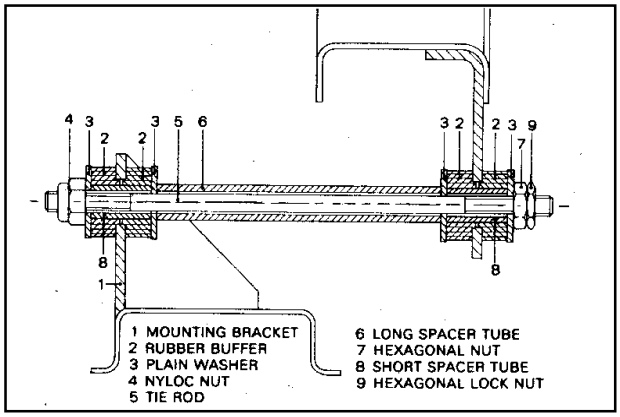



*Fig. 2 Radiator Upper mounting*

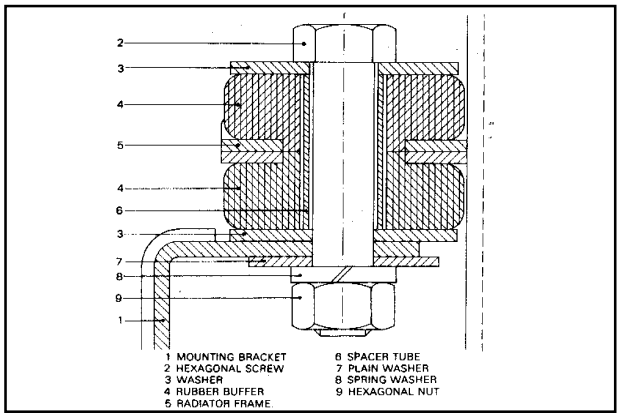



*Fig. 3 Radiator Lower mounting*

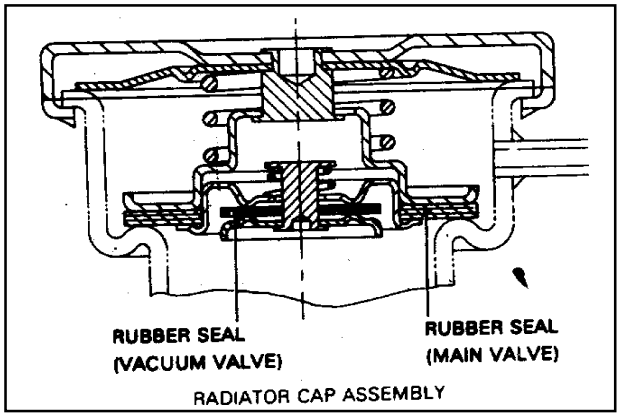



*Fig. 4 Radiator cap assembly*

**Cleaning of cooling system**

This should be done at every 72,000km. OR every 2 years whichever is earlier.

Caution : Do not add cold coolant too quickly to a hot engine.

Wait until the temperature falls below 50 $^0$C before draining.

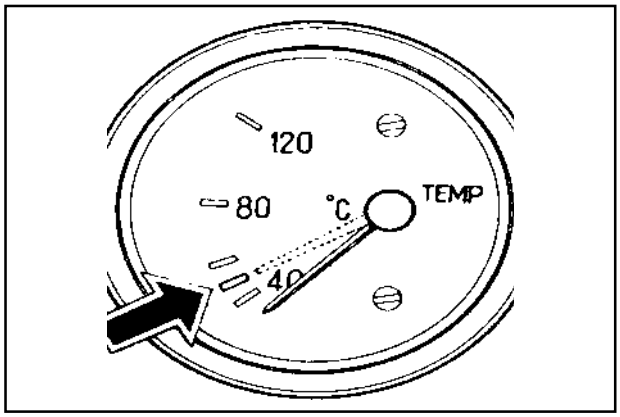



*Fig. 5 Coolant draining*

Drain the cooling system by opening the drain valve on the radiator and removing the plug at the inlet to water pump. Use a drain pan with a capacity of 30 litres.

**Prolonged and repeated contact with used antifreeze can cause skin disorders or other body injury.**

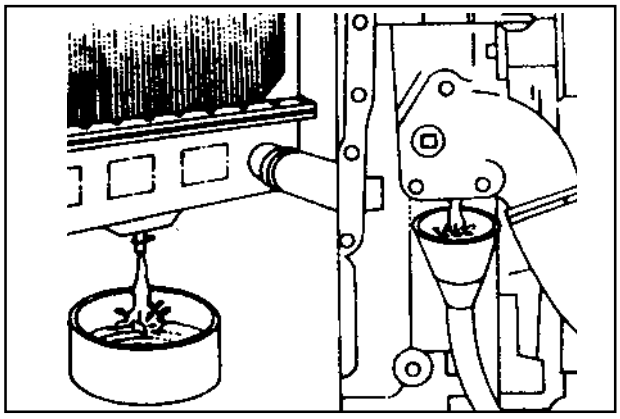


*Fig. 6 Draining procedure*

Mix 0.5 kg of sodium carbonate with water for preparing flushing mixture.

Fill the system slowly.

Wait 2 or 3 minutes to allow air to be vented and add mixture to bring the level to the top.

Do not install the radiator cap.

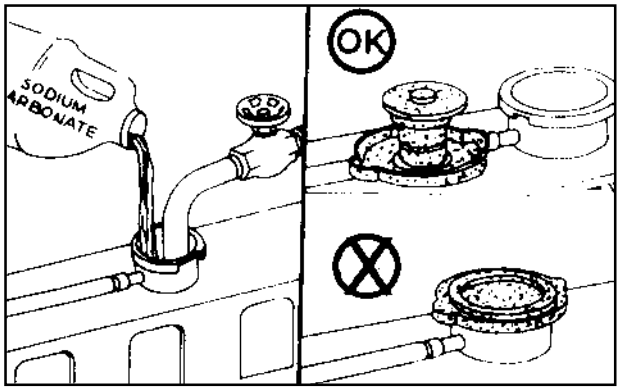



*Fig. 7 System flushing & filling*

Operate the engine for 5 mins. with the flushing mixture temperature above 80 $^0$C.

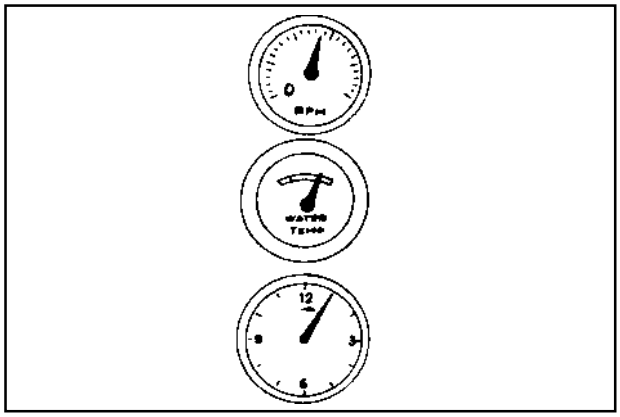



*Fig. 8 Operating procedure*

Shut the engine off and drain the cooling system.

Fill the cooling system with clean water. Be sure to vent the engine for complete filling.

*Do not install the radiator cap.*

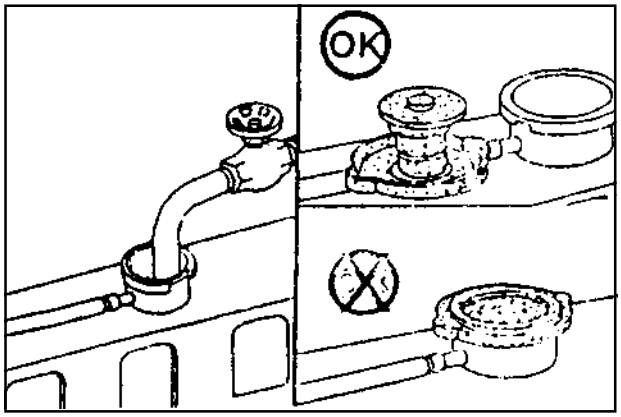



*Fig. 9 System filling*

Again operate the engine for 5 mins. with the water temperature above 80 $^0$C.

Shut the engine and drain the cooling system.

If the water drained is still dirty, the system must be flushed again until the water is clean.

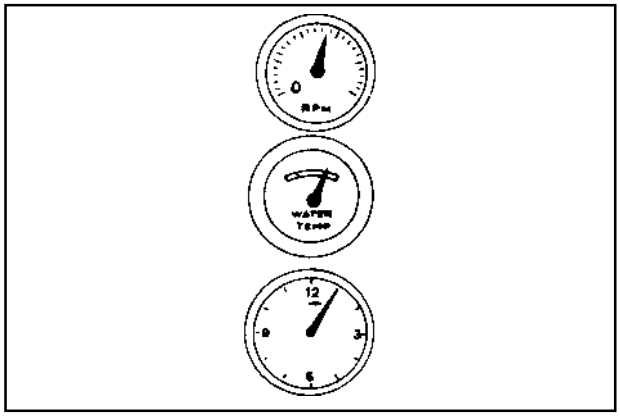



*Fig. 10 Operating procedure*

Use a mixture of 50% water and 50% Ethylene Glycol antifreeze to fill the cooling system.

Total system capacity : 24 litres

Engine capacity : 9 litres

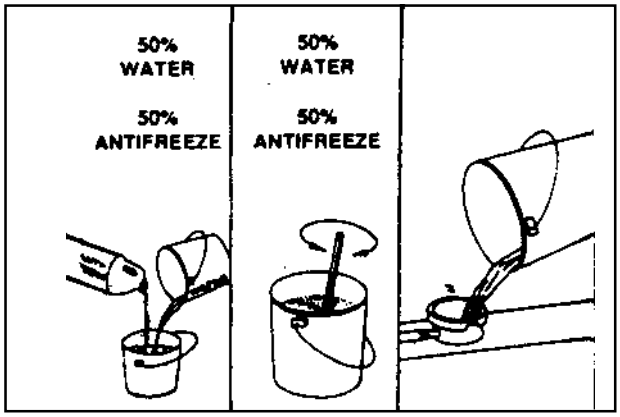



*Fig. 11 Coolant mixture filling*

Fill the system slowly to prevent air locks. During filling air must be vented from the engine and coolant.

Maxium fill rate : 19 litres / min

Do not exceed this fill rate.

Wait for 2 to 3 minutes to allow the air to be vented and then add mixture to bring the level to the top.

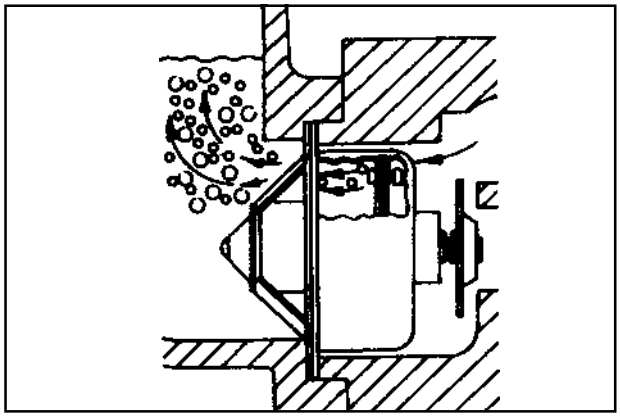


*Fig. 12 Filling & venting*

Install the pressure cap. Operate the engine until it reaches a temperature of $80^0$ C, and check for coolant leaks.

Wait until the coolant temperature is below $50^0$ C and check the coolant level again to make sure the system is full of coolant.

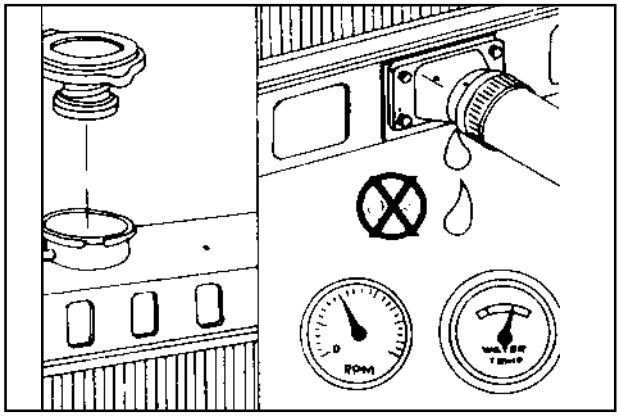


*Fig.13 System check*

**Testing radiator for leaks**

1. Remove radiator cap and suitably plug inlet, filling neck and outlet of radiator.
2. Remove drain cock adapter from bottom tank.
3. With suitable adapter connect pressurised air supply to the drain cock hole of radiator and submerge radiator in water tank.
4. Admit air at 1.0 bar into radiator. Check for leaks and if any, mark them suitably.
5. Take out radiator from water tank and disconnect air supply. Remove all the plugs.
6. Rectify leaks by soldering & recheck radiator for leakage.
7. Fit back drain cock adapter in its position.
8. Fit back radiator cap.

**Instructions for soldering radiator**

1. Use 40% tin content solder. This solder has higher tin content and hence lower melting temperature than the one used in manufacture of radiator. Use of this will not have any effect on original soldering.
2. Use non-corrosive fluxes for soldering. Neutralise and wash residues to avoid any consequent damage. Acid should not be used for this purpose.
3. Use only temperature flame of low pressure gas. Do not use high temperature flame of oxy-acetylene or commercial blow lamp.

**Checking radiator cap**

1. Check radiator cap for perfect sealing in filler neck.
2. Check radiator cap, main and vacuum valve opening pressure.
3. Replace defective cap with new one.

**Installation of radiator vehicle**

1. Mount radiator on support frame. Tighten fastening screws.
2. Install radiator with mounting frame in its position. Take care that fan blades and radiator fins are not damaged while installing.
3. Assemble radiator upper and lower mountings as shown in fig. 2 & 3 and tighten end fastenings. Ensure radiator core is sufficiently away (about 40mm) from tip of fan blades and blades do not foul with fan shroud.
4. Connect inlet and outlet rubber hoses to radiator and tighten their hose clips.
5. Check oil filler hose for damage/leakage and rectify, if necessary.
6. Install oil filler neck and dipstick brackets on radiator. Tighten their mounting screws.
7. Close drain cock.
8. Fill coolant in radiator till it flows through overflow pipe.

   **Note:** Add anti-freeze agent as necessary. Refer group 00.
9. Fit radiator cap and secure firmly.
10. Start engine and check hoses/hose connections for leakage. Tighten leaky hose connections.
11. Stop the engine. Replace defective hoses with new ones. Top up water level in radiator.

**Note :**

a. To ensure cooling system is completely filled, run engine for short duration and top up coolant level in radiator.

b. Do not top up radiator by suddenly pouring coolant while engine is hot. Run engine at low idling speed and top up radiator slowly.

c. Check temperature gauge for proper functioning. Replace defective gauge.

d. Prior to installation of radiator, it is recommended to check thermostat for proper functioning.

**Expansion volume radiator**

An improved expansion volume radiator is now being fitted on the vehicle. In earlier radiators there was loss of coolant through overflow pipe due to increase in temperature/ pressure of coolant and hence the need to top up coolant on daily basis. In the improved radiators an air column is provided which absorbs any expansion of coolant and thus preventing spillage of coolant through overflow pipe.

**Construction :**

1. A brass tube having 3mm dia. hole is brazed to filler neck and protrudes inside the top tank of the radiator.
2. Top tank volume is larger than conventional radiator.
3. Pressurised cap with vacuum valve is fitted on neck of radiator. Other construction is like conventional radiator.

**Working principle:**

1. Fill the radiator with coolant at a moderate flow rate and ensure that the radiator is full with coolant upto the bottom edge of brass tube. Now there is an air column above the coolant level.
2. When engine attains the normal operating temperature, the coolant also expands causing the air above it to escape through the 3mm dia hole and thus preventing loss of coolant.
3. When the coolant temperature is decreases due to vacuum action, fresh air is sucked thus maintaining air column above the coolant level.

**Important Points :**

1. Use always genuine radiator cap with pressure and vacuum valve. Absence of radiator cap defeat the very purpose of expansion volume radiator which gives advantages of preventing spillage of coolant through overflow pipe.
2. While filling radiator, filling rate should be moderate.

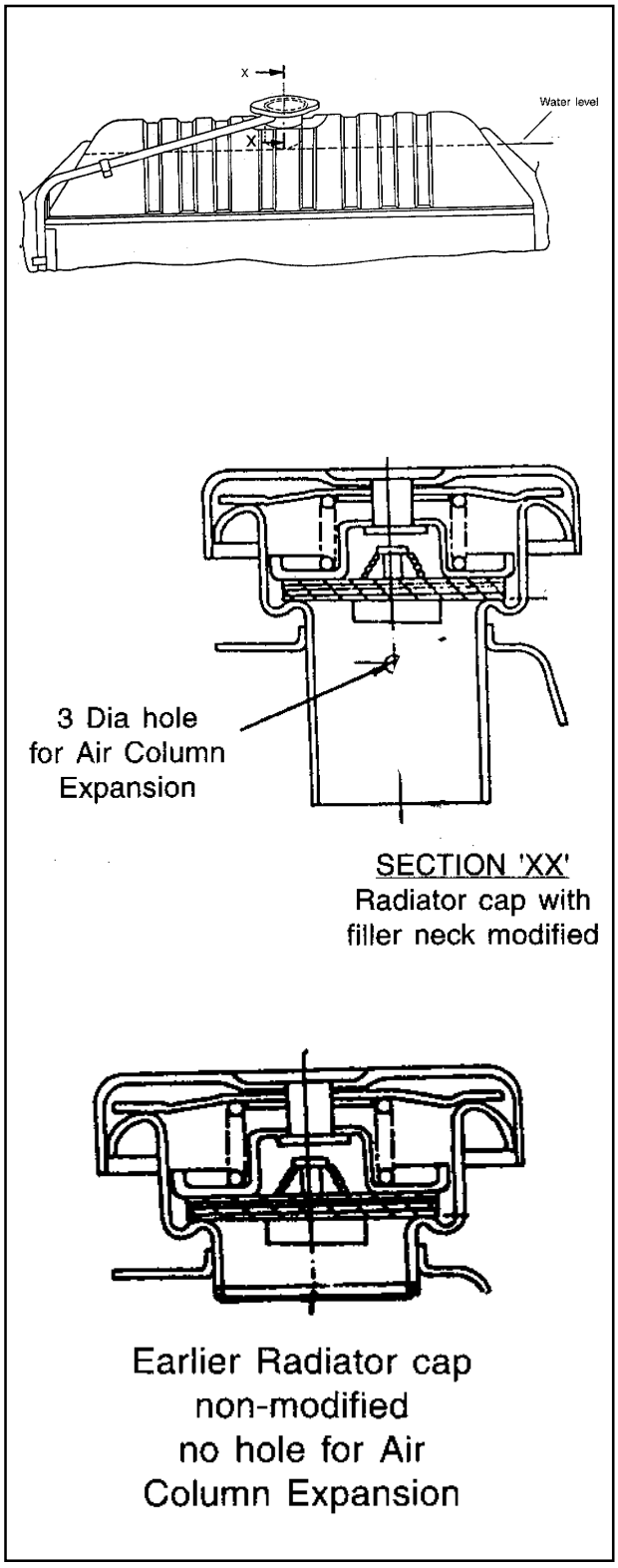



*Fig.14 Radiator with ex;pansion volume*

**Coolant Recommendations / Specifications**

Heavy duty diesel engines require a balanced coolant mixture of water and antifreeze. Drain and replace the mixture every 2 years, 320,000 km or 6,000 hours of operation (whichever occurs first) to eliminate buildup of harmful chemicals.

- **Antifreeze is essential in any climate**

  It broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point. Do not use more than 50 percent antifreeze in the mixture unless additional freeze protection is required.

  **Never** use more than 68 percent antifreeze under any condition.

- **Use soft water in the coolant mixture**

  Water must not exceed 300 ppm hardness, or contain more than 100 ppm of either chloride or sulphate.

  Specifications - Use low silicate antifreeze which meets ASTM 4985 test (GM6038M spec.) criteria.

  Concentration - Antifreeze must be used in any climate for both freeze and boiling point protection.

**A 50 percent concentration level (40 percent to 60 percent range) of ethylene glycol in most climates is recommended.**

Antifreeze at 68 percent concentration provides the maximum freeze protection and must never be exceeded under any condition. Antifreeze protection decreases above 68 percent.

Ethylene - Glycol

40% = -23$^0$C

50% = -37$^0$C

60% = -54$^0$C

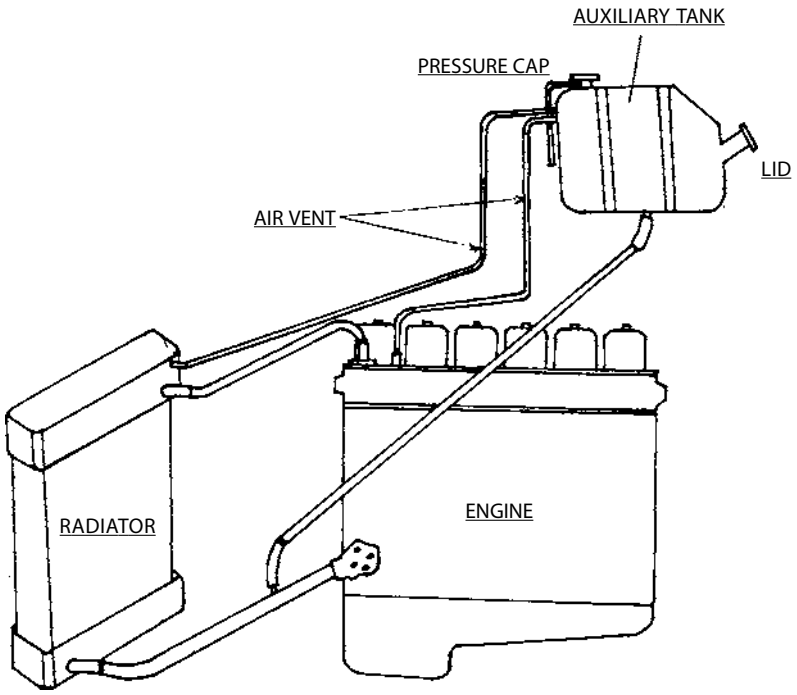
68% = -71$^0$C

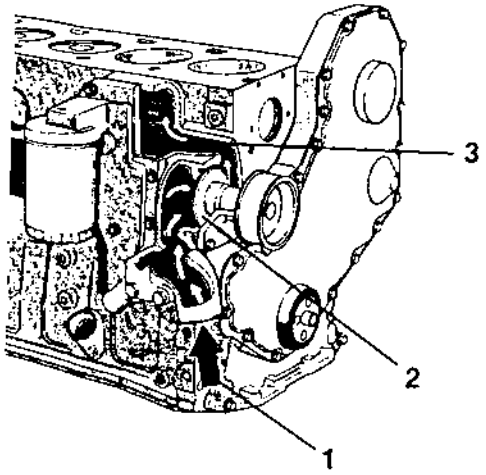
**Concentration Testing - Antifreeze concentration must be checked using a refractometer** (such as fleetguard Part No. CC2800). "Floating ball" type density testers or hydrometers are not accurate enough for use with heavy duty diesel cooling systems.

**RECOMMENDED ANTIFREEZE**

| | | |
|---|---|---|
| BRAND | | ETHYLENE GLYCOL |
| IOC | - | SERVO AUTO COOL |
| INDROL | - | LONG LIFE COOLANT |
| SUNSTAR LUBRICANTS | - | GOLDEN CRUISER 1200 |

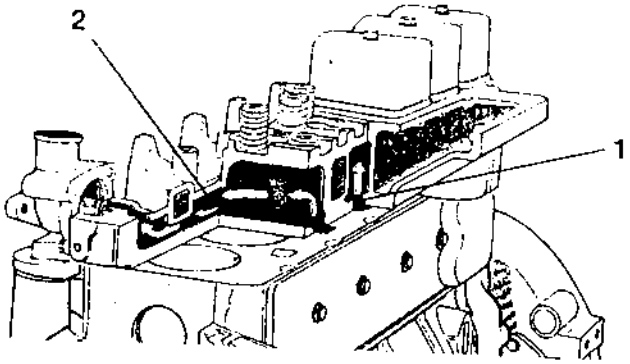
**engine cooling system**





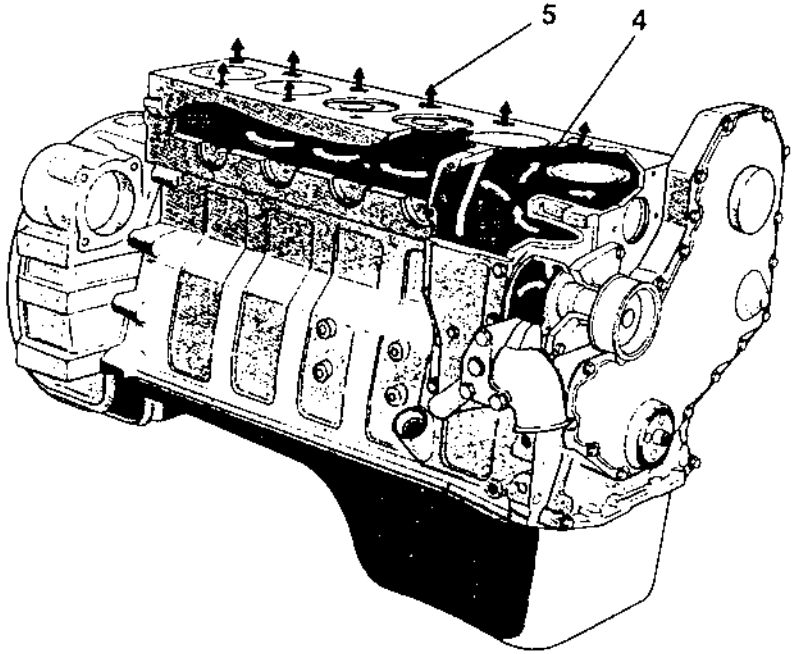

### *Cylinder Block*

1. Coolant Inlet
2. Pump Impeller
3. Coolant Flow Past Oil Cooler
4. Coolant Flow Past Cylinders
5. Coolant to Cylinder Head




### *Cylinder Head*

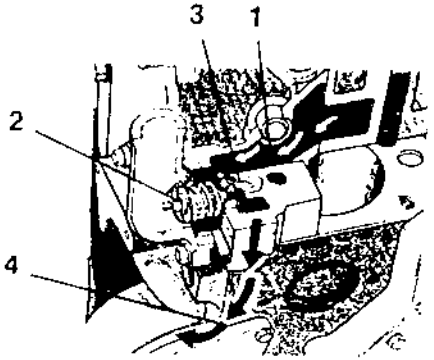
1. Coolant Flow from Cylinder Block
2. Coolant to Thermostat Housing




### *Thermostat*

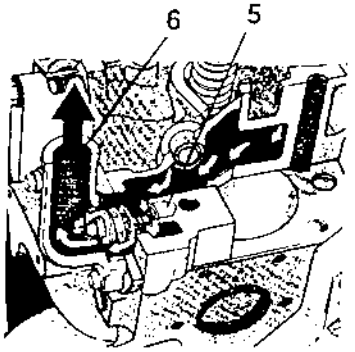
*Closed*

1. Coolant Flow Past Injector
2. Thermostat
3. Coolant By-Pass Passage
4. Coolant Flow to Pump Inlet




*Open*

5. By-Pass Closed
6. Coolant Flow Back to Radiator



## Aluminium Radiator

### 1.0 INTRODUCTION

This manual explains the procedure for servicing (specifically, the sealing of leakages) of aluminium radiators fitted with plastic tanks that are damaged in actual usage due to improper handling before installation on the vehicle. The procedure covers the following aspects of servicing :-

- Leakage spot detection
- Sealing Techniques and the tools required
- Confirmation of proper sealing

### 2.0 DETAILS OF RADIATOR :

A typical radiator is illustrated in fig.15 for the reference of users of this manual.

**Caution :** Users are requested to get themselves familiar with all the parts and the assembly of radiator before undertaking the servicing.

### 3.0 SERVICING KIT

The radiator servicing kit consists of following items :-

- Clinch and release tool (CRT)
- Attachment for clinching (attachment for releasing the clinches is already fitted on the CRT) Fig. 16
- Piler
- Sealant resin and hardener containers (Araldite Standard of M/s Ciba Geigy make)
- Aluminium container
- Container for mixing resin and hardener
- Araldite applicator
- Stirrer
- Brush

**Note :**

- Suitable size piler having its tips covered with PVC tape may be used in case the CRT is not available.
- Araldite rapid may be used in place of Araldite standard for faster drying and curing of seal.

**CAUTION :** Screw driver must be avoided at any cost.

### 4.0 PROCEDURE FOR SERVICING

### 4.1 Removal of radiator from vehicle -

- Allow the coolant in the radiator to reach to the room temperature.
- Drain the coolant from radiator completely.
- Remove all the mounting fasteners, attachments like shroud, pipes etc.

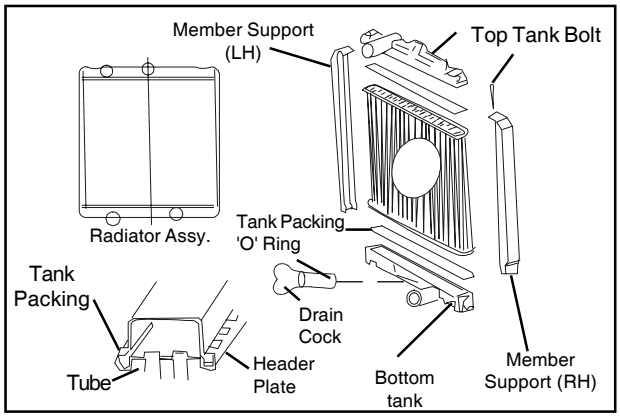



*Fig.15 Details of Raditor*

- Take out the radiator from the vehicle carefully to avoid damage to any of its part.

**CAUTION :** Radiator core and plastic tanks are susceptible to cracking due to impact and deformation.

### 4.2 Detection of Leakage Spot -

- Connect the inlet of the radiator to air supply at the gauge pressure of 1.5 bar.
- Seal all other outlet points.
- Dip the radiator completely in a clean water tank.
- Tilt the radiator and shake it vigorously to let the air bubbles trapped at the clinching area to escape.
- Observe carefully for one minute and locate the source of air leakage on the radiator from the direction of air bubbles that are coming out of the radiator.

**CAUTION :** Do not use the water tank that is used for copper radiators.

### 4.3 Sealing the Leakage Spot

Following procedure shall be adopted for leakage at different locations of the radiator.

#### 4.3.1 Plastic Tank -

- Take out the member support using right size spanner.

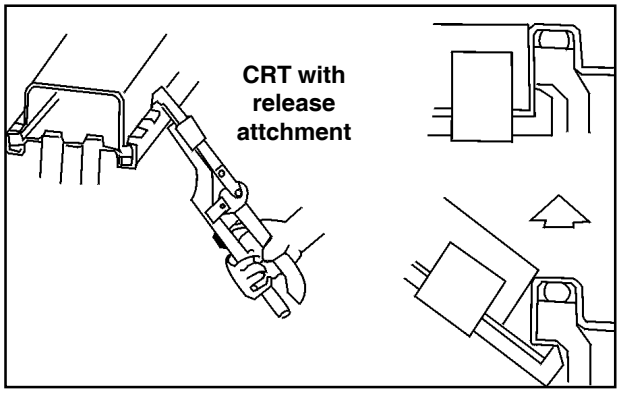



*Fig.16 Releasing the clinch projections*

- Release the clinch projections of header plate using CRT and clinch releasing attachment as illustrated in fig. 16
- After making all the clinching projections up, take out the tank from its seat in header plate while grasping the outlet.
- In case, it takes more effort, pat the tank with rubber or plastic hammer lightly as illustrated in fig. 17
- Take off the tank packing.
- Clean the area of the header plate where the tank sits, thoroughly.
- Insert new tank packing in the place without twisting.
- Insert new tank (top or bottom) as applicable.

**Note :** If the source of leakage is at the base of the tank, i.e. area between header plate and tank there is no need to replace the tank.

**CAUTION :** Tank packing shall be replaced, every time, the tank is taken off for servicing.

- If gap is found between the clinching projections of header plate and tank, softly hammer the projections as shown in fig.18
- Clinch the header plate projections with CRT and clinching attachment as shown in fig.19. The sequence of clinching should be followed as illustrated in the figure.
- At the place, where the CRT cannot be used, the clinching may be done by the pilers.
- After clinching, confirm the dimension as shown in fig.20

**CAUTION :** If any of the clinching projections is broken during the clinching or releasing process, discontinue the servicing and replace the entire radiator by a new one.

- Fix the member supports and tighten the bolts

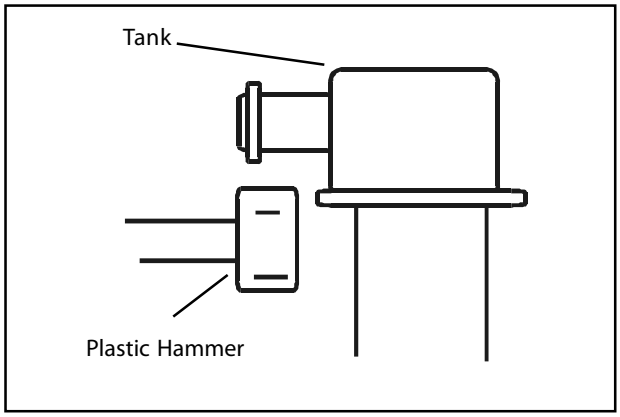



*Fig.17 Patting the tank with plastic hammer*

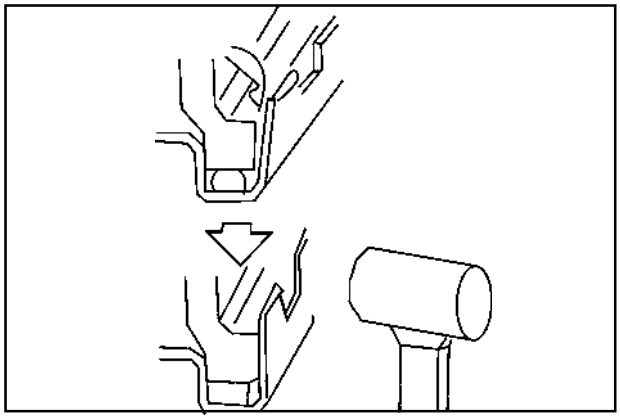


*Fig.18 Hammering the clinching projections softly*

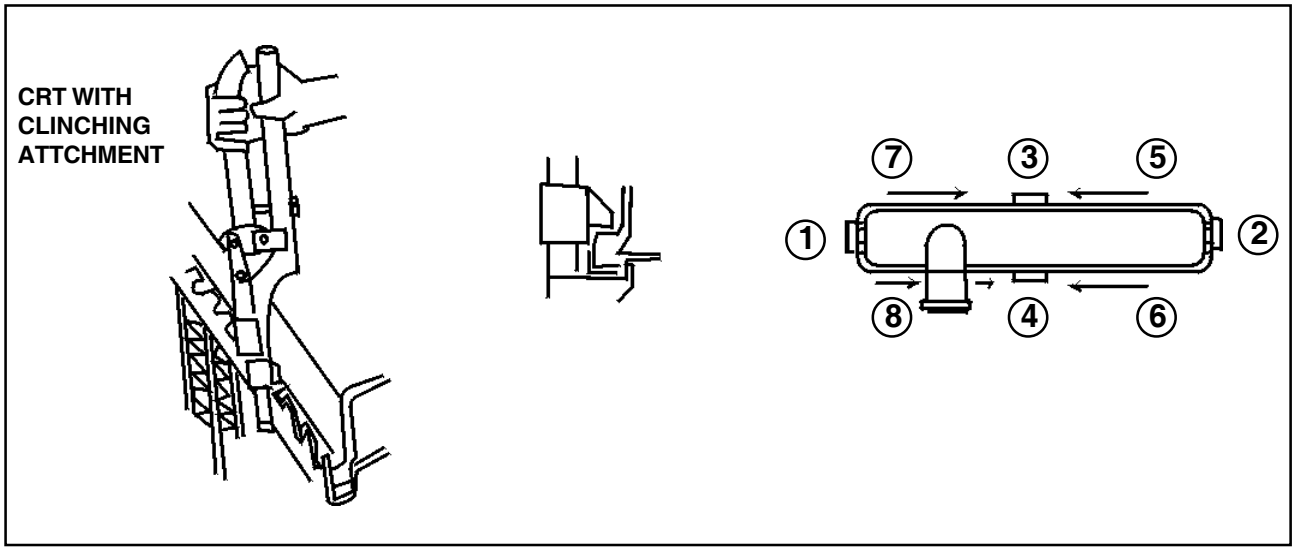



*Fig.19 Clinching the header plate projections*

properly.

**4.3.2 Pipe Component, Drain Cock and Pressure Cap**

**4.3.2.1 Pipe Component**

- Take out the pipe component using 10 size spanner.
- Remove the 'O' ring.
- Clean the seat of pipe component and the 'O' ring groove.
- Insert a new 'O' ring.
- Fit the pipe component back, ensuring proper tightness of the bolts.

**4.3.2.2 Drain Cock**

- Unscrew the drain cock.
- Remove the 'O' ring.
- Clean the 'O' ring groove.
- Insert a new 'O' ring.
- Screw the drain cock back.

**4.3.2.3 Pressure Cap**

- Replace the pressure cap with a new one, if leakage is through it after cleaning.

**4.3.3.Radiator Core -**

Different procedure of sealing shall be followed for minor and major leaks in the radiator core.

**Minor Leak :** Leak spots which are very minute, are to be sealed in following manner.

- Install the radiator onto the vehicle as explained in section 5.0
- Pour the contents of Alumaseal in the radiator.
- Fill proper quantity of coolant liquid.
- Run the engine in idling for 20 minutes.

**Major Leaks :** Procedure of sealing major leaks in the radiator is as follows :

- Wash the core with clean water and use brush provided in the kit to remove dirt, dust etc.
- To remove the greasy spot on the core, apply thinner with cotton swab and take off the grease.
- Dry the core using a dryer.

**CAUTION :** Drying by heating must be avoided.

- Mix adequate quantity of Araldite resin and hardener in the ratio of 1:1 in the container and stir it thoroughly.
- Apply the mixture immediately at the leakage spot with the stirrer or the Araldite applicator as per convenience.
- If required, apply the mixture again after 1 to 1.5 hour.
- Allow the mixture to dry and harden under the shade

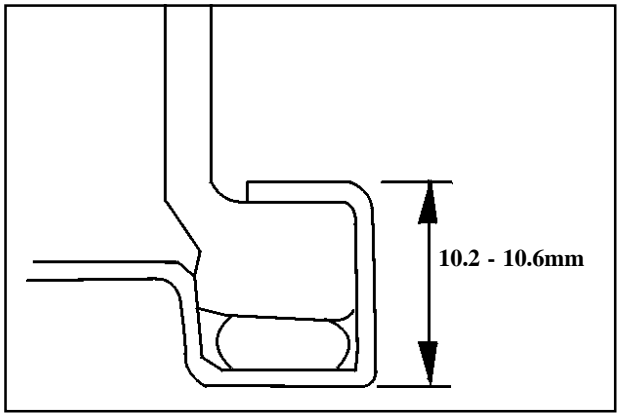



*Fig.20*

at room temperature for 10-12 hour.

**Note :**

- Araldite Rapid of M/s Ciba Geigy dries and hardens within one hour and hence users may use it to minimize the down time.
- Silver colour paint may be used for touching up the araldite spots and impart the aluminium type appearance.

**CAUTION :**

- Do not damage the fins during the process.
- Confirm that fins are set properly, if disturbed during the process.
- As the Araldite is inflammable, do not dry it by heating.
- Proper cleaning of radiator core is must for proper setting of Araldite or else it will come off.

**4.4 Confirmation of Proper Sealing**

- After the sealing work is over, assemble the radiator properly.
- Subject the assembled radiator to leakage test as illustrated in section 4.2

  **Note :** If the problem of leakage persists, it is advisable to replace the radiator with new one.

**5.0 RADIATOR INSTALLATION**

- Ensure that all the openings of the radiator are closed properly except the inlet.
- Fill the radiator with proper quantity of fresh coolant as recommended.
- Fit the fan shroud.
- Install the radiator on the vehicle ensuring proper alignment, damping etc. as applicable.
- Connect the inlet and outlet pipes and clamp them.

Now your radiator is ready for use.

# Electrical System 54

# Electrical System 54

## CONTENTS

Technical Specifications ..... 5
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Instrument panel gauges ..... 9
Instrument panel indicators and switches ..... 12
Battery ..... 15
Fuses and relay cluster ..... 15
Head lamps & bulb replacement ..... 17
Wiring diagram ..... 19

**1. Technical Specification**

| | | |
|---|---|---|
| System Voltage | : | 24 Volts |
| Alternator Capacity | : | 45 Amps |
| as per DIN:72311 & BS:3911 | : | 12 Volts,150 Ah capacity (2 Nos) |

## 2. Switches

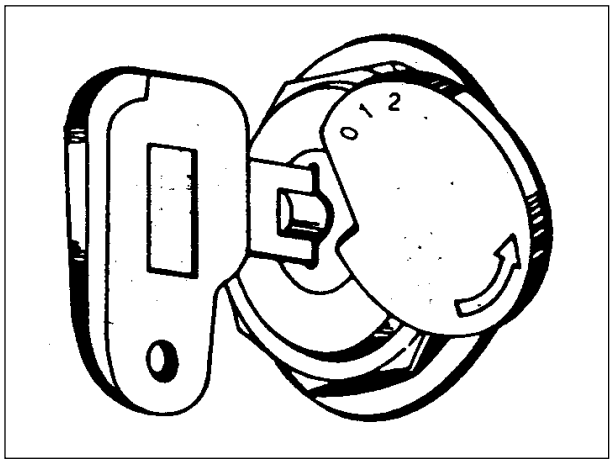
Main line switch with protective cap (turn protective cap aside to insert the key in main line switch)

Key positions with key pressed in the switch

0- On

1- On + Parking lights

2- On + Parking lights + Head lights




**Main line Switch**

It is multi contact switch box with a switch key, which has three positions marked 0-1-2.

When the key is inserted in position 'O', the starter motor push button, panel switches, turn indicator switch, horn push button and automatic switches of stop lights and parking brake become operative.

The key can be inserted/removed in position '1' and '2' also.

**Starter Switch**

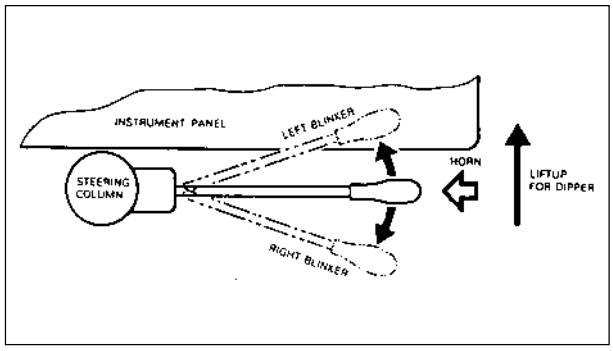
It is push-operated spring loaded switch placed in series with the main line switch, to start the engine after inserting the key in main line switch.

**Piano switches**

It is a bank of four switches operating wiper windscreen washer, P.T. O switches and engine exhaust brake isolator.

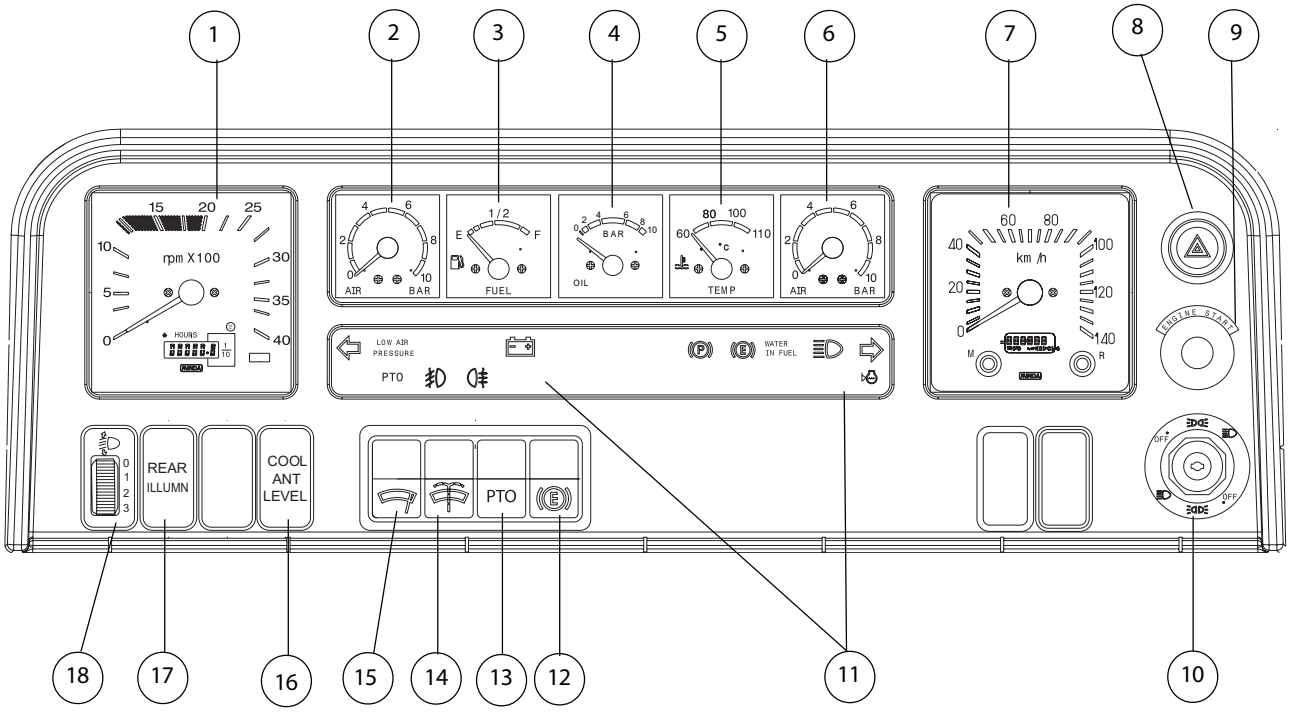
**Combination switch**

It is a lever operated multi-contact switch mounted on the steering column. In different positions it enables to operate turn signals, change over from main to dip beam and vice versa, and operate the horn as shown.



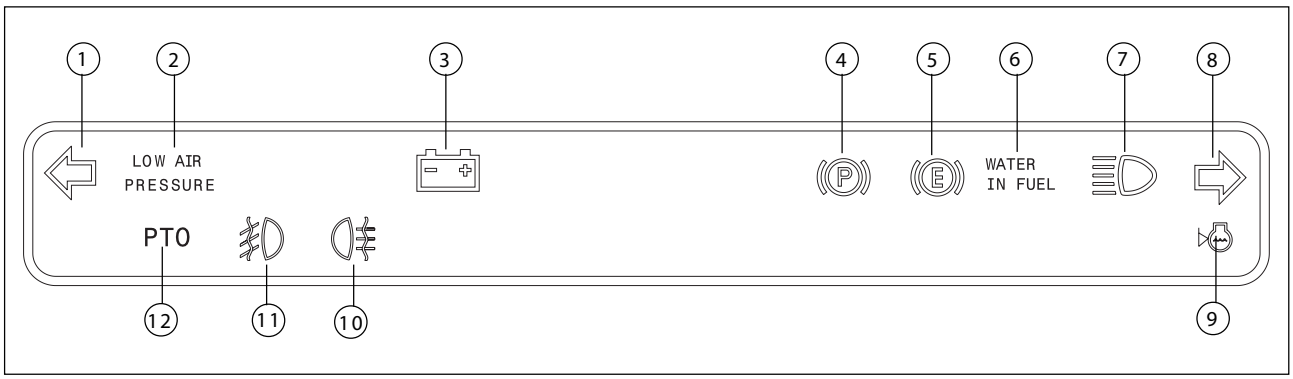

*Combination switch*

## 3. Instrument Panel SA/SAK 1212TC




Note :
*Hour meter and PTO fitted on SAK model only.*

1. Rpm Meter With Hour Meter
2. Air Pressure Gauge
3. Fuel Gauge
4. Oil Pressure Gauge
5. Temp Gauge
6. Air Pressure Gauge
7. Speedo Meter With Trip Meter
8. Hazard Warning Switch
9. Starter Push Button
10. Ignition Main Line Switch
11. Indicators & Warning Lamps
12. Exhaust Brake Switch
13. PTO Switch*
14. Wind Shield Washer Switch
15. Wiper Switch
16. Coolant Level Check Switch
17. Rear Illumination Switch
18. Head Lamp Levelling Switch




*Indicator Bank*

1. Turn Signal Left
2. Low air pressure
3. Battery charging lamp
4. Parking brake "ON"
5. Engine exhaust brake "ON"
6. Water in Fuel
7. Head lamp high beam
8. Turn signal right
9. Low coolant level indicator
10. Fog lamp rear
11. Fog lamp front
12. PTO Engaged indicator

## 4. Instrument Panel Gauges

### Fuel gauge

The fuel gauge indicates the level of fuel in the tank. It is electrically operated. The fuel level is indicated on the gauge through sensing unit mounted on the fuel tank.




*Fuel gauge*

### Oil pressure gauge

Minimum allowable engine oil pressure

1 Idling speed : 0.69 bar
1 Rated speed : 2.07 bar




### Air pressure gauges

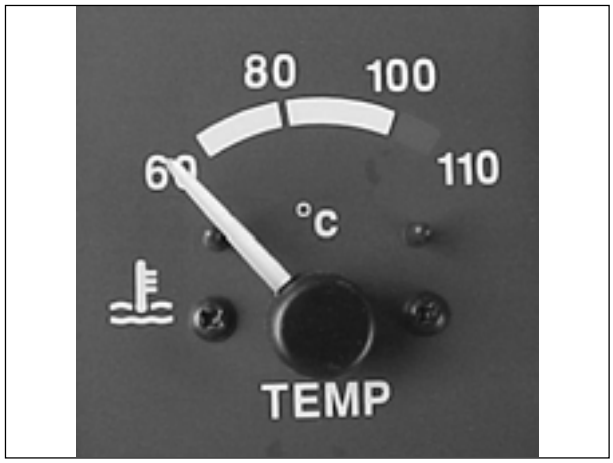
Two separate air pressure gauges have been provided for front and rear brake air circuits. Air connections have been taken from dual brake valves. The vehicle should not be driven till a minimum air pressure of 5.6 bar is reached after starting the engine in both the air tanks. If the air pressure is found to be constantly below 5.3 $\pm$ 0.3 bar, this may be due to leakage or improper functioning of the air compressor.




*Air pressure gauge*

**Coolant temperature gauge**

The temperature gauge shows the temperature of the coolant in the engine in degrees Celsius. The temperature on the gauge is indicated through an electrical signal provided by the temperature sensor unit (Transducer) Mounted on the engine , before thermostat. When the **pointer** goes **in red band on dial** , **it indicates engine overheating,** this may be due to less quantity of coolant in the auxilliary tank. While driving ,overheating of the engine is observed, and the coolant level in the auxilliary tank is found to be low , **top up only when the engine has cooled down , or engine running at fast idling** as otherwise cylinder head may crack



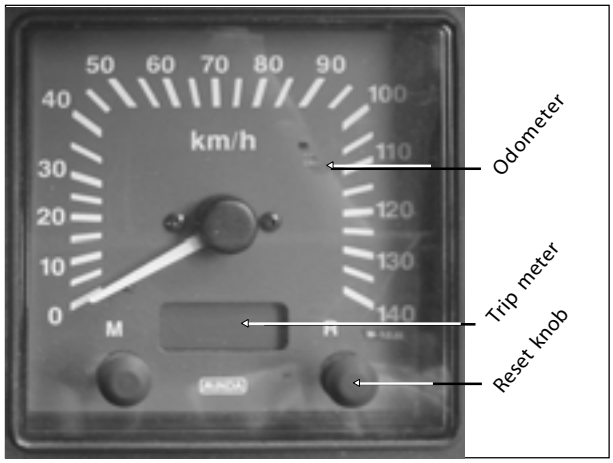

*Coolant temperature gauge*

**Speedometer :**

Speedometer needle position indicates the vehicle speed in kmph. Odometer indicates the distance covered by the vehicle in km. It is driven by a electrical signal coming out from Electronic Speed Sensor fitted in Gearbox.

Speedometer ratio is marked on the front.

A trip meter is also incorporated on the speedometer, which enables to note the distance covered during the trips between the origin and destination. The meter can be reset to zero by pushing the knob, after the trip travelled.




*Speedometer, with trip meter*

The RPM meter cum HOUR meter is provided on tipper vehicles to indicate cummulative hours of operation of engine. Maintenance schedule is recommended based on the hours of operation for the tipper models.




*RPM meter with Hour meter (For SAK tippers)*

**RPM Meter**

For optimum fuel economy always drive the vehicle engine RPM in green band.




*RPM Meter (For SA)*

**Head lamp levelling**

Motorised Head lamp focusing shall be adjusted with the help of the knob along the vertical axis as required, depending upon loading condition of the vehicle.




*Knob for Head lamp focus levelling*

## 5. Indicators and Switches

**Parking brake indicator**

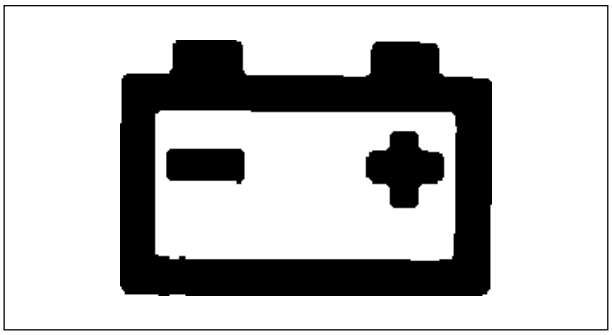
This indicator comes ON when parking brake is applied and goes OFF when it is released.




*Parking brake indicator*

**Battery charging indicator**

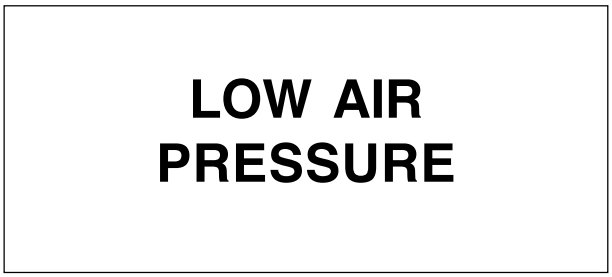
It is provided in the instrument panel. It glows when the key is inserted in the main line switch. With the engine idling the lamp goes off. During the engine vehicle operation if the lamp lights up, it means either battery is not getting charged or alternator is defective. Get the vehicle attended at our authorised dealer/ Authorised service station at once.



*Battery charging indicator*

**Low air pressure indicator**

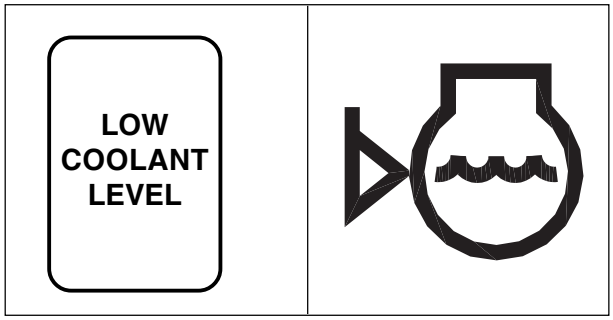
Two low pressure switches are connected separately for front and rear air circuits at the dual brake valve. Both switches are connected to low air pressure indicator on instrument panel. When pressure is below 5.4 ± 0.5 bar, sensor switches activate low air pressure circuit. Indicator light glows on the instrument panel. Simultaneously a beeper beeps indicating low air pressure in the system.




*Low air pressure indicator*

**Low Coolant Level Check Switch / Indicator**

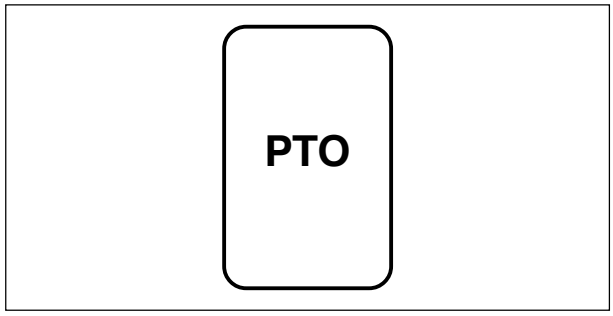
When the Low Coolant Level Switch is put to ON position, the Low Level Indicator on the instrument cluster will flash once and the extinguish. This indicates that the Coolant level is within the acceptable limits. If the indicator continues to glow, it indicates low coolant level. Top up the coolant and recheck with the help of the Switch.




*Low Coolant Level Check Switch / Indicator*

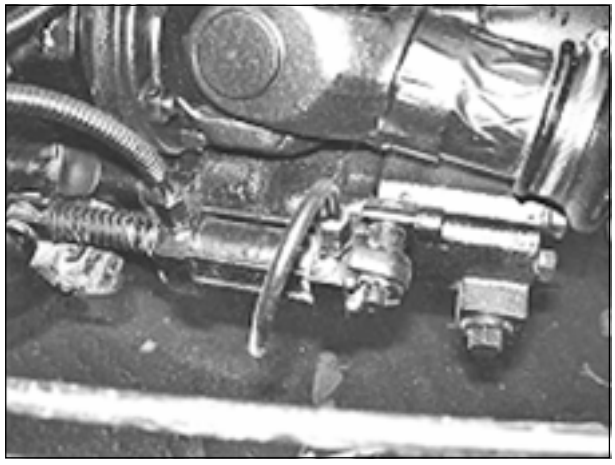
**PTO operation for tipper**

PTO is pneumatically operated through an electrical switch located in instrument panel. To engage the PTO, build up air pressure to 8.1 bar. With engine idle, press the clutch pedal fully and put 'ON' the PTO switch. To disengage the PTO press the clutch pedal fully and put 'OFF' the switch.




PTO is operated through electro- magnetic cylinder mounted on the axial piston pump . Air is supplied to electro magnetic valve through DDU.

Magnetic valve is activated/deactivated by operating the piano switch "PTO" provided in the dash board.



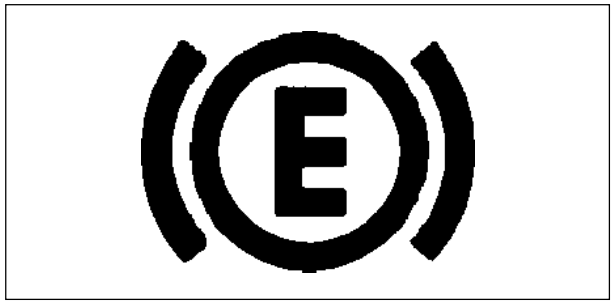
*Air Cylinder for PTO operation*

**Exhaust brake indicator**

Exhaust brake operation is coupled with service brake. Whenever brake pedal is depressed for applying brakes, exhaust brake also gets applied and indicator lamp (E) glows on the instrument panel.

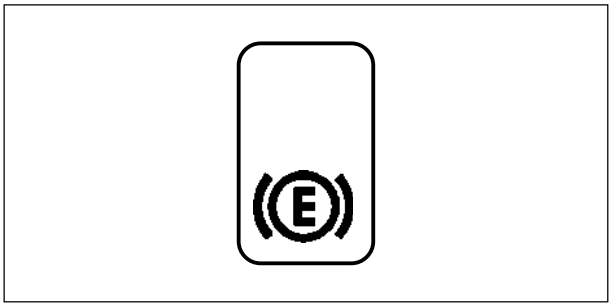
Stop light switch provides signals both for rear tail lamps as well as for exhaust brake solenoid valve.

Solenoid valve opens, allowing the compressed air to flow to air cylinder thus, operating the exhaust brake, if isolator switch is kept 'ON'.



**Exhaust brake isolator switch**

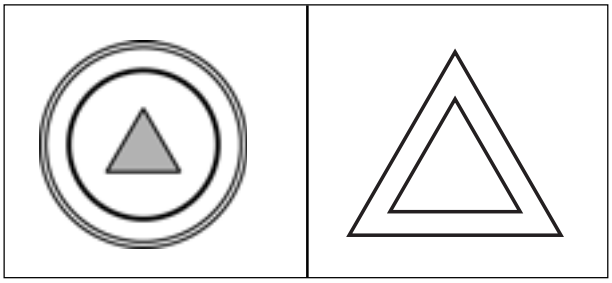
In certain situations like starting of vehicle on an upgradient, simultaneous acceleration and partial braking of vehicle are required. Isolator switch can be used to cut off air supply to exhaust brake, by putting it in off (disengaged) position. Isolator switch should be put on (engaged), as soon as isolation requirement is over.




*Exhaust brake isolator switch*

**Hazard warning switch/ indicator**

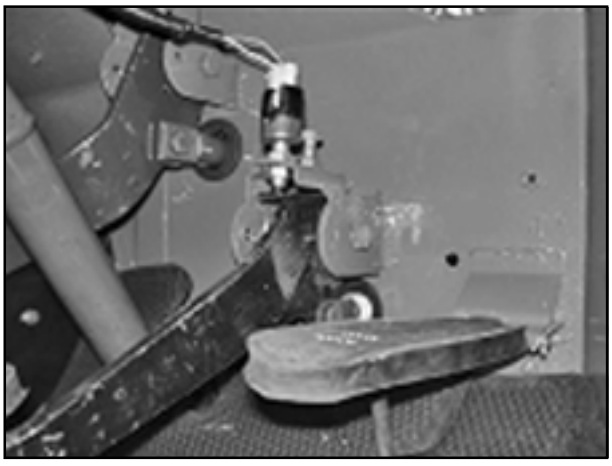
In case of emergency to warn other road users about the hazardous condition of the vehicle, pull the knob to "ON" position. All the turning signals of right and left side starts flashing along with lamp on the knob. Push to put " OFF" the hazard warning.



*Hazard warning switch/ indicator*

**Mechanical stop light switch**

A mechanical stop light switch is mounted at brake pedal lever mounting bracket. Whenever brake pedal is depressed for applying brakes, stop light switch comes into operation and stop lights at rear tail lamps glow.



*Mechanical stop light switch*

### 6. Battery

Electrolyte level should be 10 to 12 mm above the top of the battery plates. Battery mounting clamps and starter motor terminals must be kept clean and firm. Apply vaseline/petroleum jelly on battery terminals.

Caution : disconnect the battery terminal before carrying out arc welding work on the vehicle.



*Battery*

### 7. Fuses and Relay cluster

In order to protect the cable harness from damage in case of short circuit and overloads, blade type fuses as per IS 2577 are provided in the fuse box.

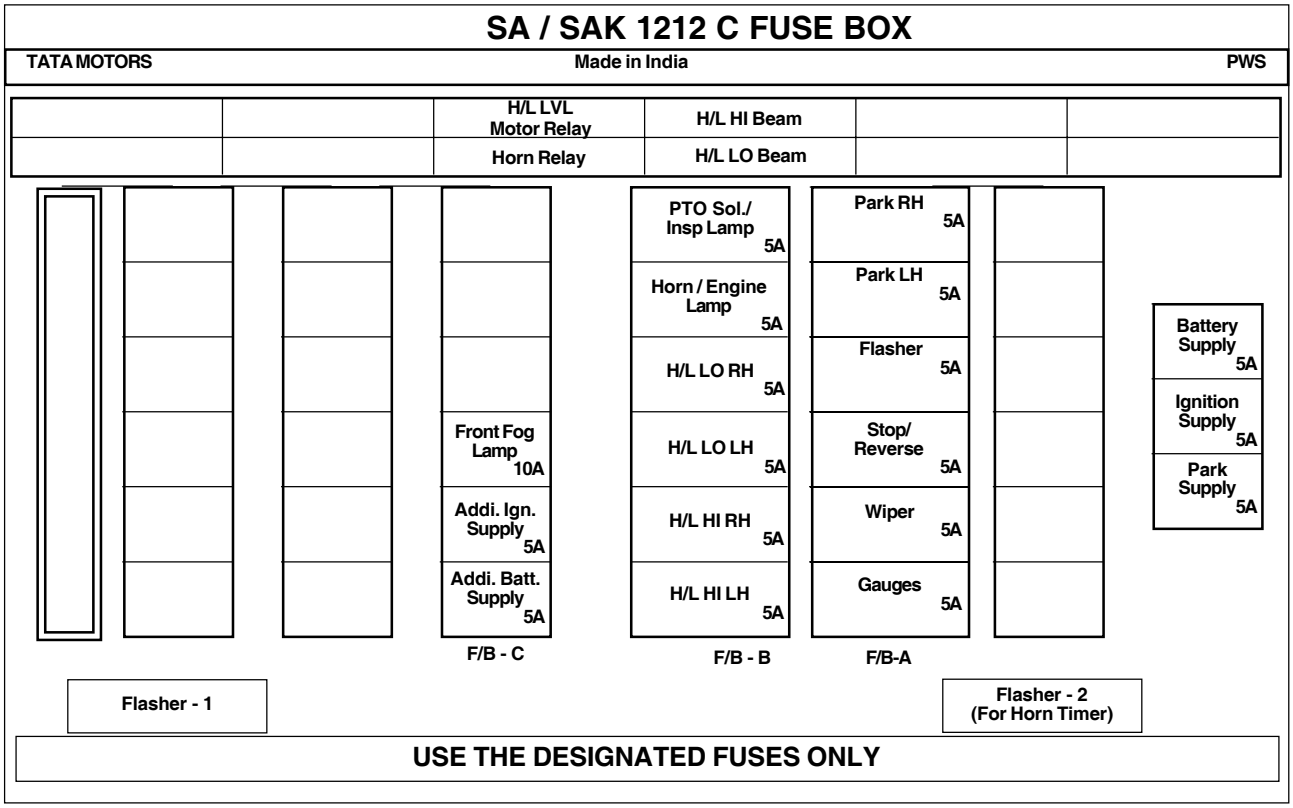
The fuse box are located in the engine compartment on the firewall, which incorporate fuse and for black out equipment & blower etc.

In case of a fault in the electrical system check the respective fuse. The particulars of the consumers served by each fuse are printed on the fuse box cover. While fitting fuse box cover ensure that cover knob rests in the slot provided inside fuse box.

The consumers served by each fuse are printed on the transparent cover of the fuse box.



*Fuse box*



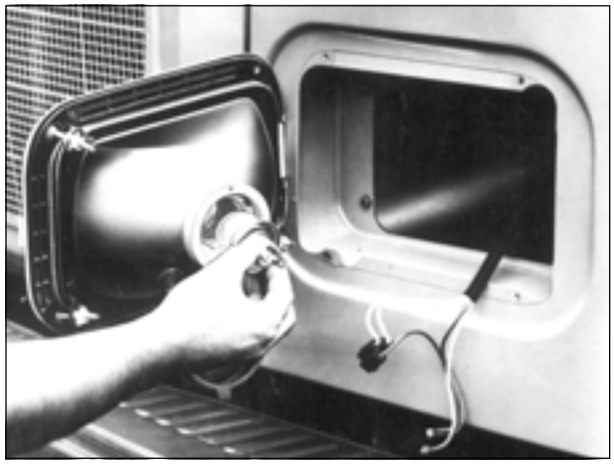

**STICKER SHOWING FROM TOP OF THE COVER**

## 8. Head lamp and bulb replacement

### Head lamps

The head lamp system provides two types of light beams; a main beam to give Maximum light well ahead of the vehicle, and a dipped beam which is shorter and lower so that it will not dazzle on on-coming drivers, and can be used in low visibility area.

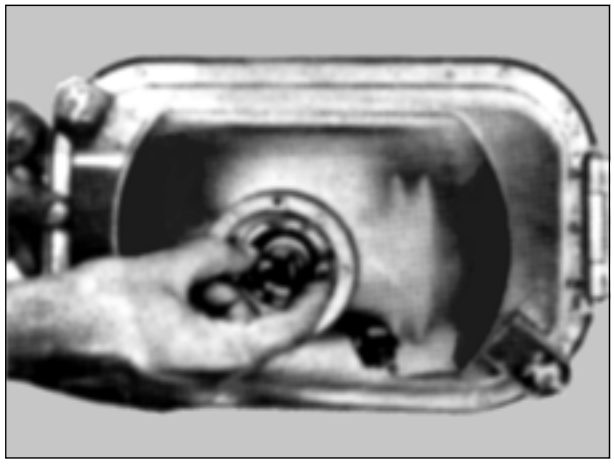
Separate filaments in a single bulb in each headlamp provide the main and dipped beams.



*Replacing head lamp bulb*

Bulbs are made with accurately located filaments and a locating flange, so that when fitted into reflector, which is permanently bonded together with lens, the bulb is always at focus. The design ensures that bulb can be fitted only in the correct position. It cannot be fitted

With filaments reversed. The head lamp also has a parking lamp.



*Locking the head lamp bulb with lock ring*

### Bulb Replacement

Remove rubber cap from rear of head lamp. Push out cable socket with bulb and remove locking ring. Replace with new bulb taking care for proper fitment and lock the hub with lock ring. Refit cable socket with bulb on the head lamp and press it in position. Seat the rubber cap in position.



*Adjusting head lamp focus*

**Note: -**
Do not clean the reflector, as it will cause damage to mirror finished surface. Do not replace bulb with dirty or oily hands since oil will evaporate due to the bulb heat and strain the reflector.
After replacing bulb check head lamp alignment.

**Head Lamps Alignment**
The head lights must be properly aligned in order to obtain maximum road safety as regards proper road illumination and to reduce the glare on the oncoming traffic.

It is recommended to check the alignment of head lights periodically and whenever bulbs are replaced, by means of screen as shown in figure.

The head lamp alignment in this type, asymmetrical dipped beams, is done only by adjusting the dipped beams unlike other head lamps where main beams are adjusted.

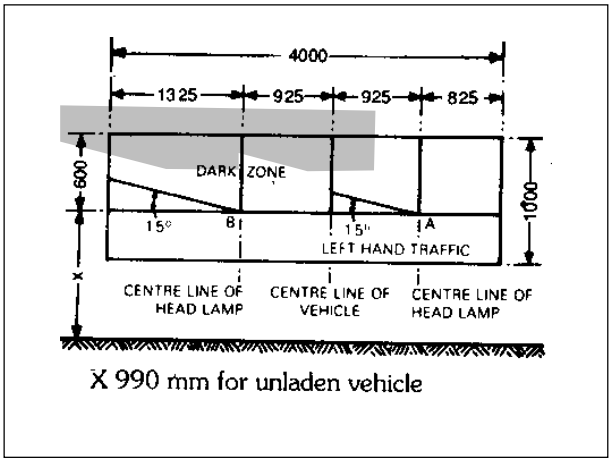
The vehicle should be parked 10 m away from the screen, with its center in line with the central vertical line on the screen and the screen at right angles to longitudinal axis of vehicle. The vehicle should be in unladen condition with no sag in suspension springs and all tyres equally inflated.

On the market up screen as shown in figure, the area above the horizontal and inclined lines (shaded) is called 'The Dark Zone', and the area below it is called 'The Illuminated Zone'.

Each lamp is aligned individually by masking the other lamp. The head lamp is first adjusted for the proper height of the dipped beam by the adjusting screw at its top. The light from dipped beam should fall below the horizontal and inclined lines i.e. in the 'The Dark Zone'. Thereafter the lateral adjustment is done by the adjusting screw at the bottom so that contour of the dipped beam coincides with contour formed by horizontal and inclined lines below 'The Dark Zone'. When properly aligned the most illuminated area will be just below the intersection (Point A) of the two lines.

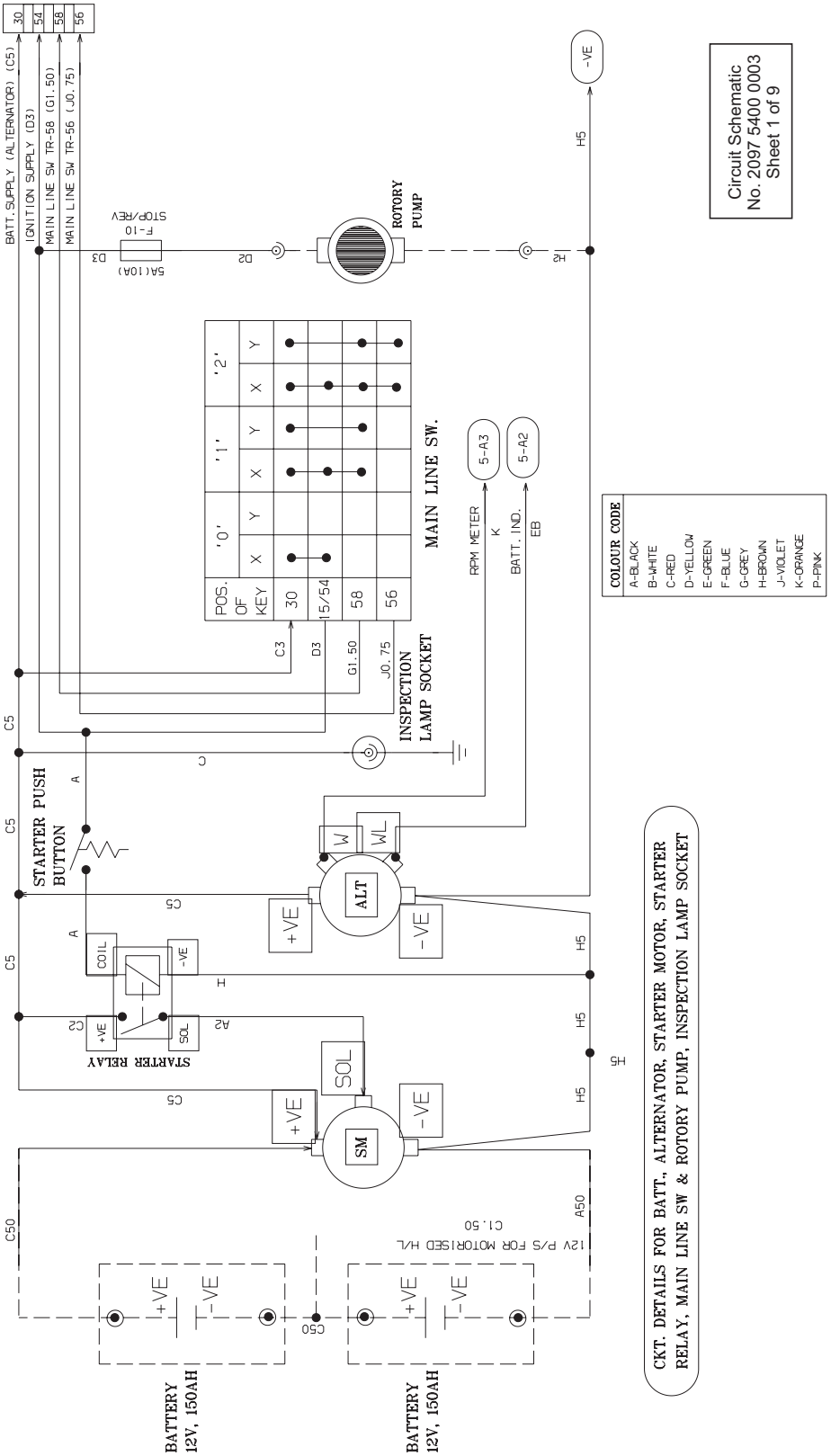
The second head lamp is adjusted in a similar manner without disturbing the position of the vehicle and the screen. Now Switch "ON" Main beam lights. They will be symmetrical above the points of intersection (Point A and B) of the vertical lines and the horizontal line. It is possible that the main beams may not be exactly symmetrical but for this reason the head lamps should not be realigned.

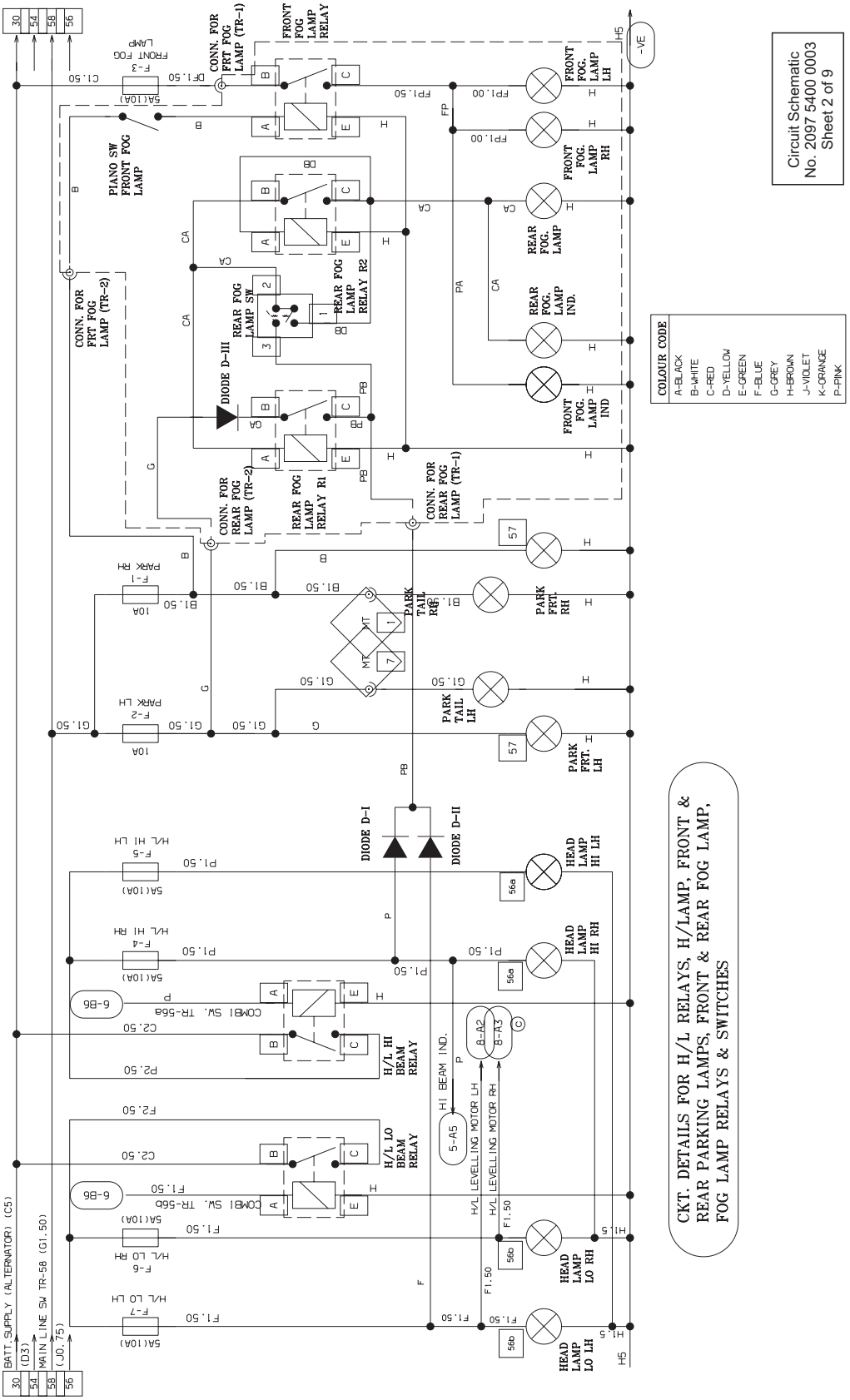
**Preferably, alignment should be done in the dark.**

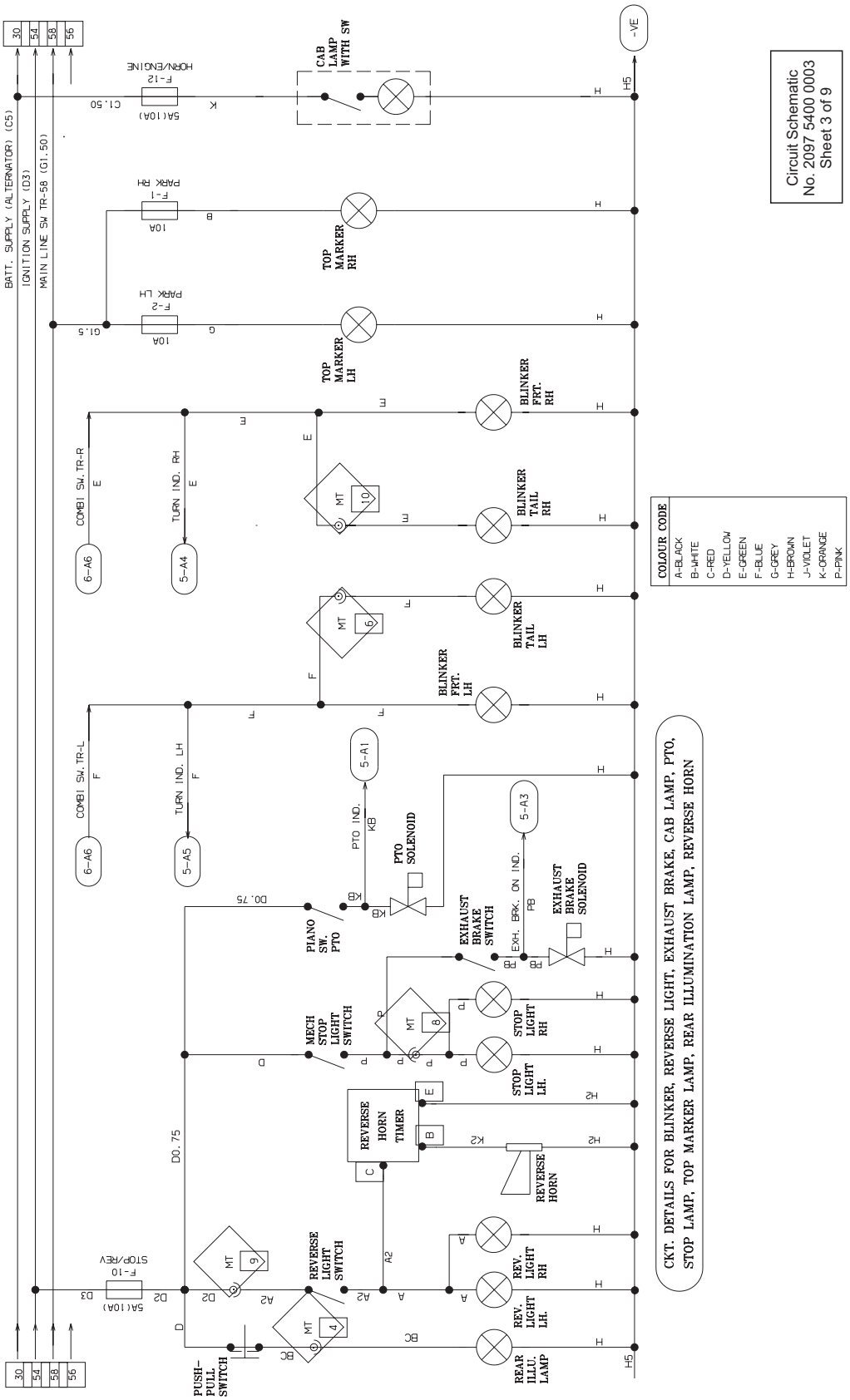


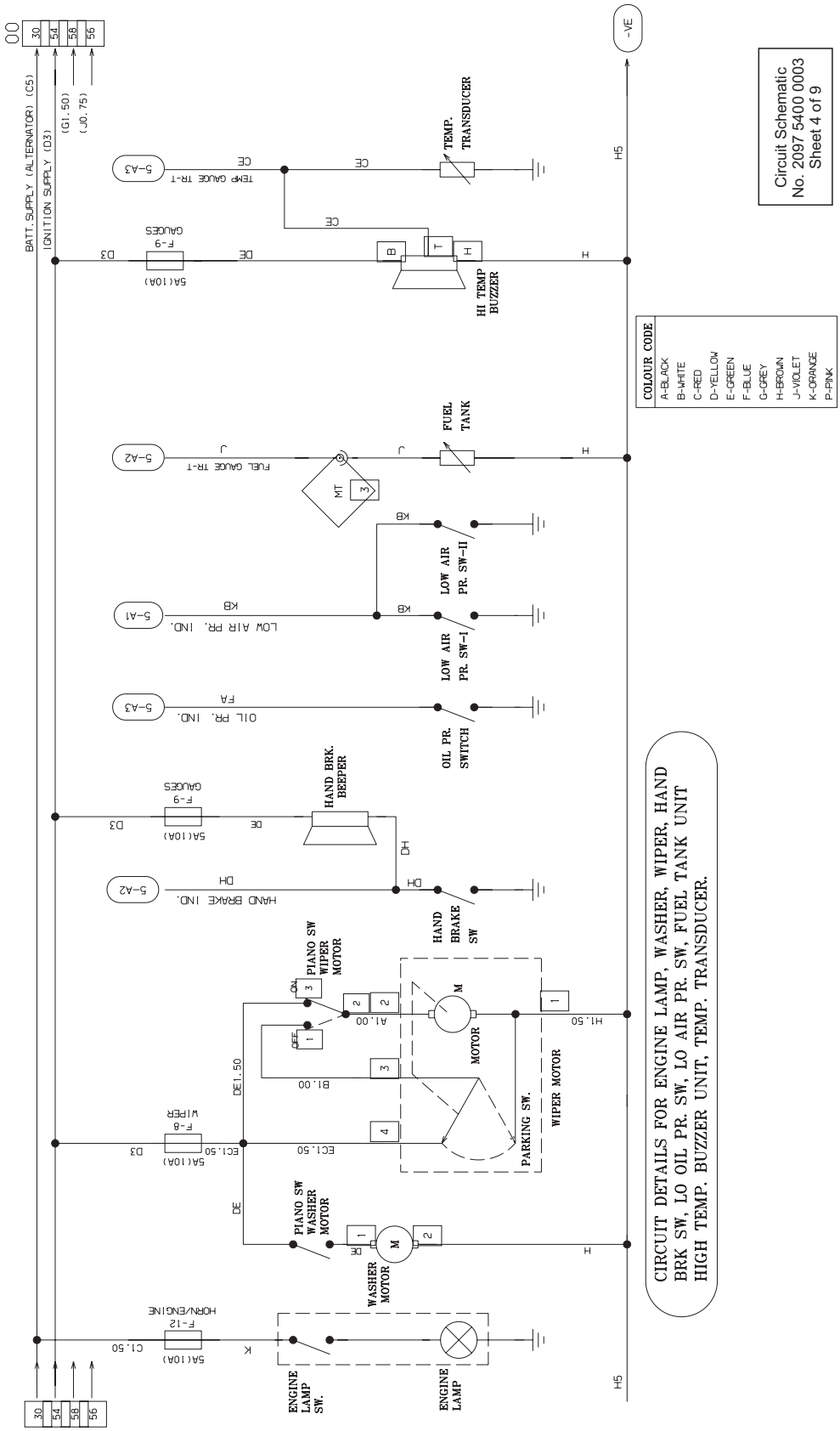
X 990 mm for unladen vehicle

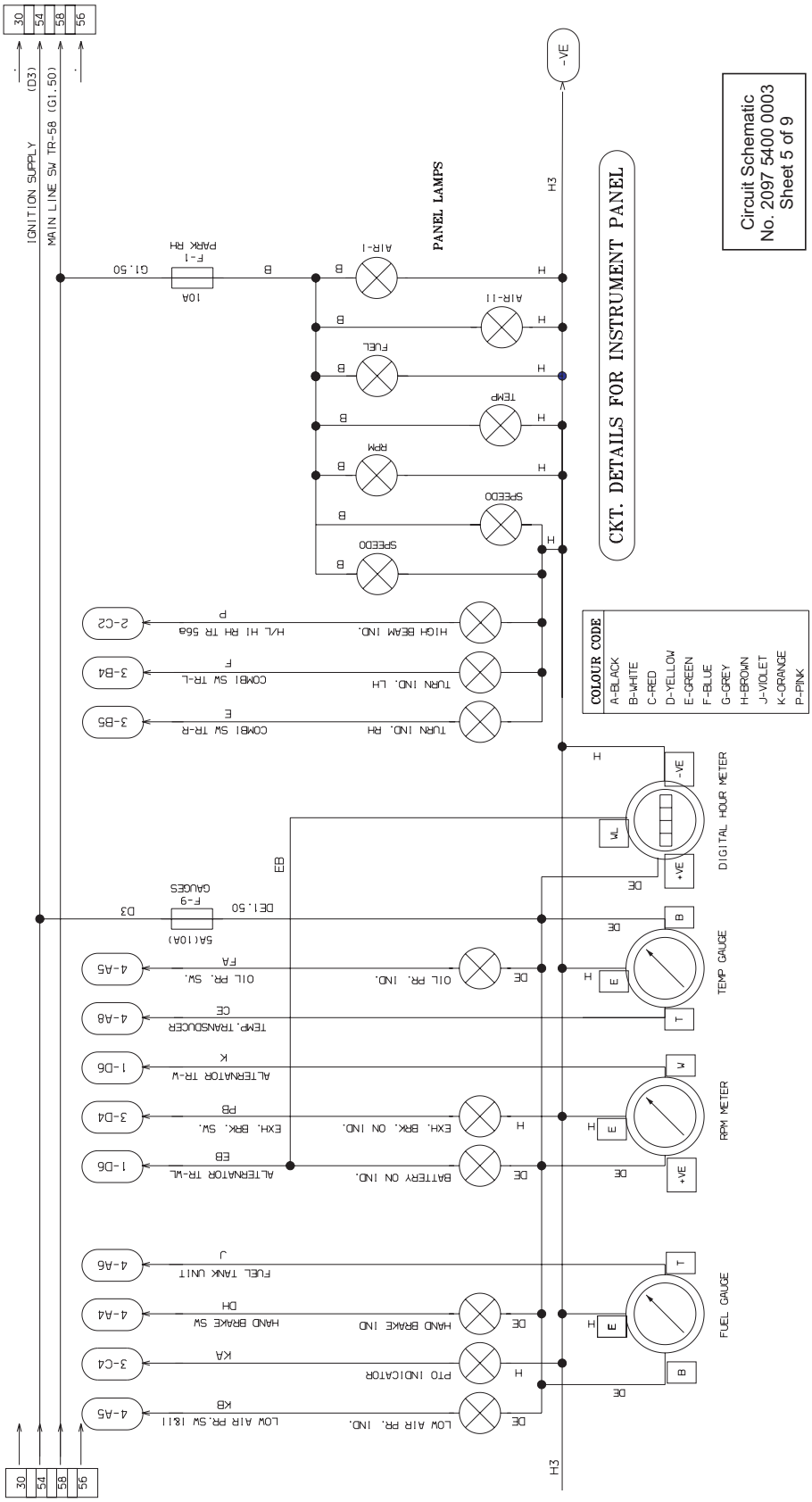
## Circuit Schematics

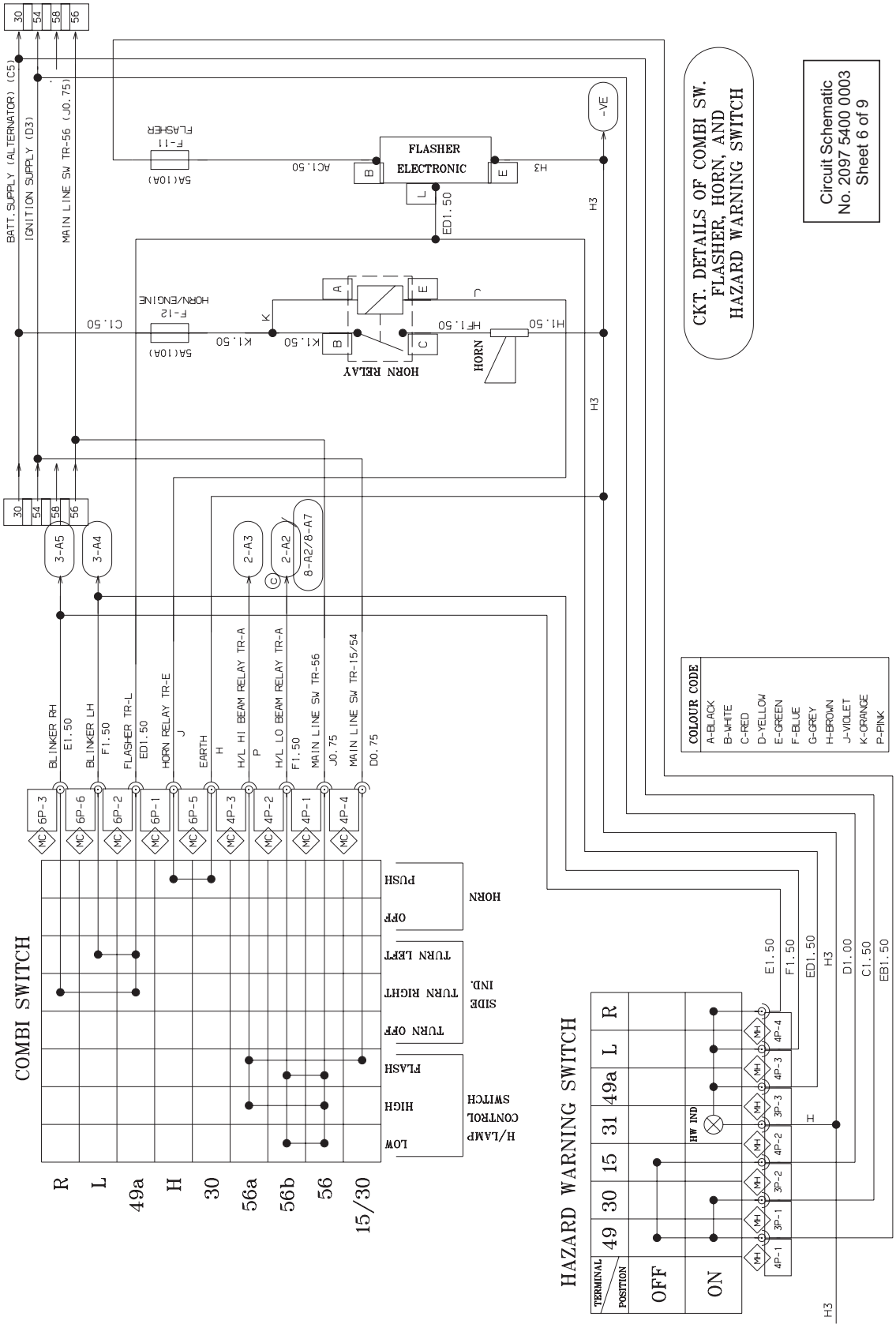


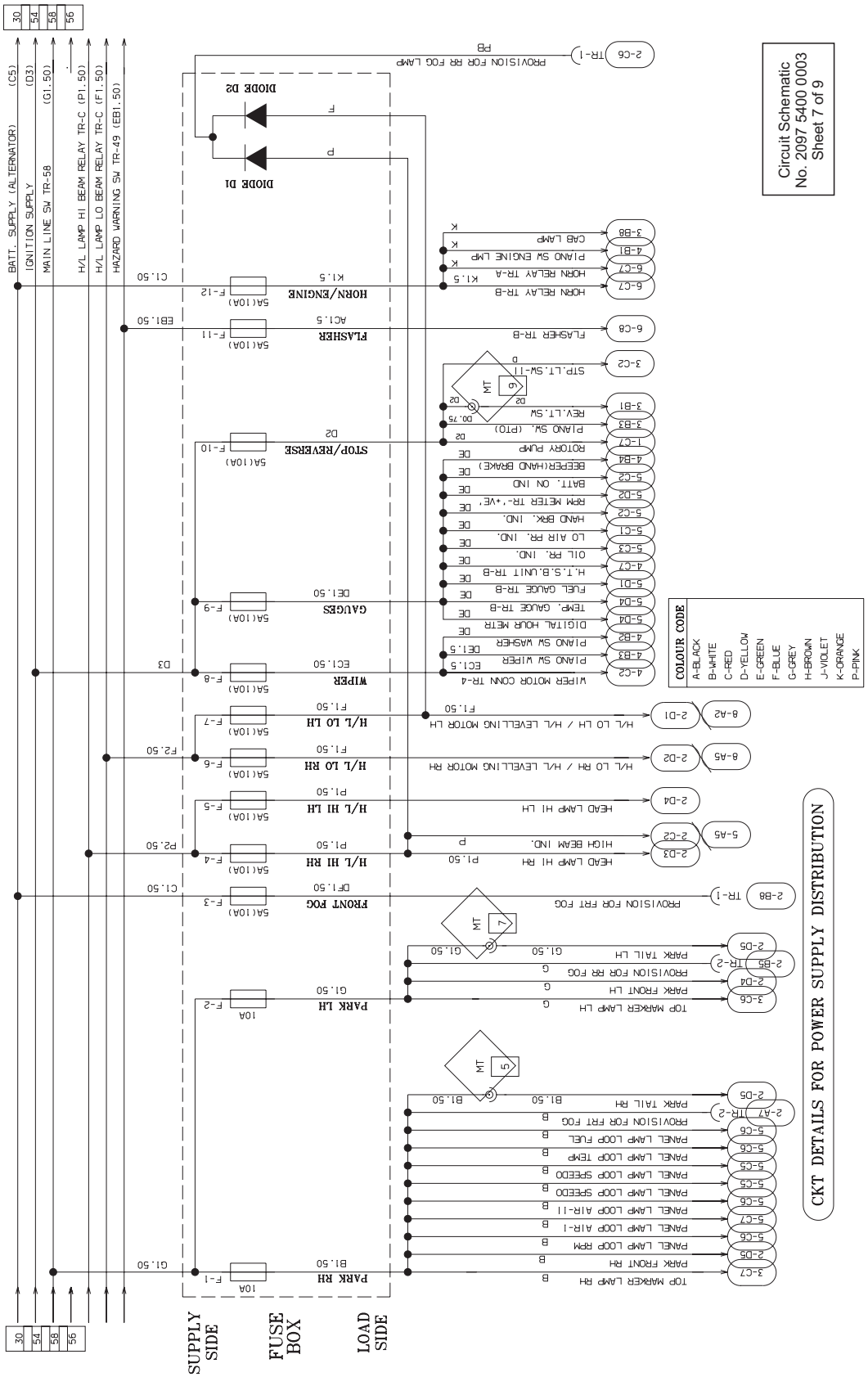

Circuit Schematic
No. 2097 5400 0003
Sheet 2 of 9
COLOUR CODE
A-BLACK
B-WHITE
C-RED
D-YELLOW
E-GREEN
F-BLUE
G-GREY
H-BROWN
J-VIOLET
K-ORANGE
P-PINK
CKT. DETAILS FOR H/L RELAYS, H/LAMP, FRONT & REAR PARKING LAMPS, FRONT & REAR FOG LAMP, FOG LAMP RELAYS & SWITCHES
BATT. SUPPLY (ALTERNATOR) (C5)
MAIN LINE SW TR-58 (G1.50)
FRONT FOG LAMP
CONN. FOR FRT FOG LAMP (TR-1)
FRONT FOG LAMP RELAY
PIANO SW FRONT FOG LAMP
CONN. FOR FRT FOG LAMP (TR-2)
REAR FOG LAMP SW
REAR FOG LAMP RELAY R2
DIODE D-III
REAR FOG LAMP RELAY R1
CONN. FOR REAR FOG LAMP (TR-2)
CONN. FOR REAR FOG LAMP (TR-1)
FRONT FOG. LAMP LH
FRONT FOG. LAMP RH
REAR FOG. LAMP
REAR FOG. LAMP IND.
FRONT FOG. LAMP IND
PARK RH
PARK LH
PARK TAIL RH
PARK TAIL LH
PARK FRT. RH
PARK FRT. LH
DIODE D-I
DIODE D-II
H/L HI LH
H/L HI RH
H/L LO RH
H/L LO LH
HEAD LAMP HI LH
HEAD LAMP HI RH
HEAD LAMP LO RH
HEAD LAMP LO LH
COMBI SW. TR-56a
COMBI SW. TR-56b
H/L HI BEAM RELAY
H/L LO BEAM RELAY
HI BEAM IND.
H/L LEVELLING MOTOR LH
H/L LEVELLING MOTOR RH
-VE

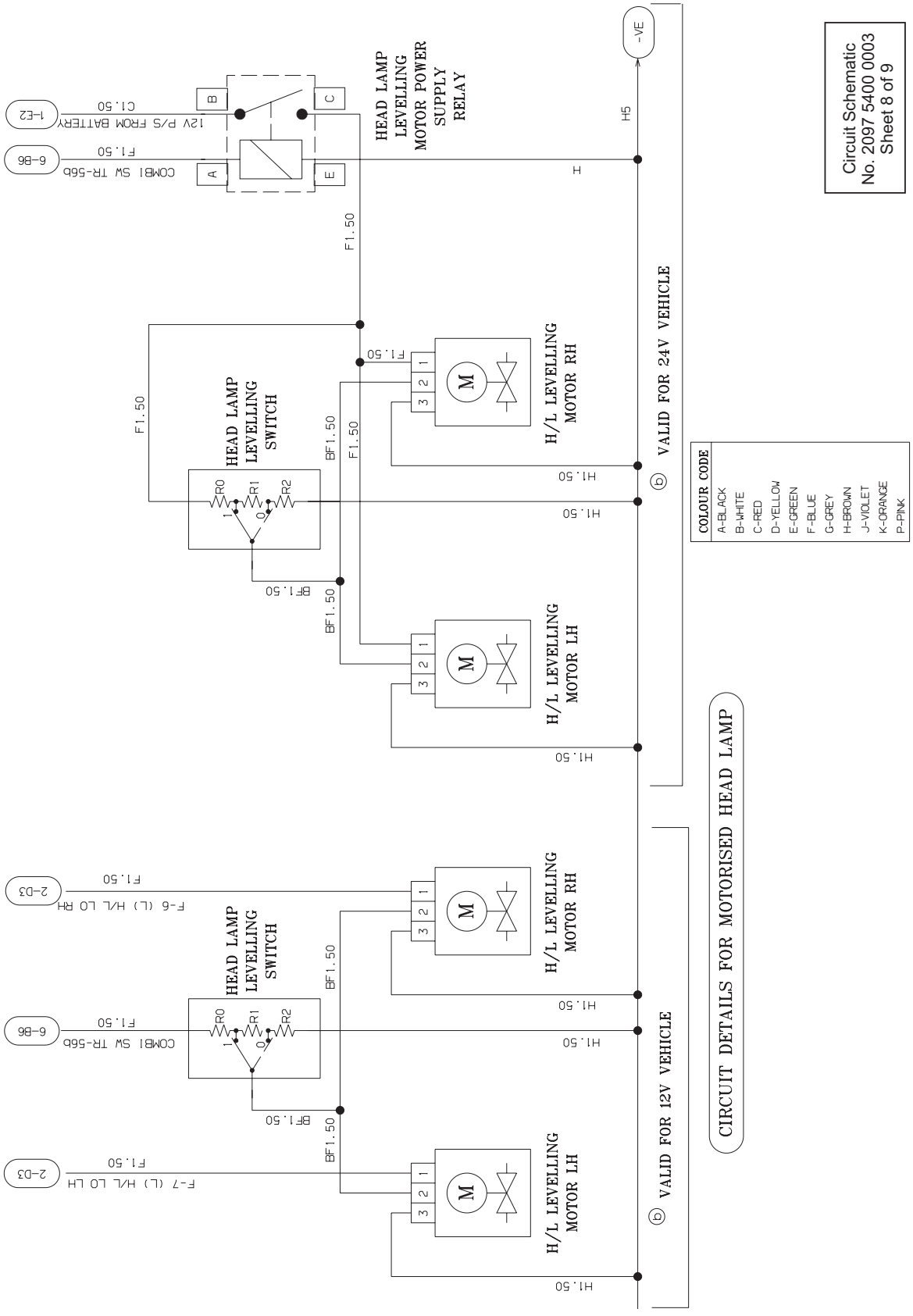

Circuit Schematic
No. 2097 5400 0003
Sheet 3 of 9
BATT. SUPPLY (ALTERNATOR) (C5)
IGNITION SUPPLY (D3)
MAIN LINE SW TR-58 (G1.50)
30
54
58
56
HORN/ENGINE
F-12
5A(10A)
CAB LAMP WITH SW
-VE
H5
PARK RH
F-1
10A
TOP MARKER RH
PARK LH
F-2
10A
TOP MARKER LH
BLINKER FRT. RH
BLINKER TAIL RH
BLINKER TAIL LH
BLINKER FRT. LH
COMBI SW.TR-R
TURN IND. RH
COMBI SW.TR-L
TURN IND. LH
6-A6
5-A4
5-A5
5-A1
5-A3
PTO IND.
PTO SOLENOID
PIANO SW. PTO
EXHAUST BRAKE SWITCH
EXH. BRK. ON IND.
EXHAUST BRAKE SOLENOID
MECH STOP LIGHT SWITCH
STOP LIGHT RH
STOP LIGHT LH.
REVERSE HORN TIMER
REVERSE HORN
REVERSE LIGHT SWITCH
STOP/REV
F-10
REV. LIGHT RH
REV. LIGHT LH.
REAR ILLU. LAMP
PUSH-PULL SWITCH
MT
COLOUR CODE
A-BLACK
B-WHITE
C-RED
D-YELLOW
E-GREEN
F-BLUE
G-GREY
H-BROWN
J-VIOLET
K-ORANGE
P-PINK
CKT. DETAILS FOR BLINKER, REVERSE LIGHT, EXHAUST BRAKE, CAB LAMP, PTO, STOP LAMP, TOP MARKER LAMP, REAR ILLUMINATION LAMP, REVERSE HORN

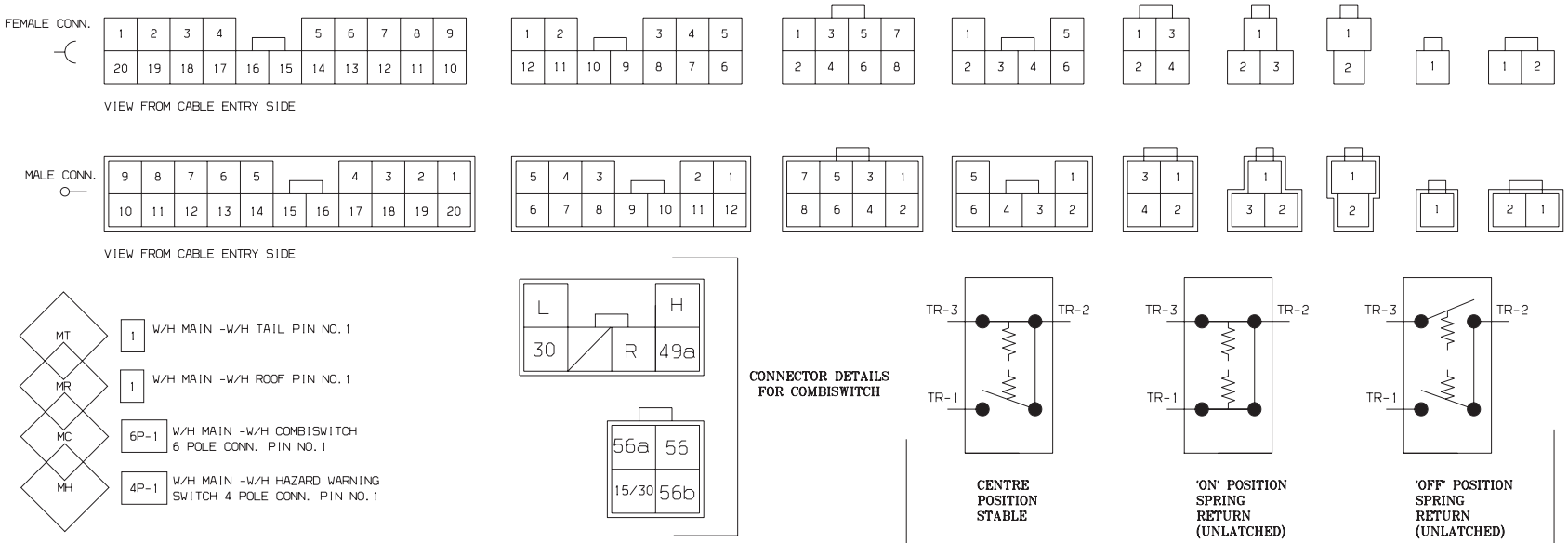

Circuit Schematic
No. 2097 5400 0003
Sheet 4 of 9
COLOUR CODE
A-BLACK
B-WHITE
C-RED
D-YELLOW
E-GREEN
F-BLUE
G-GREY
H-BROWN
J-VIOLET
K-ORANGE
P-PINK
-VE
BATT. SUPPLY (ALTERNATOR) (C5)
IGNITION SUPPLY (D3)
(G1.50)
(J0.75)
30
54
58
56
TEMP. TRANSDUCER
TEMP GAUGE TR-T
HI TEMP BUZZER
FUEL TANK
FUEL GAUGE TR-T
LOW AIR PR. SW-II
LOW AIR PR. SW-I
LOW AIR PR. IND.
OIL PR. SWITCH
OIL PR. IND.
HAND BRK. BEEPER
HAND BRAKE SW
HAND BRAKE IND.
PIANO SW WIPER MOTOR
WIPER MOTOR
PARKING SW.
MOTOR
PIANO SW WASHER MOTOR
WASHER MOTOR
HORN/ENGINE
ENGINE LAMP SW.
ENGINE LAMP
F-9 GAUGES
F-8 WIPER
F-12
5A(10A)
CIRCUIT DETAILS FOR ENGINE LAMP, WASHER, WIPER, HAND
BRK SW, LO OIL PR. SW, LO AIR PR. SW, FUEL TANK UNIT
HIGH TEMP. BUZZER UNIT, TEMP. TRANSDUCER.


Circuit Schematic
No. 2097 5400 0003
Sheet 5 of 9
CKT. DETAILS FOR INSTRUMENT PANEL
PANEL LAMPS
IGNITION SUPPLY (D3)
MAIN LINE SW TR-58 (G1.50)
-VE
H3
COLOUR CODE
A-BLACK
B-WHITE
C-RED
D-YELLOW
E-GREEN
F-BLUE
G-GREY
H-BROWN
J-VIOLET
K-ORANGE
P-PINK
AIR-I
AIR-II
FUEL
TEMP
RPM
SPEEDO
SPEEDO
PARK RH
F-1
10A
G1.50
HIGH BEAM IND.
TURN IND. LH
TURN IND. RH
2-C2
3-B4
3-B5
OIL PR. IND.
BATTERY ON IND.
EXH. BRK. ON IND.
LOW AIR PR. IND.
HAND BRAKE IND
PTO INDICATOR
FUEL TANK UNIT
DIGITAL HOUR METER
TEMP GAUGE
RPM METER
FUEL GAUGE
F-9
5A(10A)
DE1.50
D3
EB
30
54
58
56


CKT. DETAILS OF COMBI SW.
FLASHER, HORN, AND
HAZARD WARNING SWITCH
Circuit Schematic
No. 2097 5400 0003
Sheet 6 of 9
COLOUR CODE
A-BLACK
B-WHITE
C-RED
D-YELLOW
E-GREEN
F-BLUE
G-GREY
H-BROWN
J-VIOLET
K-ORANGE
P-PINK
BATT. SUPPLY (ALTERNATOR) (C5)
IGNITION SUPPLY (D3)
MAIN LINE SW TR-56 (J0.75)
FLASHER
ELECTRONIC
-VE
HORN RELAY
HORN
COMBI SWITCH
HAZARD WARNING SWITCH
TERMINAL
POSITION
OFF
ON
HW IND
R
L
49a
H
30
56a
56b
56
15/30
HORN
PUSH
OFF
SIDE IND.
TURN LEFT
TURN RIGHT
TURN OFF
H/LAMP CONTROL SWITCH
FLASH
HIGH
LOW


Circuit Schematic
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CKT DETAILS FOR POWER SUPPLY DISTRIBUTION
SUPPLY SIDE
FUSE BOX
LOAD SIDE
COLOUR CODE
A-BLACK
B-WHITE
C-RED
D-YELLOW
E-GREEN
F-BLUE
G-GREY
H-BROWN
J-VIOLET
K-ORANGE
P-PINK
BATT. SUPPLY (ALTERNATOR) (C5)
IGNITION SUPPLY (D3)
MAIN LINE SW TR-58 (G1.50)
H/L LAMP HI BEAM RELAY TR-C (P1.50)
H/L LAMP LO BEAM RELAY TR-C (F1.50)
HAZARD WARNING SW TR-49 (EB1.50)
DIODE D2
DIODE D1
HORN/ENGINE
FLASHER
STOP/REVERSE
GAUGES
WIPER
H/L LO LH
H/L LO RH
H/L HI LH
H/L HI RH
FRONT FOG
PARK LH
PARK RH
HORN RELAY TR-B
HORN RELAY TR-A
PLANO SW ENGINE LMP
CAB LAMP
FLASHER TR-B
STP.LT.SW-11
REV.LT.SW
PLANO SW. (PTO)
ROTORY PUMP
BEEPER(HAND BRAKE)
BATT. ON IND
RPM METER TR-'+VE'
HAND BRK. IND.
LO AIR PR. IND.
OIL PR. IND.
H.T.S.B.UNIT TR-B
FUEL GAUGE TR-B
TEMP. GAUGE TR-B
DIGITAL HOUR METER
PLANO SW WASHER
PLANO SW WIPER
WIPER MOTOR CONN TR-4
H/L LO LH / H/L LEVELLING MOTOR LH
H/L LO RH / H/L LEVELLING MOTOR RH
HEAD LAMP HI LH
HEAD LAMP HI RH
HIGH BEAM IND.
PROVISION FOR FRT FOG
PARK TAIL LH
PROVISION FOR RR FOG
PARK FRONT LH
TOP MARKER LAMP LH
PARK TAIL RH
PROVISION FOR FRT FOG
PANEL LAMP LOOP FUEL
PANEL LAMP LOOP TEMP
PANEL LAMP LOOP SPEEDO
PANEL LAMP LOOP SPEEDO
PANEL LAMP LOOP AIR-11
PANEL LAMP LOOP AIR-1
PANEL LAMP LOOP RPM
PARK FRONT RH
TOP MARKER LAMP RH
PROVISION FOR RR FOG LAMP


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CIRCUIT DETAILS FOR MOTORISED HEAD LAMP
HEAD LAMP LEVELLING MOTOR POWER SUPPLY RELAY
HEAD LAMP LEVELLING SWITCH
H/L LEVELLING MOTOR RH
H/L LEVELLING MOTOR LH
VALID FOR 24V VEHICLE
VALID FOR 12V VEHICLE
-VE
H5
H
F1.50
BF1.50
H1.50
1-E2
6-B6
2-D3
12V P/S FROM BATTERY C1.50
COMBI SW TR-56b F1.50
F-6 (L) H/L LO RH F1.50
F-7 (L) H/L LO LH F1.50
R0
R1
R2
COLOUR CODE
A-BLACK
B-WHITE
C-RED
D-YELLOW
E-GREEN
F-BLUE
G-GREY
H-BROWN
J-VIOLET
K-ORANGE
P-PINK




REAR FOG LAMP SW – CIRCUIT DIAGRAM

| COLOUR CODE |
|---|
| A-BLACK |
| B-WHITE |
| C-RED |
| D-YELLOW |
| E-GREEN |
| F-BLUE |
| G-GREY |
| H-BROWN |
| J-VIOLET |
| K-ORANGE |
| P-PINK |

## KEY CODES:-

1. AB1.50 = A IS MAIN COLOUR, B IS SUBSIDIARY COLOUR AND 1.50 IS THE CROSS SECTION OF WIRE IN SQ MM
2. UN-SPECIFIED CROSS SECTION OF WIRE IS 0.50 SQ MM
3. SYMBOL (4-A2) REPRESENTS - FOR ALL OTHER DETAILS REFER SH.NO.-4 ZONE A2
4. SYMBOL [2] REPRESENTS TERMINAL-2
5. SYMBOL —( REPRESENTS FEMALE CONN.
6. SYMBOL —O REPRESENTS MALE CONN.
7. [SM] INDICATES STARTER MOTOR.
8. [ALT] INDICATES ALTERNATOR.
9. SYMBOL (-VE) REPRESENTS BATTERY NEGATIVE.
10. BATTERY CKT.SHOWN IN DOTTED LINE IS VALID FOR 24V SYSTEM.
11. FUSE RATING SHOWN IN BKT. ARE VALID FOR 12V SYSTEM OTHERWISE VALID FOR 24V SYSTEM.
12. SYMBOL ⏚ REPRESENTS CHASSIS GROUND.

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