

ELECTRICAL SYSTEM SPECIFICATIONS 1

7.0000

ELECTRICAL SYSTEM SPECIFICATIONS

CHARGING SYSTEMS

GENERATOR	LUCAS CA45 PV6 (Ventilated)
Nominal Voltage.....	12
Cutting in Speed.....	1300 RPM (Maximum)
At Gen Volts.....	13
Maximum Continuous Output.....	25 Amp
At RPM.....	2050 (Maximum)
At Gen Volts.....	13.5
On Resistance Load.....	0.54 Ohms
Field Resistance.....	6.0 Ohms
Brush Spring Pressures.....	567-794 gm (20-28 ozs)
Replace Brushes At.....	8.73 mm (11/32")
REGULATOR/CONTROLLER	LUCAS RB310 (Current Voltage)
Air Gap Setting.....	
Voltage Regulator Setting Gauge.....	.46 mm (.018")
Current Regulator Setting Gauge.....	.46 mm (.018")
Voltage Regulator Bi-Metal Thickness.....	.30 mm (.012")
Open-Circuit Voltage Setting.....	
0-25°C (32-77°F).....	15.0-15.5 Volt
26-40°C (79-104°F).....	14.75-15.2 Volt
At Gen Speed.....	3000 RPM
Current Setting at 4000 RPM.....	25 Amps ± 1
Cut-Out Setting.....	
Cutting-in Voltage.....	12.7-13.3 Volts
Drop-off Voltage.....	9.5-11.0 Volts
Maximum Open-Circuit Setting.....	16.2 Volts @ 4500 RPM
GENERATOR	LUCAS C45 P-6 (Non-Ventilated)
Nominal Voltage.....	12
Cutting-in Speed.....	1300 RPM (Maximum)
At Gen Volts.....	13
Maximum Continuous Output.....	13 Amp } (Test Amps, Cold:)
At RPM.....	1640 (Maximum) } (25 at 2050 RPM)
At Gen Volts.....	13.5
On Resistance Load.....	1.04 Ohms
Field Resistance.....	6.0 Ohms
Brush Spring Pressures.....	567-794 gm (20-28 ozs)
Replace Brushes At.....	8.73 mm (11/32")
REGULATOR/CONTROLLER	LUCAS RB108 (Compensated Voltage)
Air Gap Setting.....	
Voltage Regulator Setting Gauge.....	.48-.56 mm (.019"-.022")
Cut-Out Gap (Stop Arm and Tongue).....	.63-1.02 mm (.025"-.040")
Cut-Out Contact Gap.....	.25-.51 mm (.010"-.020")
Open-Circuit Voltage Setting.....	
At 3000 RPM.....	16.0-16.3 Volts
At 4500 RPM.....	17.1 Volts
Cut-Out Settings.....	
Cutting-in Voltage.....	12.7-13.3 Volts
Drop-off Voltage.....	8.5-11.0 Volts
Resistance Values at 20°C (68°F).....	
Carbon Type Resistor.....	60-75 Ohms
Wire Wound Type Resistor.....	55-65 Ohms
Shunt Winding Resistance.....	50-56 Ohms

ELECTRICAL SYSTEM SPECIFICATIONS 2

GENERATOR	LUCAS C40L
Nominal Voltage	12
Cutting-in Speed	1350 RPM (Maximum)
At Gen Volts	13
Maximum Continuous Output	25 Amp
At RPM	2275 (Maximum)
At Gen Volts	13.5
On Resistance Load	0.54 Ohms
Field Resistance	5.9 Ohms
Brush Spring Pressures	850-370 gms (30-13 ozs)
Replace Brushes At	7.14 mm (9/32")
REGULATOR/CONTROLLER	LUCAS RB 340
Air Gap Setting	1.37 ± .05 mm
Voltage Regulator	(.054" ± .002")
Current Regulator	1.37 ± .05 mm
Cut-Out Relay	(.054" ± .002")
Setting Limits in Service	1.02 ± .127 mm
	(.040" ± .005")

Ambient Temperature	O.C. Voltage Checking	If Between (Volts)	Reset to (Volts)
0-25°C (32-77°F)	14.5-15.5	14.0-14.5 15.5-16.0	14.5 15.5
26-40°C (78-104°F)	14.25-15.25	13.75-14.25 15.25-15.75	14.25 15.25

SETTING FOR REPAIRED UNITS

If the original O.C. setting has been disturbed or if the contacts have been serviced, the regulator should be re-set 'Cold' to the following figure for each corresponding ambient temperature range:-

Ambient Temperature	O.C. Voltage Re-set
0-25°C (32-77°F)	14.75
26-40°C (78-104°F)	14.5

Note:

Adjustment should be completed within 30 seconds, otherwise heating of the shunt winding will cause a false setting to be made.

ELECTRICAL SETTINGS

Voltage Regulator	14.5-15.5 @ 3000 RPM
O.C. Volts at 20°C	
Current Regulator	25 ± 1 Amps @ 4500 RPM
Setting Amps	
Cut-Out	
Cut-in Voltage	12.7-13.3 Volts
Drop-Off Voltage	9.5-11.0 Volts

GENERATOR	LUCAS CA40A
Nominal Voltage	12
Cutting-in Speed	1100 RPM (Maximum)
At Gen Volts	13.0

ELECTRICAL SYSTEM SPECIFICATIONS 3

Maximum Continuous Output	11 Amp
At RPM	1700 (Maximum)
At Gen Volts	13.5
On Resistance Load	1.23 Ohms
Field Resistance	6.0 Ohms
Brush Spring Pressures.....	850-370 gm (30-13 ozs)
Replace Brushes At.....	7.14 mm (9/32")
REGULATOR/CONTROLLER	LUCAS RB108
Air Gap Setting	
Voltage Regulator Setting Gauge	.48-.56 mm (.019"- .022")
Cut-Out Gap (Stop Arm and Tongue).....	.63-1.02 mm (.025"- .040")
Cut-Out Contact Gap.....	.25-.51 mm (.010"- .020")
Open-Circuit Voltage Setting	
At 3000 RPM.....	16.0-16.3 Volts
At 4500 RPM.....	17.1 Volts
Cut-Out Settings	
Cutting-in Voltage.....	12.7-13.5 Volts
Drop-Off Voltage	8.5-11.0 Volts
Resistance Values at 20°C (68°F)	
Carbon Type Resistor.....	60-75 Ohms
Wire Wound Type Resistor	55-65 Ohms
Shunt Winding Resistance	50-56 Ohms
GENERATOR.....	CAV GL 45-12-4M
Nominal Voltage	12
Cutting-in Speed	1100 RPM
Maximum Output (Enclosed)	20 Amps @ 13.5 Volts
Maximum Output (Ventilated)	25 Amps @ 13.5 Volts
Maximum Load Speed (Enclosed)	1480 RPM (13.5 Volts)
Maximum Load Speed (Ventilated)	1600 RPM (13.5 Volts)
Field Resistance	5.4 ± 5% Ohms
Maximum Permissible Speed	5000 RPM
Brush Spring Tension.....	770-940 gms (27-33 ozs)
Replace Brushes At.....	10.7 mm (0.42")
REGULATOR/CONTROLLER	CAV 6GC
Air Gap Setting	
Voltage Regulator Setting Gauge	0.45 mm (0.018")
Current Regulator Setting Gauge	0.53 mm (0.021")
Voltage Regulator Bi-Metal Thickness.....	0.3 mm (0.012")
Open Circuit Voltage Setting (20°C)	
With Normal Speed Enclosed Generator.....	14.0-14.5 Volt
Current Setting	20 Amps + 0 - 1
At Gen Speed.....	3000 RPM
Open Circuit Voltage Setting (20°C)	
With Ventilated Generator.....	14.0-14.5 Volt
Current Setting	25 Amps + 0 - 1
At Gen Speed.....	3000 RPM
Cut-Out Settings	
Cutting-In Voltage	13.0-13.5 Volts
Drop-Off Voltage	9.5-11.0 Volts
Maximum Open Circuit Setting	16.2 Volts @ 4500 RPM
Resistor Values	
Contacts Resistor	100 ± 5 Ohms (ORANGE)
Field Parallel Resistor.....	40 ± 4 Ohms (YELLOW)
Shunt Windings at 20°C	
Voltage Regulator	103-115 Ohms
Cut-Out Relay	58-65 Ohms

ELECTRICAL SYSTEM SPECIFICATIONS 4

GENERATOR	CAV GL-45-24-7E (Enclosed)
Nominal Voltage	24
Cutting-in Speed	1150 RPM
Maximum Output	15 Amps @ 27 Volts
Maximum Load Speed	1550 RPM (27 Volts)
Field Resistance	15.4 $\pm$ 5% Ohms
Maximum Permissible Speed	5000 RPM
Brush Spring Tension	770-940 gms (27-33 ozs)
Replace Brushes At	10.7 mm (0.42")
REGULATOR/CONTROLLER	CAV 6GC
Air Gap Settings	
Voltage Regulator Setting Gauge	0.66 mm (0.026")
Current Regulator Setting Gauge	0.66 mm (0.026")
Voltage Regulator Bi-Metal Thickness	0.25 mm (0.010")
Open Circuit Voltage Setting (20°C)	
With Normal Speed Enclosed Generator	28-28.5 Volts
Current Setting	15 Amps $\pm$ 0
At Gen Speed	3000 RPM
Cut-Out Settings	
Cutting-In Voltage	26.5-27.0 Volts
Drop-Off Voltage	19.0-23.0 Volts
Maximum Open Circuit Setting	31.0 Volts @ 4500 RPM
Resistor Values	
Contacts Resistor	240 $\pm$ 12 Ohms (BLUE)
Field Parallel Resistor	40 $\pm$ 4 Ohms (YELLOW)
Swamp Resistor	30 $\pm$ 1.5 Ohms (GREEN)
Shunt Windings at 20°C	
Voltage Regulator	103-115 Ohms
Cut-Out Relay	58-65 Ohms
ALTERNATOR	CAV AC5-12
Nominal Voltage	12
Cutting-In Speed	1125 RPM
Maximum Output (Hot)	55 Amps @ 13.5 Volts
Field Resistance	3.2 Ohms $\pm$ 5%
Maximum Permissible Speed	10,000 RPM
Brush Spring Tension	227 gm (8 ozs)
Replace Brushes At	7.94 mm (0.32")
Slip Rings	
Maximum Eccentricity	0.05 mm (0.002")
Minimum Diameter	28.85 mm (1.136")
REGULATOR	CAV 440/12/2
ALTERNATOR	CAV AC5-24
Nominal Voltage	24
Cutting-In Speed	1125 RPM
Maximum Output (Hot)	31 Amps @ 27.5 Volts
Field Resistance	9.6 Ohms $\pm$ 5%
Maximum Permissible Speed	10,000 RPM
Brush Spring Tension	227 gm (8 ozs)
Replace Brushes At	7.94 mm (0.32")
Slip Rings	
Maximum Eccentricity	0.05 mm (0.002")
Minimum Diameter	28.85 mm (1.136")
REGULATOR	CAV 440/24/2

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ALTERNATOR	LUCAS 17ACR
Nominal Voltage	12
Cutting-In Speed	1550 RPM (Maximum)
Earth Polarity	Negative
Nominal d.c. Output (Hot)	36 Amps @ 14V and 6000 RPM
Alternator Controlled Voltage	13.6-14.4V
(Measured across battery terminals with alternator current stabilised below 10 Amp)	
Maximum Permissible Speed	15,000 RPM
Field Resistance	4.2 Ohms
Brush Spring Pressure	255-368 gms (9-13 ozs)
Replace Brushes At	8 mm (5/16")

REGULATOR	LUCAS 8TR
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ALTERNATOR	AC Delco DN 460
Nominal Voltage	12
Earth Polarity	Negative
Cold Output	24 Amps @ 2000 RPM and 13.5V
Hot Output	35 Amps
Field Resistance	2.65-2.95 Ohms
Replace Brushes At	5.08 mm (0.2")
Slip Ring Diameter	21.95 mm (0.864") Minimum

SOLENOID SHUTDOWN

SHUTDOWN SOLENOID	CAV 263A-25
Voltage	12
Rating	Continuous
Pull In Winding Coil	0.45 Ohms at 27 Amps
Hold In Winding Coil	9.2 Ohms at 1.3 Amps
Contact Gap	1.27-1.78 mm (0.05-0.07 ins)

SHUTDOWN SOLENOID	CAV 263A-23
Voltage	24
Rating	Continuous
Pull In Winding Coil	1.3 Ohms at 18.5 Amps
Hold In Winding Coil	39 Ohms at 0.6 Amps
Contact Gap	1.27-1.78 mm (0.05-0.07 ins)

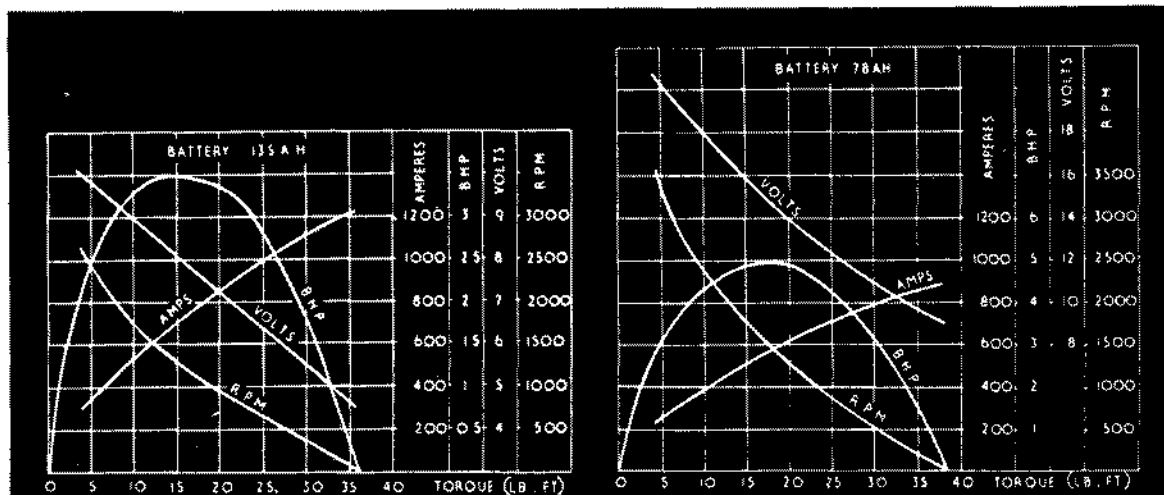
SHUTDOWN SOLENOID	Synchro-Start 1500 Series
Rated Voltage	24V D.C.
Pull Current	11 Amps
Hold Current	0.2 Amps
Pull Rating	2.724 Kg at 19 mm at rated voltage & 23°C
	(6 lb at ¾ in at rated voltage & 73°F)
Hold Rating	6.81 Kg at rated voltage & 23°C (15 lb at rated voltage & 73°F)
Duty Cycle	Continuous
Operations/Minute	Consult Factory If Energised More Than Six Times Per Minute
Weight	454 gms (1 lb) (Approx)

STARTER MOTORS

STARTER	CAV CA45 'D' & 'F'
Type	Co-Axial
Voltage	12 or 24 d.c.

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Wiring.....	Insulated or Earth Return
Mounting.....	Flange
Rotation.....	Clockwise or Anticlockwise
Net Weight.....	14.5 Kg
Brush Spring Tension.....	2.7-3.4 Kg (6-7.5 lb)
Brush Length (New).....	24 mm (12V), 19 mm (24V)
	12 mm (0.5 ins) Minimum



Output curves of 12 volt Starter

Output curves of 24 volt Starter

STARTER	LUCAS M50
Voltage.....	12
Lock Torque Test	
Min. Torque.....	45.4 Nm (33.5 lb ft)
Max. Current.....	1165 Amps
Terminal Volts.....	5.0
Running Torque at 1000 RPM	
Min. Torque.....	20.9 Nm (15.4 lb ft)
Max. Current.....	670 Amps
Terminal Volts.....	8.0
Light Running Test	
Max. Current.....	115 Amps
Speed.....	5500-8000 RPM
Min. Pressure on New Brush.....	11.68 N (42 oz f.)
Brush Length to be Replaced.....	8.0 mm (0.313 ins)

STARTER	Delco Remy MT
Voltage.....	12

NO LOAD TEST

TYPE	PART NUMBER	VOLTS	MIN AMPS	MAX AMPS	MIN RPM	MAX RPM
30 MT	1113202	9.0	50 *	70 *	3500	5500
35 MT	1113637	11.6	85 *	125 *	5900	8100
40 MT	1114084	11.5	90 *	130 *	5600	7600

* Includes Solenoid

WINDINGS

TYPE	SWITCH MODEL	RATED VOLTAGE	CURRENT CONSUMPTION			
			BOTH WINDINGS		HOLD-IN WINDINGS	
			AMPS	VOLTS	AMPS	VOLTS
30 MT	1115510	12	26-29	5	18-20	10
35 MT	1119885	12	70.4-77.8	10	18-20	10
40 MT	1119879	12	65.3-73.3	10	12.7-14.3	10

POWER GENERATORS

ALTERNATOR

Markon 410 x (220)
Markon 410 y (330)

Ratings			220G	330G
50 Hz	Standby Output	KW	27	41
		KVA	34	51.5
	Continuous Output	KW	25	38
		KVA	31.25	47.5
60 Hz	Standby Output	KW	32	50
		KVA	40	62.5
	Continuous Output	KW	30	44
		KVA	37.5	55

Air Gap Between Rotor and Stator

Engine	Main	Exciter
220 cu in	0.025" Nominal	0.025" (0.018" Minimum)
330 cu in	0.042" Nominal	0.025" (0.018" Minimum)

OUTPUT FOR THREE PHASE ALTERNATORS

$$\text{KILOWATTS} = \frac{1.73 \times \text{Volts} \times \text{Amps} \times \text{PF}}{1000}$$

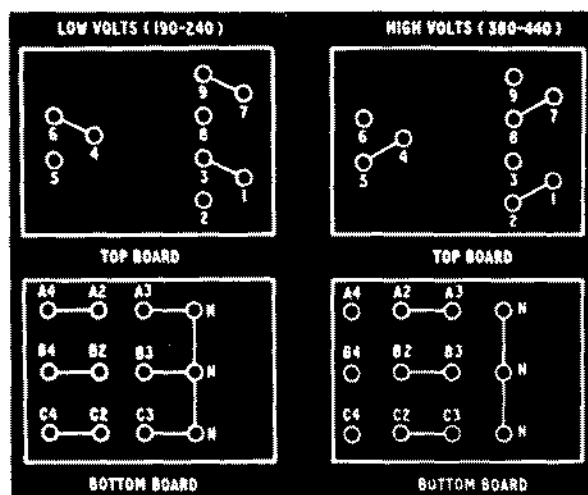
$$\text{AMPS} = \frac{\text{Kilowatts} \times 1000}{1.73 \times \text{Volts} \times \text{PF}}$$

$$\text{POWER FACTOR} = \frac{\text{KW}}{\text{KVA}}$$

$$\text{KVA} = \frac{\text{AMPS} \times \text{VOLTS} \times 1.73}{1000}$$

ELECTRICAL SYSTEM SPECIFICATIONS 8

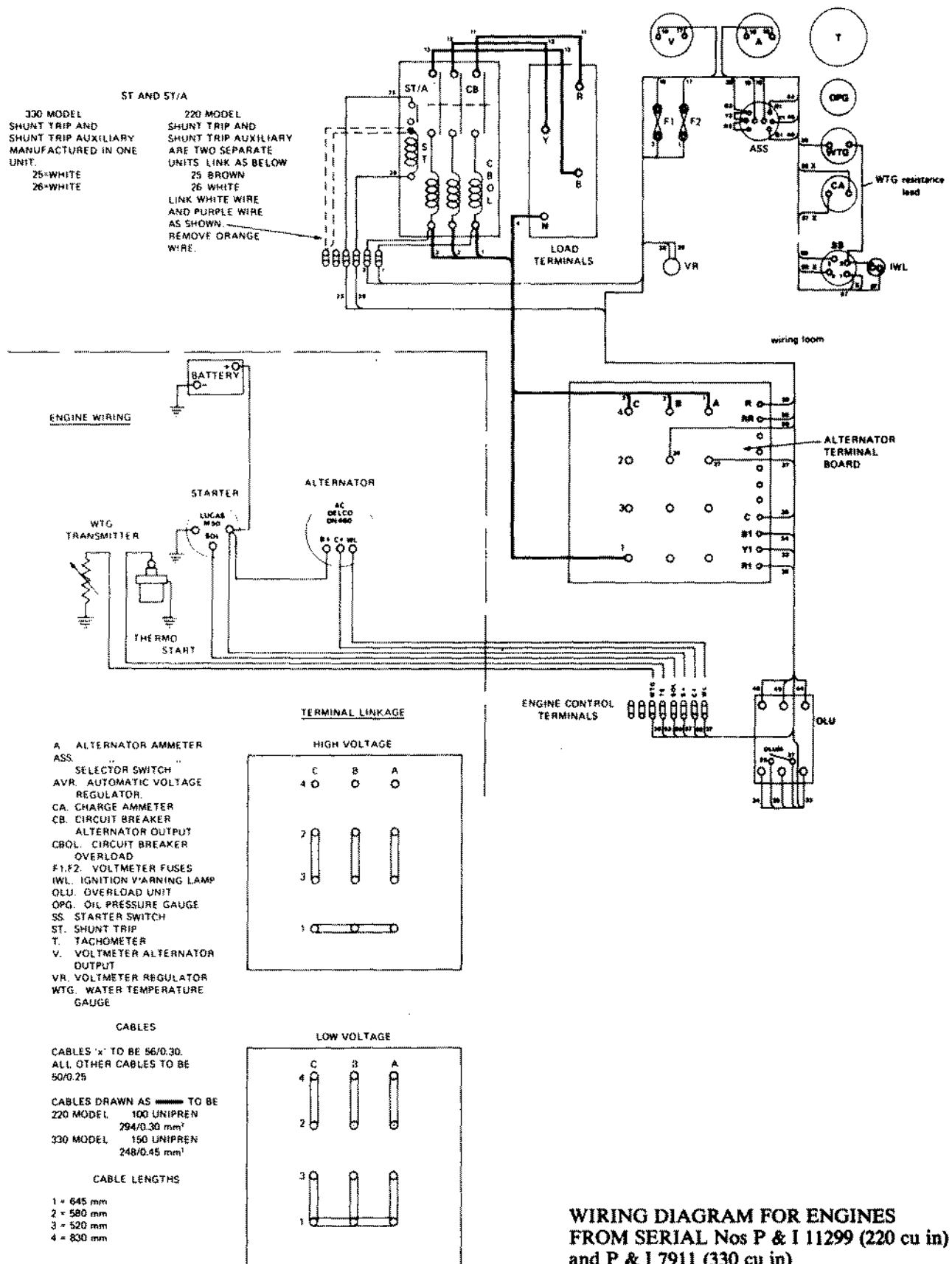
Terminal Link Diagrams For Frequency & Voltage Selections



Oil Dashpot Overload Settings

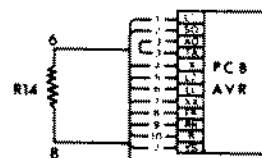
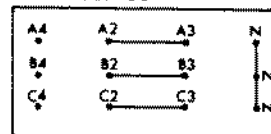
MODEL	KVL (Standby)	VL (Volts)	FLC (Amps)	CT Ratio	O/L Setting Current (Amps)
220G	40	480	48	100:5	4.8
	10	416	55.5		5.4
	40	203	111		5.4
	40	240	95		4.8
	34	380	51.5		5.1
	34	440	44.5		4.4
	34	220	89		4.4
	34	190	103		5.1
330G	62.5	480	75	150:5	5.0
	62.5	416	86		5.4
	62.5	208	173		5.4
	62.5	240	150		5.0
	51.5	380	78.5		5.2
	51.5	440	68		4.5
	51.5	220	135		4.5
	51.5	190	156		5.2

WIRING DIAGRAMS 1

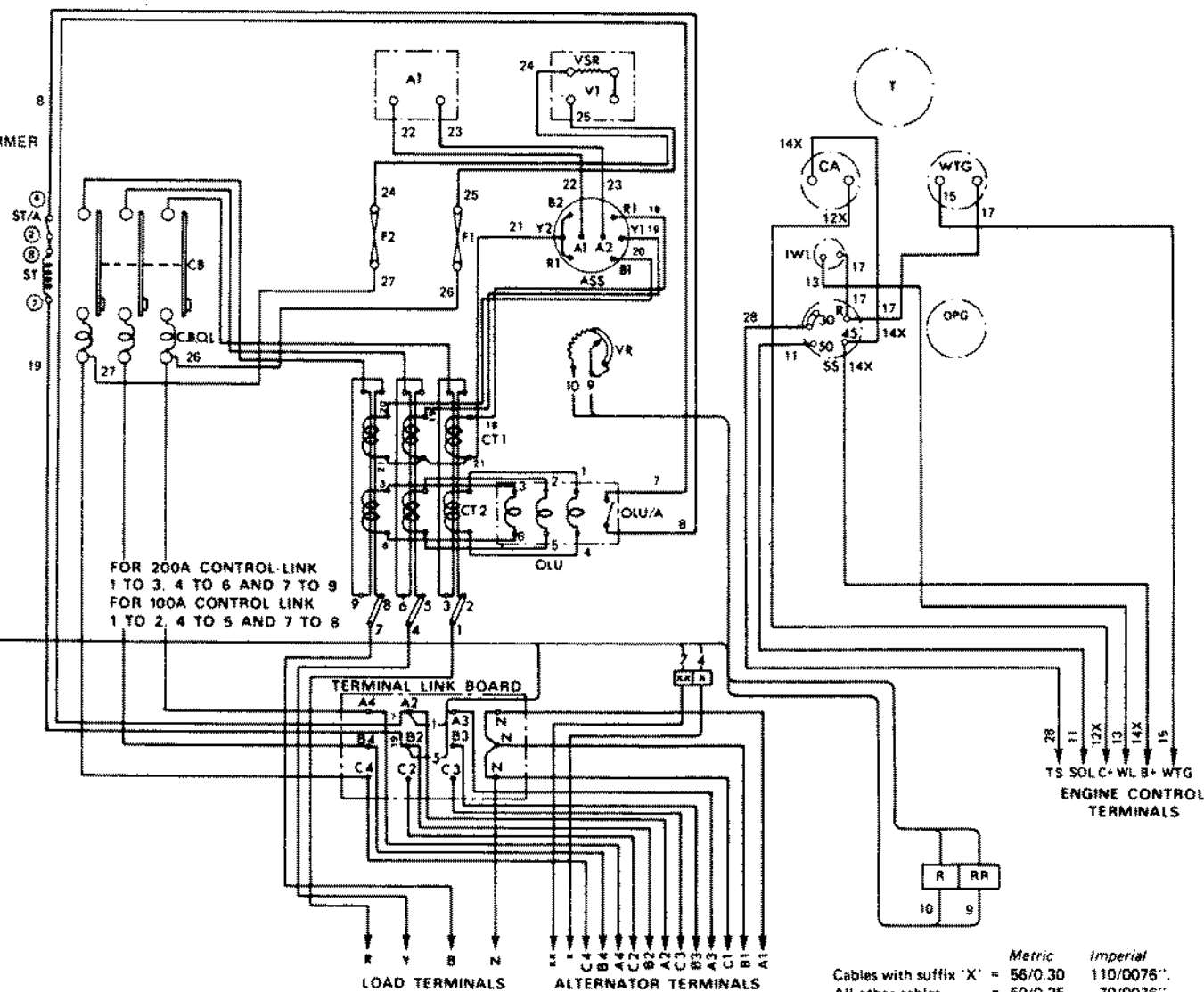
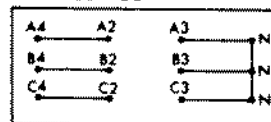


LEGEND

AL	ALTERNATOR AMMETER
CB	ALTERNATOR OUTPUT CIRCUIT BREAKER
CBOL	ALTERNATOR OUTPUT CIRCUIT BREAKER OVER LOAD
CT1	AMMETER CURRENT TRANSFORMER
CT2	OLU CURRENT TRANSFORMER
CA	CHARGE AMMETER
F1-F2	VOLTMETER FUSES
IWL	IGNITION WARNING LAMP
ASS	AMMETER SELECTOR SWITCH
OLU	OVERLOAD UNIT
OPG	OIL PRESSURE GAUGE
SS	STARTER SWITCH
ST	SHUNT TRIP
T	TACHOMETER
VR	VARIABLE RESISTANCE
*VI	ALTERNATOR VOLTmeter
VSR	ALTERNATOR VOLTmeter SERIES RESISTANCE
WTG	WATER TEMPERATURE GAUGE
R14	FEED BACK RESISTANCE

TERMINAL LINKAGE
HIGH VOLTAGE

LOW VOLTAGE



WIRING DIAGRAM FOR ENGINES PRIOR TO
SERIAL NUMBERS P & I 11299 (220 cu in)
and P & I 7911 (330 cu in)

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SECTION 8

CLUTCH SYSTEM

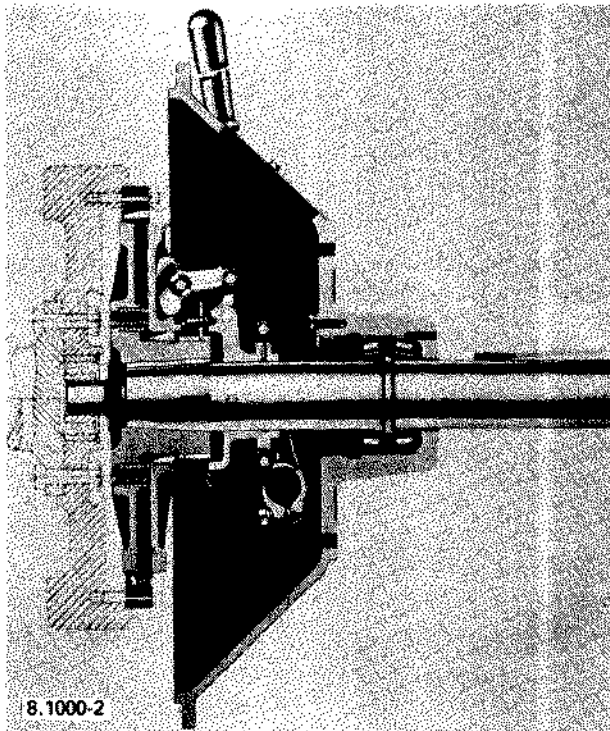
Contents

Power Take-Off Overcentre Clutch	8.1000
Automotive Clutch	8.1000A
Clutch Fork & Release Bearings	8.1100
Clutch System Specifications	8.0000

8.1000

POWER TAKE-OFF OVERCENTRE CLUTCH**POWER TAKE-OFF OVERCENTRE CLUTCH (DESCRIPTION)**

1. Power Take-Offs consist of a housing assembly and a clutch unit assembly, the former being attached to the engine crankcase whilst the latter is mounted on the power take-off shaft; additionally, the clutch unit incorporates a drive ring which is bolted to the flywheel.
2. The clutch operating lever is carried on a cross-shaft running through the housing and to which a clutch withdrawal yoke is keyed; the yoke is secured by two bolts and is formed with two jaws which engage the release-bearing trunnions.

**HOUSING ASSEMBLY**

3. The power take-off shaft is supported in the housing assembly and runs in two tapered roller bearings which are kept in position by a bearing retainer; the latter part is formed with slots in order that it may be screwed in or out to adjust the bearings and give correct end-float to the shaft, it is secured against vibration by a lockplate which engages on to the slots. (In some cases it will be found that the bearings are contained within a bearing-housing which is bolted to the clutch housing). Annular grooves formed in the bore of the housing and of the bearing retained, prevent the egress of lubricant from the bearing housing when the shaft is revolving.

4. Two grease nipples are located on the outside of the clutch housing, one being screwed in and serving the main bearings with lubricant, whilst the other is secured by a circlip and serves the clutch release bearing through a flexible tube. A further grease nipple is screwed into the end of the shaft for the purpose of lubricating the pilot bearing in the flywheel; for convenience this nipple may be fitted in place of a screwed plug part-way along the shaft, and the plug fitted in the nipple's original position.
5. Access to the interior of the clutch, and to the adjusting ring in particular, is permitted by the removal of an inspection cover which is secured by two screws.

CLUTCH-UNIT ASSEMBLY

6. The inner end of the power take-off shaft is tapered to carry the body of the clutch-unit which is keyed into position and secured by a nut and a lock-washer. Splines are formed on the body to receive a pressure plate carrying three pins upon which release levers are mounted, the levers being counter-balanced to offset the effects of centrifugal force, which might otherwise tend to disengage the clutch: each release lever carries an anti-rattle spring which reacts against the pressure plate to eliminate any "shake" which may be present. (In the instance of Twin Plate Clutches, four release levers are fitted and also an intermediate pressure plate is used). The heels of the release levers are arranged to contact the inner face of an adjusting ring which is secured on to the clutch body.
7. Torque transmission is effected through a facing member which is supplied for replacement in three sections and, when the clutch is engaged, is clamped between the pressure plate and the flange of the clutch body; the facing sections are formed with gear teeth which engage with corresponding teeth on the inside diameter of the clutch drive ring. (With Twin Plate Clutches, two sets of facings are used, one being interposed between the pressure plate and the intermediate pressure plate whilst the other is between the latter part and the clutch body).
8. As the facing member wears, the clamping action will become less positive; in order to avoid clutch slip, therefore, it will be necessary periodically to compensate for this wear by screwing the adjusting ring further on to the body. Positive adjustment is ensured by an automatic locking device comprising a pinion which is loaded by a Belleville washer and mounted on a rivet in the adjusting ring. The pinion engages the splines on the clutch body and is able to rotate as the adjusting ring is turned; at the conclusion of adjustment the pinion is locked by the loading of the Belleville washer and prevents the adjusting ring from slackening itself off.

RELEASE BEARING

9. A release sleeve is mounted on the shaft, beyond the clutch body, and is formed with a flange encircled by the two halves of a release bearing which are held by two bolts fitted with self-locking nuts; a trunnion is formed upon each half of the release bearing to engage the jaws of the release yoke; the

POWER TAKE-OFF OVERCENTRE CLUTCH 2

sleeve is connected to the release levers by means of links fitted in pairs.

OPERATION

10. When the operating handle is moved to engage the clutch, the release sleeve moves inwards and the links cause the release levers to pivot about the pins on which they are mounted, thus displacing the pressure plate inwards. Continued movement of the release sleeve causes the inner ends of the links to move "over-centre" (ie further inwards than the outer ends), which positively clamps the facing member between the pressure plate and clutch body. The engine torque is now transmitted to the power take-off shaft via the drive ring, the facing member and the clutch body. Upon moving the handle to disengage the clutch, the pressure plate is displaced away from the facing member by the action of the release levers and by four springs assembled between the plate and the clutch body; the torque transmission is thus discontinued. It is important that the clutch is engaged at low engine RPM, 800-1000 RPM, if maximum life is to be obtained from the facings.

POWER TAKE-OFF OVERCENTRE CLUTCH (REMOVAL)

11. Withdraw the driving pulley or gear from the end of the shaft.
12. Engage clutch to ensure simultaneous withdrawal of the facing sections.
13. Remove the bolts securing the clutch housing to the crankcase from the engine.
14. Remove the drive ring from the flywheel.

POWER TAKE-OFF OVERCENTRE CLUTCH (INSPECTION AND OVERHAUL)

15. The exploded view of the single plate clutch shown below, 8.1000-15, can be used as a guide when

dismantling the power take-off, the double plate clutch is similar.

16. Move the operating lever to disengage the clutch, withdraw the facing sections and remove the lever from the cross-shaft.

17. After the clutch has been in use for some time, the facings should present a polished appearance through which the grain of the material is clearly visible. If small quantities of lubricant have contacted the facings, they will present a darker appearance due to burning of the lubricant, consequent upon the heat generated during engagement. Provided that the grain of the facing material remains clearly distinguishable, the clutch will continue to yield a satisfactory performance.

18. If an excessive amount of lubricant has fouled the facings they may be glazed with a thin carbon deposit which obliterates the grain of the material. The lubricant may be only partially burned, and in this case a resinous deposit will be apparent, the effect of which is undesirable.

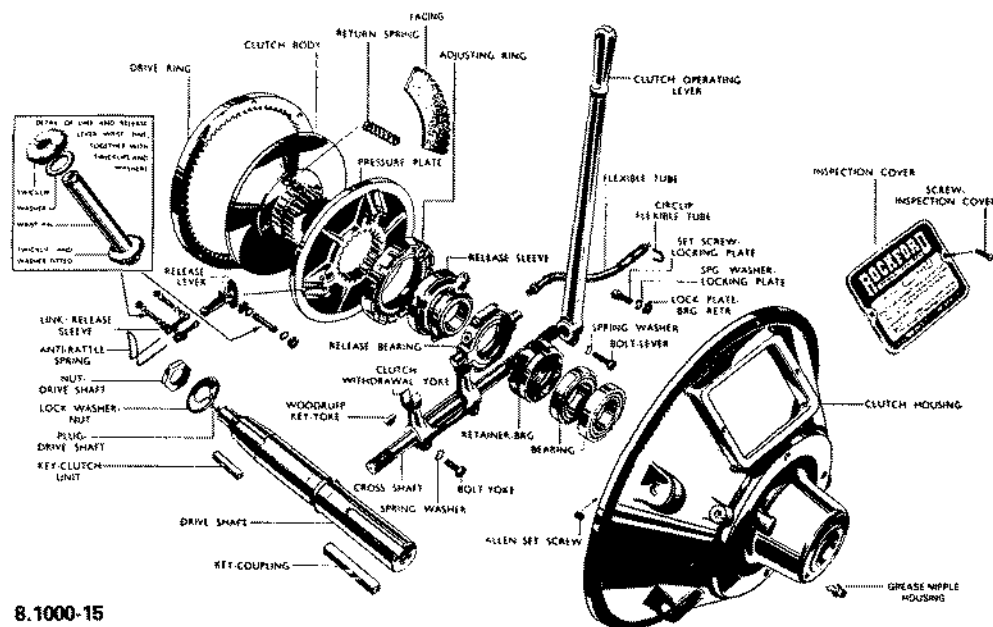
19. An even greater quantity of lubricant will blacken the facings, and the torque-transmitting capacity of the clutch will diminish.

20. In all cases where excessive fouling of the facings has occurred, renewal will be necessary and the presence of lubricant must be determined and remedied.

21. It is unlikely that the teeth of the facings will be worn, but they should nevertheless be subjected to careful inspection.

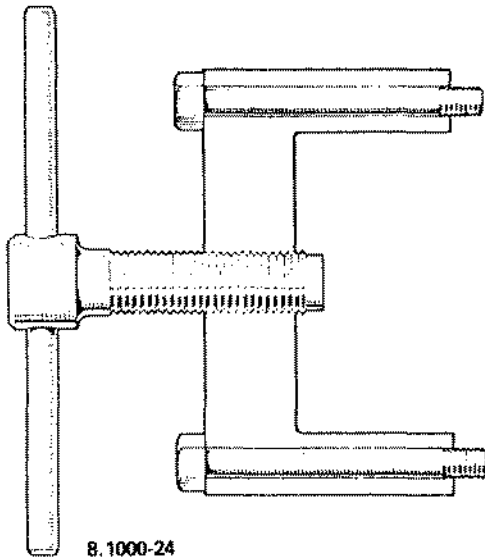
22. If any one section of a facing is faulty, all three sections must be renewed.

23. Remove the inspection cover and disconnect the flexible hose (where applicable) by removing the circlip at the outer end and unscrewing the union at the inner end (in some cases it will also be necessary to release a locking clip inside the housing).



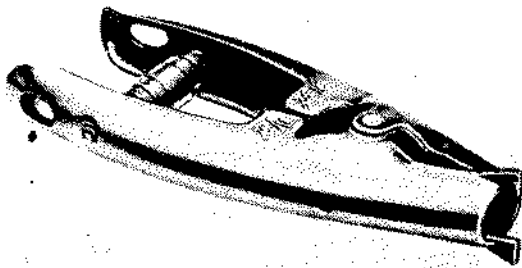
POWER TAKE-OFF OVERCENTRE CLUTCH 3

24. Remove the nut and lockwasher, and extract the clutch unit from the power take-off shaft. This can be achieved by attaching the clutch withdrawal tool to the two threaded holes (0.50 ins BSF) in the forward face of the clutch assembly and then turning the puller screw to loosen the clutch assembly.

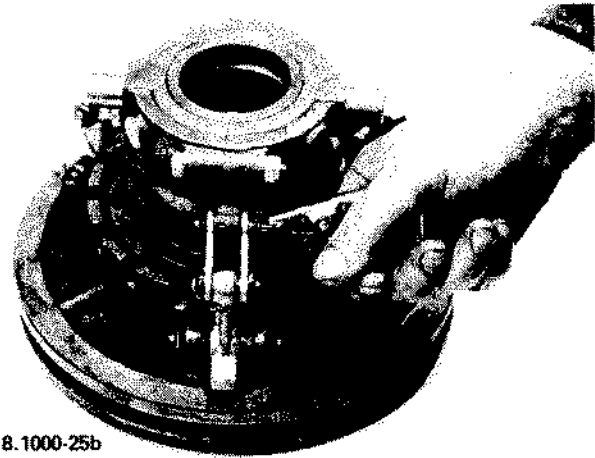


8.1000-24

25. Remove one Twicklip, using the special Twicklip pliers shown below (or snap ring, if fitted) from each of the wrist pins, expel the pins and separate the release levers, the links and the release sleeve. Unscrew the self-locking nuts from the release bearing bolts and separate the halves of the bearing.



8.1000-25a



8.1000-25b

26. Unscrew the adjusting ring from the clutch body, slide off the pressure plate and, where applicable, the intermediate pressure plate, and remove the four return springs.

27. Slacken the release-yoke clamping bolts, slide the yoke clear of the Woodruff keys, remove the keys from the cross-shaft and push the shaft out of the housing.

28. Remove the key from the outer end of the power take-off shaft, unscrew the bearing retainer and expel the shaft and its bearings, using a hide-faced mallet. Drive the bearing off the shaft, remembering that they are prevented from moving in one direction by a shoulder on the shaft. The cup of one bearing may, in all probability, remain in the housing, and its removal may be effected by tapping metal rods inserted through holes in the outer end of the housing.

29. Immediately prior to assembly, lightly smear with grease the jaws of the withdrawal yoke, the bores of the cross-shaft bosses in the clutch housing, the wrist pins, the heels of the release levers and the inner contact surfaces of the links. The recommended lubricant is a high melting-point grease.

RECOMMENDED LUBRICANTS UNITED KINGDOM

The following high melting point greases are suggested as being suitable. The order in which they are listed does not imply any preference. This list does not imply approval by General Motors Limited or constitute a complete list of available products which are suitable.

BP	CASTROL	DUCKHAMS	ESSO	GULF	MOBIL	REGENT	SHELL
Ener-Grease L.2	Castrol-ease LM	LB 10 Grease	Esso Multi-Purpose Grease H	Gulfsil Grease G.64 A-2	Mobil-Grease MP	Marfac Multi-Purpose 2	Retinax A

Or GM 4733-M specification

POWER TAKE-OFF OVERCENTRE CLUTCH 4

HOUSING ASSEMBLY

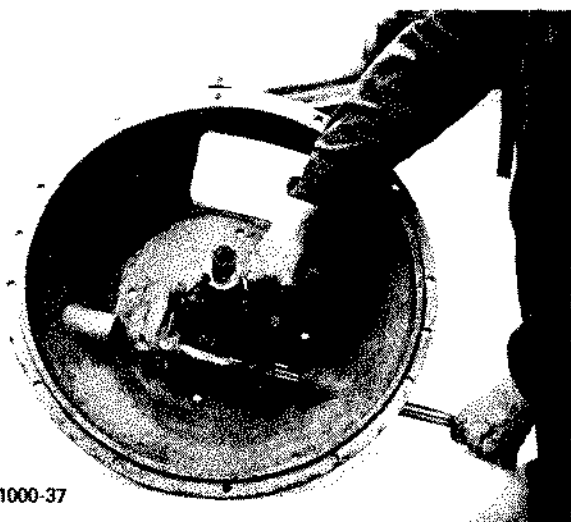
30. Ensure that the socket headed grub screw is fitted inside the clutch-housing to blank-off the longitudinal channel through which the main bearings are lubricated (this grub screw is not used if the bearing-housing is a separate part). The bearing-housing, if applicable, is to be securely attached to the clutch-housing by setscrews, each of which is fitted with a spring washer.

31. Fit the rear tapered-roller bearing cup in the clutch housing or bearing-housing ensuring that it is square and firmly home.

32. Press the roller and cone assemblies into position against the spacing shoulder, ensuring that they are perfectly square against the shoulder. At this stage, apply the suggested grease in the space between the bearings. When lubricating, the object is to use a quantity of grease sufficient to ensure that the clutch will not run dry and overheat (causing possible seizure of the bearings); on the other hand, the use of too great a quantity would lead to a greasy clutch with resultant slip. The aim should be to have the whole of the space inside the bearing housing filled to no more than two-thirds of its capacity; whilst this cannot be measured, overpacking should be avoided as it would cause overheating; the rule should be to apply a little grease and often to the bearings, with only the slightest trace of leakage when the clutch is running.

33. Assemble the shaft and bearings in the housing, followed by the forward roller bearing cup which must be inserted into the bore squarely and true; lightly tap the cup until the bearing retainer can be engaged in the threads. Screw up the retainer, by means of the slots provided, until the end-float of the shaft has been reduced to approximately 1.3 mm (0.05 ins).

34. Attach a clock indicator to the flange of the clutch housing so that the plunger of the indicator is in contact with the face of the pilot-end of the shaft.



8.1000-37

35. Whilst slowly revolving the shaft, screw up the bearing retainer until the 1.3 mm (0.05 ins) end-float has been reduced to 0.13 mm/0.18 mm (0.005/0.007 ins).

36. Remove the clock indicator and strike the outer end of the shaft with a hide-faced mallet to ensure that the forward cup is in register with the bearing retainer; re-check the end-float and make any slight adjustment that may be necessary. Fit the locking plate inside the housing to secure the bearing retainer, using a spring washer, on the setscrew (if the locking plate is of the type which incorporates a clip for securing the flexible tube, it should not be fitted until a later stage).

37. Hold the withdrawal yoke inside the housing (as shown in 8.1000-37) with the clamp bolts facing outwards, and push the cross-shaft through the housing and the yoke, fitting two Woodruff keys. Ensure that the yoke is centrally disposed and tighten the clamp bolts.

CLUTCH UNIT

38. Lay the clutch body on the bench, with the splines uppermost, and, if applicable, locate the intermediate pressure plate upon it (the flat side facing downwards); fit the four return springs in the pockets and slide the pressure plate on to the body, flat face first. Screw the adjusting ring on to the body, exercising the utmost caution when the pinion engages the splines; the setting of the adjusting ring will be performed after the clutch has been attached to the engine.

39. Fit the anti-rattle springs on the release levers, position the levers within the lugs on the pressure plate so that the web on each faces outwards, and fit the wrist pins; fit the Twicklip or, if applicable, the circlips (note that if the former are used they must be fitted with the round-section washers before being attached to the wrist pins). Attach a pair of links to each release lever, again using wrist pins together with the Twicklips and washer or, if applicable, the circlips (note that the enlarged ends of the links are to point inwards).

40. Place the halves of the release bearing around the release sleeve and secure with the bolts and self-locking nuts. Offer up the release sleeve to the links, fit the wrist pins, and secure with the Twicklips and washers or, if applicable, the circlips.

41. Fit the facing segments between the pressure plate and the clutch body; in the case of a Twin plate clutch, the first set of facings is fitted between the body and the intermediate pressure plate, whilst the second set is fitted between the intermediate pressure plate and the main pressure plate. Locate the drive ring over the facings, so that the teeth are correctly engaged, and place blocks beneath the ring to support it in that position.

42. Press down upon the release bearing to engage the clutch; the drive ring may now be removed and the facing segments will remain firmly gripped between the pressure plate and the clutch body.

43. Screw the flexible tube or the grease nipple (whichever is applicable) into the release bearing.

NOTE. On the later clutches, a shakeproof washer is fitted at the threaded end of the tube.

POWER TAKE-OFF OVERCENTRE CLUTCH 5

ASSEMBLING THE CLUTCH UNIT TO THE SHAFT

44. Offer up the clutch unit to the power take-off shaft, with the keyways aligned and with the release bearing trunnions engaging the jaws of the withdrawal yoke; the bearing is to be located so that the boss into which the flexible tube is screwed is on the same side as the inspection hole in the clutch housing; if a grease nipple is fitted on the bearing trunnion it is to be on the same side as the smaller hole at the side of the housing. Fit the key, the lock-washer and the nut, securely tighten the nut to 238-245 Nm (175-180 lbs/ft) torque and set the lockwasher.

45. Pass the outer end of the flexible tube through the appropriate hole in the housing, and secure with the circlip; if applicable, fit the tube locking clip inside the housing.

POWER TAKE-OFF OVERCENTRE CLUTCH (REFITTING)

46. Assemble the drive ring to the flywheel.

47. Offer up the clutch and Power Take-off assembly to the crankcase and tighten the securing bolts.

48. Fit the grease nipple which serves the main bearing and if the bearings have not been removed during overhaul lubricate them as described previously.

49. Fit the operating lever at the most suitable angle on the cross-shaft and secure by tightening the clamp bolt.

50. Adjust the clutch as follows:-

Turn the adjusting ring in the required direction, using a tommy-bar, until torque transmitting capacity is obtained without incurring excessive hand loads at the operating lever (in most applications, 25 kgm (55 lbs) hand load will be found adequate). The adjusting ring should be stiff to operate, on no account is lubricant to be applied to the pinion.

51. In some applications a socket screw is fitted in the adjusting ring to provide an additional lock. It must be unscrewed before adjustment is made, and re-tightened after adjustment, ensuring that it engages in a tooth space and not on the crest of the threads.

52. Regular attention to clutch adjustment is necessary to obviate the onset of clutch slip. The time interval between checks will depend upon the application and usage of the clutch. Failure to maintain the clutch in correct adjustment may lead to serious damage.

53. Fit the inspection cover.

54. Disengage the clutch and check that the power take-off shaft will rotate easily by hand without showing any binding tendencies.

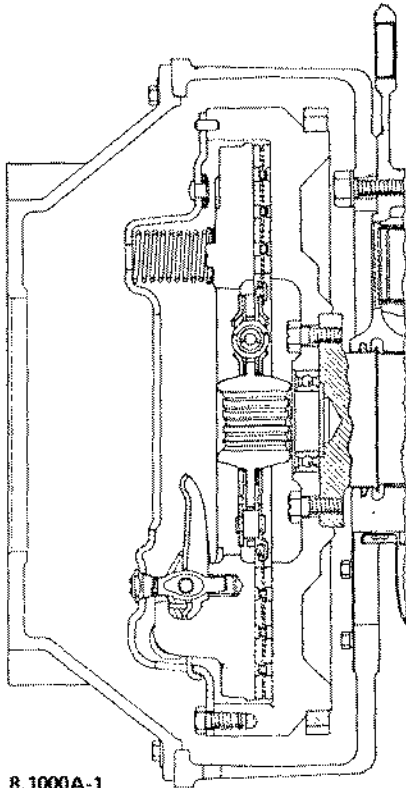
55. Install the driving pulley or gear.

8.1000A

AUTOMOTIVE CLUTCH

AUTOMOTIVE CLUTCH (DESCRIPTION)

1. The clutch is a Borg and Beck multiple coil spring dry plate type, bolted to the flywheel and enclosed in a detachable housing bolted to the flywheel housing. The clutch is operated by a pedal through a push rod, clutch fork and release bearing.



2. The clutch used on 220 cu in engines is 10 inches, while the clutch used on 330 cu in engines is 12 or 13 inches.

3. The clutch assembly comprises two main units, a pressure plate and cover assembly and a disc assembly. The driving pressure is provided by coil springs located between the pressure plate and cover which are connected by four drive straps. Four levers are incorporated for clutch release, and pivot on pins passing through adjustable eye bolts. The levers are fitted with anti-rattle springs. The disc plate has riveted friction facings cushioned by spring steel segments and the splined hub is spring-loaded by coil type and damper springs.

AUTOMOTIVE CLUTCH (REMOVAL)

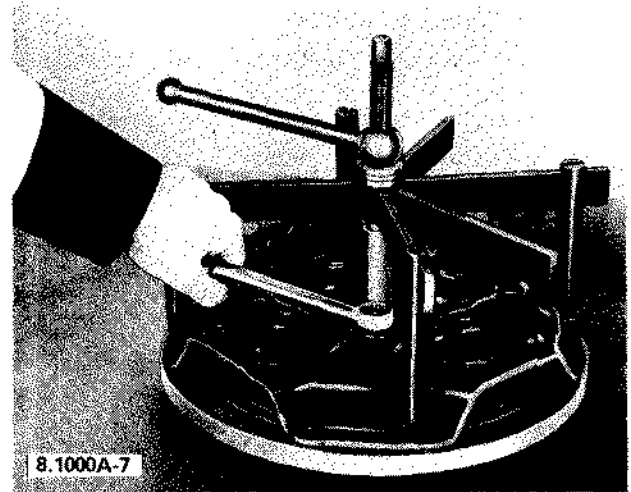
4. Remove the clutch housing, fork and release bearing as described under section 8.1100.

5. Remove the eight bolts and washers securing the clutch assembly to the flywheel and withdraw the clutch assembly together with the disc assembly from the locating dowels.

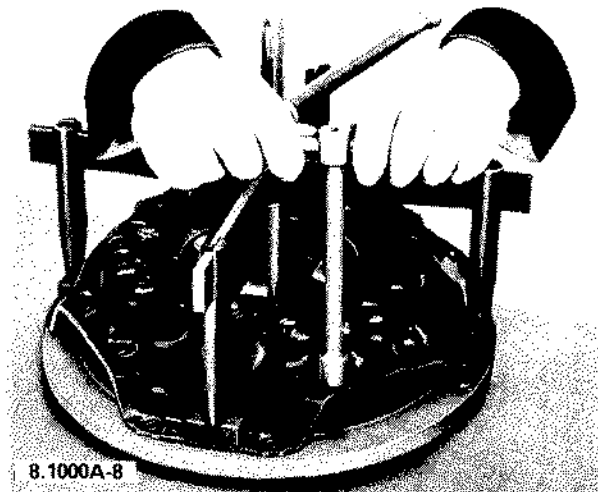
AUTOMOTIVE CLUTCH (INSPECTION AND OVERHAUL)

6. Mark the clutch cover and pressure plate so that they can be reassembled in the original relative position, if neither has to be renewed.

7. Using a clutch jig, compress the thrust springs and unscrew the eye bolt nuts.



8. Remove the four bolts securing the drive straps.

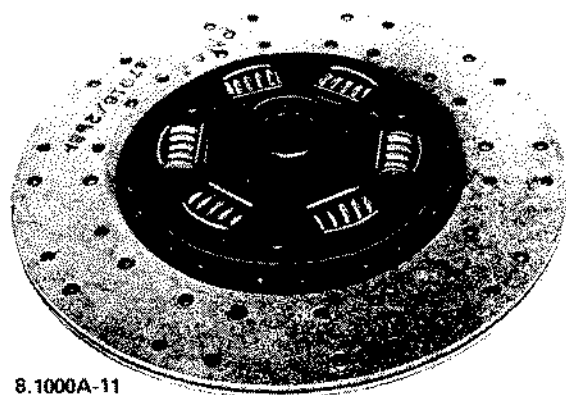


9. Release the pressure on the clutch cover. Lift off the cover, and remove the springs, struts, release levers and eye bolts.

10. Check the disc hub springs for slackness, and the friction facings for wear.

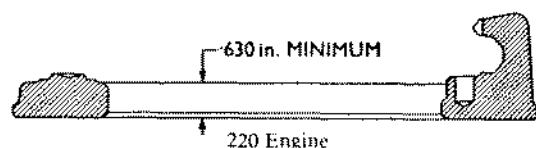
11. When renewing friction facings do not shear the rivets with a chisel as this may distort the clutch disc segments. The rivets should be drilled, using a 7/64 ins diameter drill, sufficiently to allow them to be punched out without distorting the segments. Carefully rivet a facing to each side of the segments, inserting the rivets so that the heads of each radial pair run alternately on each side of the disc.

AUTOMOTIVE CLUTCH 2

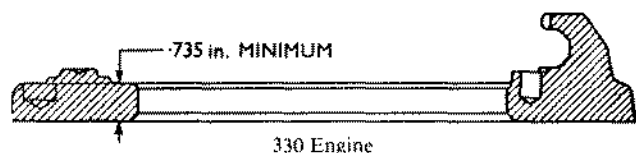


8.1000A-11

12. Check the friction surface of the pressure plate for wear or scores, scores on the friction surface of the pressure plate can be removed by grinding, provided the plate thickness after machining is not less than the specified thickness. Thickness must be checked at the position indicated at various points around the plate.



220 Engine



330 Engine

8.1000A-12

13. Check the rate of the thrust springs from the following table:

THRUST SPRINGS

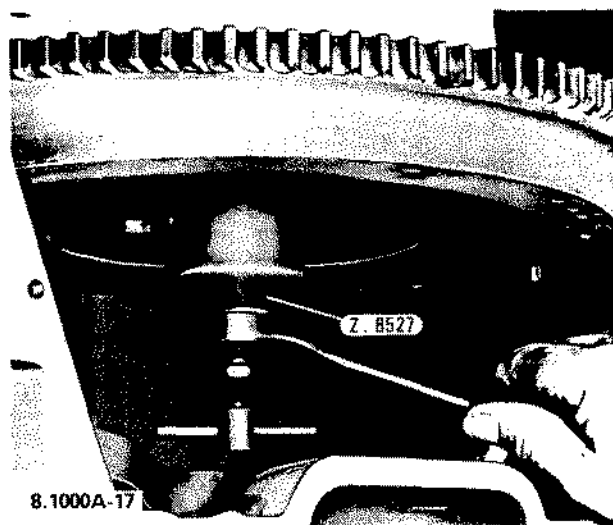
TYPE 10 AS	— Colour Code — Black
	— Assembled Height — 42.86 mm (1 ¹¹ / ₁₆ ")
	— Load at Assembled Height — 68.1-72.64 Kg (150-160 lb)
TYPE 12 AS	— Colour Code — Cream
	— Assembled Height — 42.86 mm (1 ¹¹ / ₁₆ ")
	— Load at Assembled Height — 54.48-59.02 Kg (120-130 lb)
TYPE 13 AS	— Colour Code — Yellow/Light Green
	— Assembled Height — 42.86 mm (1 ¹¹ / ₁₆ ")
	— Load at Assembled Height — 61.29-65.83 Kg (135-145 lb)

14. Renew all springs if any show signs of collapse, or if there is evidence of the pressure plate having overheated.

15. Place the cover on the base of the jig to check the distortion of the attaching flange.

16. Check the spigot bearing in the crankshaft flange for roughness.

17. To renew, first withdraw the bearing, using Drag-Z8527. Ensure that the new bearing is packed with GM 4616-M or GM 4617-M grease, and install it so that the shielded side is facing away from the engine.



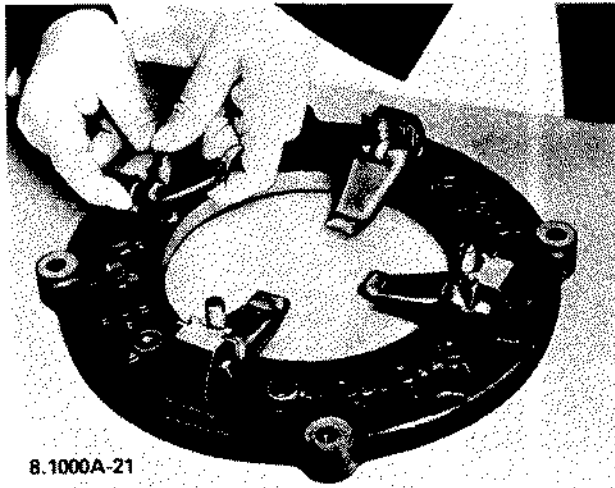
8.1000A-17

18. Check the friction surface of the flywheel for wear or scores. If necessary, remove and reface.

19. Lubricate the bearing surfaces of the release levers, eye bolts, pins and struts with the GM 4530-M grease. Use the lubricant sparingly to avoid contact with the friction facings.

20. Assemble the pin to the eye bolt and place the threaded end of the bolt through the slot in the release lever so that it rests in the lever recess.

21. Assemble each release lever and eye bolt to the pressure plate, locating the plain end of the eye bolt in the hole provided in the pressure plate.



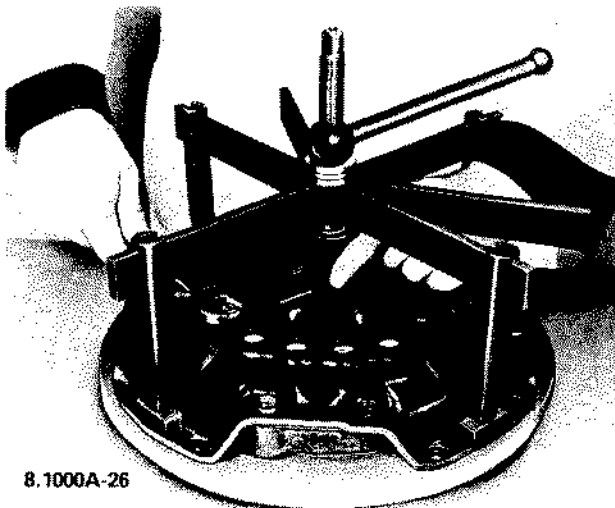
22. Raise the inner end of the lever, and insert the strut so that its lugs engage the groove in the pressure plate boss. Release the lever, making sure the eye bolt is located in the plate hole and the bottom edge of the strut located in the recess in the outer end of the lever.

23. Fit the anti-rattle spring in the holes in the clutch cover so that the spring ends are towards the centre of the cover.

24. Using the jig, complete the reassembly of the clutch, noting the points in paragraphs 25, 26, 27 and 28.

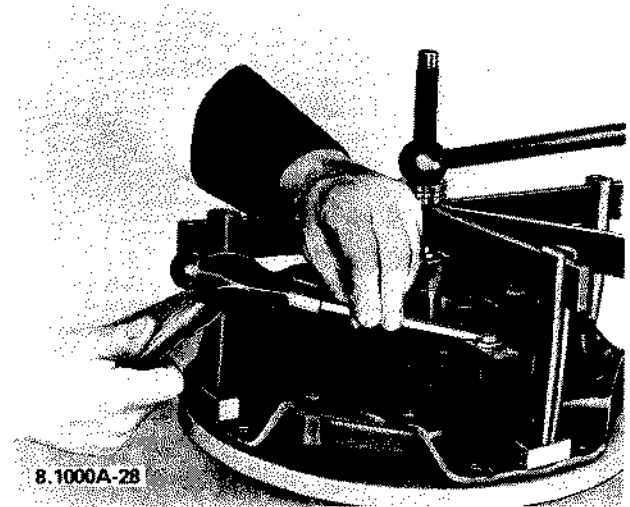
25. When reassembling the original parts, make sure that the marks made on the cover and pressure plate when disassembling, are in alignment.

26. Check and adjust the height of the release levers. Do not lock the eye bolt nuts at this stage.



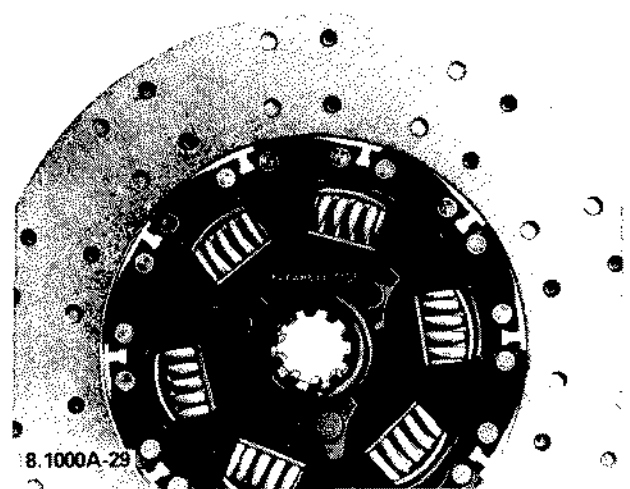
27. Operate the release levers several times so that the moving parts can settle into their working positions.

28. Make a final check of the release lever height. Adjust if necessary, then lock each eye bolt nut by staking the inner edge of the nut into each end of the eye bolt slot.



AUTOMOTIVE CLUTCH (REFITTING)

29. Install the clutch disc so that the face marked 'Flywheel Side' is towards the flywheel.



30. Before tightening the clutch cover attaching bolts, insert a clutch disc aligner through the disc hub until it engages the spigot bearing in the crankshaft. Tighten the bolts evenly to a torque of 30-37 Nm (22-27 lbs ft), then remove the shaft.

31. Refit the clutch housing, fork and release bearing as described under section 8.1100.

8.1100

CLUTCH FORK AND RELEASE BEARING

CLUTCH FORK AND RELEASE BEARING (DESCRIPTION)

1. The clutch fork pivots on a ball support mounted in the clutch housing. Housings are manufactured for both RH and LH applications. Two pins incorporated in the fork jaws engage a grooved sleeve of the release bearing which slides on the tubular extension of the transmission front cover. The bearing is of the single row ball type and is packed with lubricant and sealed during manufacture. Periodic lubrication is not required.

CLUTCH FORK AND RELEASE BEARING (REMOVAL)

2. The following procedure must be followed to remove the clutch assembly from the engine:
3. Remove the transmission.
4. Disconnect the clutch fork return spring.
5. Disconnect the clutch push rod from the pedal lever or relay lever and withdraw the rod from the fork.
6. The thrust bearing which is resting between the fork can now be removed.
7. Remove the twelve bolts and washers and withdraw the clutch housing complete with the clutch fork and ball assembly.
8. Unscrew the clutch fork and ball assembly from the housing.

CLUTCH FORK AND RELEASE BEARING (INSPECTION AND OVERHAUL)

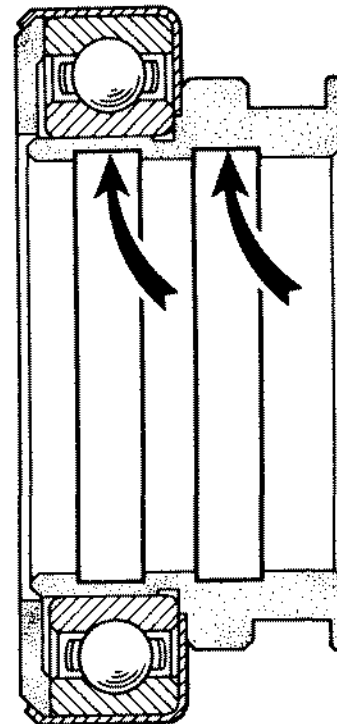
9. Inspect the ball, seating and fork jaw pins for excessive wear and replace where necessary.
10. Check the release bearing for roughness or noisy operation. The bearing is packed with lubricant during manufacture and sealed. It must not be washed in cleaning fluid or immersed in a degreasing plant, as such treatment will destroy the lubricant and render the bearing unfit for further use.

CLUTCH FORK AND RELEASE BEARING (REFITTING)

11. Screw the clutch fork and ball assembly onto the clutch housing after smearing the ball with grease, specification GM 4530-M.

12. Clean off any burrs from the faces of the clutch housing and flywheel housing before refitting the clutch housing.

13. Fill the two grooves in the release bearing, arrowed in 8.1100-13, with GM 4530-M grease and place onto the fork jaw pins.



8.1100-13

14. Reconnect the push rod to the pedal lever or relay lever.

15. Reconnect the clutch fork return spring.

16. Before installing the transmission, ensure that there are no burrs on the front cover sleeve and also smear the sleeve and the splines of the main drive pinion sparingly with grease of GM 4616-M or GM 4617-M specifications.

CLUTCH SYSTEM SPECIFICATIONS 1

8.0000

SPECIFICATIONS

Dimensions quoted are the manufacturing limits for new parts except where maximum and minimum permissible figures are given.

P.T.O. OVERCENTRE CLUTCH

Make and Type Borg & Beck 11 1/2" Single Plate
..... Borg & Beck 11 1/2" Twin Plate

CLUTCH CROSS-SHAFT

Diameter 24.73 mm (0.974 in)
Clearance in Bushes 0.13 mm (0.005 in)

RELEASE BEARING

Minimum Travel 22.35 mm (0.88 in)

TORQUE WRENCH DATA

Clutch Pedal Journal Support Pin Nut 74 Nm (55 lb ft)
Drive Shaft Nut 238-245 Nm (175-180 lb ft)

AUTOMOTIVE CLUTCH

Clutch Assembly (Make and Type)

Four Cylinder Engine Borg & Beck 10 AS Single Dry Plate
Six Cylinder Engine Borg & Beck 12 AS or 13 AS Single
Dry Plate

Clutch Disc (Type) Borglite

CLUTCH DISC

Hub Springs

	FOUR CYLINDER ENGINE	SIX CYLINDER ENGINE
Number	8	6
Identification Colour:		
Type 10 AS	4 Yellow	—
Type 12 AS	4 Blue	—
Type 13 AS	—	Light Blue
		Black

PRESSURE PLATE AND SPRINGS

Thrust Springs

	FOUR CYLINDER ENGINE	SIX CYLINDER ENGINE
Number	12	16
Assembled Height	42.86 mm (1 11/16")	42.86mm (1 11/16")
Load at Assembled Height:		
Type 10 AS	68.1-72.64 Kg (150-160 lb)	—
Type 12 AS (330 cu in engine)	—	54.48-59.02 Kg (120-130 lb)
Type 13 AS	—	61.29-65.83 Kg (135-145 lb)
Identification Colour:		
Type 10 AS	Black	—
Type 12 AS (330 cu in engine)	—	Cream
Type 13 AS	—	Yellow/ Light Green

MARCH 1980

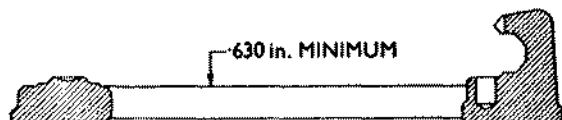
CLUTCH SYSTEM SPECIFICATIONS 2

Pressure Plate Thickness

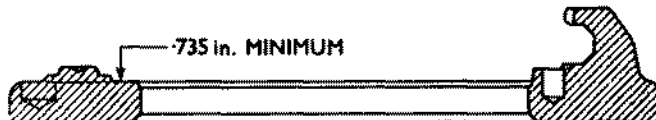
(Minimum Permissible After Refacing)	16.00 mm (.630 in)	18.68 mm (.735 in)
	Checked at several points around plate	

Release Lever Height	49.403-49.911 mm (1.945-1.965")	56.515-57.785 mm (2.225-2.275")
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Using a gauge plate 8.36-8.41 mm
(.329"-.331") thick; Lever heights
must be same within 0.381 mm (.015")



Pressure Plate Machining Limit,
Four Cylinder Engines.



Pressure Plate Machining Limit,
Six Cylinder Engines.

TORQUE WRENCH DATA

Flywheel Bolts	88-95 Nm (65-70 lb ft)
Clutch Cover to Flywheel Bolts	30-37 Nm (22-27 lb ft)

SECTION 9

TRANSMISSIONS

Contents

Hydraulic Marine Gear	9.1000
Transmission — Highway	9.4000
Transmission — Specifications	9.0000

9.1000

HYDRAULIC MARINE GEAR

A list of the marine gearboxes used on Bedford 220 and 330 cu in engines is listed below:

Borg Warner Forward & Reverse Gearboxes

71CR Direct Drive	72CR Direct Drive	73CR 2.909:1 Reduction
71CR 1.523:1 Reduction	72CR 1.523:1 Reduction	
71CR 1.91:1 Reduction	72CR 1.91:1 Reduction	
71CR 2.1:1 Reduction	72CR 2:1 Reduction	
71CR 2.57:1 Reduction	72CR 2.1:1 Reduction	
71CR 2.909:1 Reduction	72CR 2.57:1 Reduction	
	72CR 2.909:1 Reduction	

Parsons Gearboxes

DA Series	Direct Drive
HG4 Series 4/100	Direct Drive
HG4 Series 4/100	2:1 Reduction
HG4 Series 4/100	3:1 Reduction

For service and overhaul procedures covering these marine gearboxes, refer to the appropriate service manual published by the manufacturers. These can be obtained from:

Warner Gear
Division of Borg-Warner Corporation
1106 East Seymour Street
Muncie
Indiana
USA
Telephone: 317/284-8411

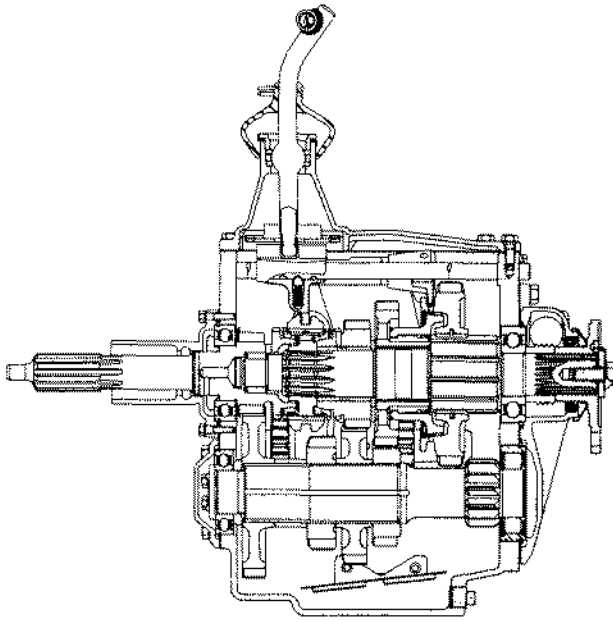
The Parsons Engineering Co. Ltd.
An Associated British Engineering Co.
Town Quay Works
Southampton
England
Telephone: Southampton 27362

9.4000

TRANSMISSION-HIGHWAY

TRANSMISSION-HIGHWAY (DESCRIPTION)

1. The transmission most used on highway applications is the Bedford four speed type.



9.4000-1

2. The Bedford four-speed transmission incorporates synchromesh engagement on second, third and fourth speeds. The rear of the main drive pinion is supported by a ball bearing in the transmission casing, and a spigot at the front end of the pinion engages a bearing in the crankshaft. The mainshaft is supported at the front by needle rollers in the main drive pinion counterbore and by a ball bearing in the rear of the transmission casing.

3. The third and fourth speed synchromesh mechanism incorporates a clutch and a hub which is splined to the mainshaft. The second speed synchromesh mechanism is incorporated in the front of the first and reverse gear. The gear houses an insert and a cone with two driving lugs for synchronizing second speed engagement. The bore of the gear is grooved to accommodate a spring damper ring and rubber compression strip.

4. The second speed gear is bushed but the third speed gear operates on a sleeve pressed on the mainshaft. The layshaft assembly is supported in the front of the transmission casing by a ball bearing and at the rear by a roller bearing. Endwise location of the layshaft is controlled by the front bearing inner

race which is clamped between a spacer on the shaft spigot and a thick washer secured by bolts. The first speed gear is integral with the layshaft, the others being keyed and pressed on the shaft.

5. The reverse idler pinion is bushed and operates on a fixed shaft pressed into the casing and secured by a spring pin.

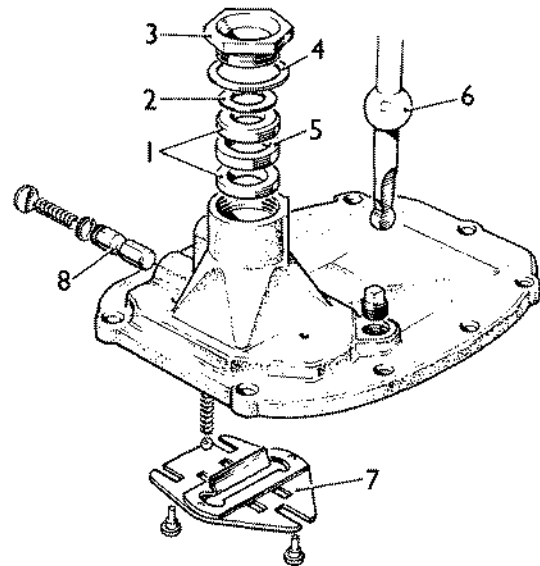
6. Striking forks and the reverse lever head operate on fixed rods in the top of the casing. Spring loaded balls, housed in the fork and reverse lever head bosses, engage slots in the rods for gear retention in the neutral and engaged positions.

7. Jaws in the reverse lever head engage the top of a reverse striking lever which pivots on an eccentric bolt in the side of the casing. The lower end of the lever engages the reverse idler pinion.

8. Individual gear selection is provided by a slotted interlock plate engaged with the forks and reverse lever head and attached to the top cover.

9. The transmission incorporates a standard SAE power take-off facing.

10. There are two types of transmission top covers, the first incorporates two ball seatings (1), a spacer (5) and washer (2). The change speed lever (6) is retained by a nut (3) which is locked by a tab washer (4).



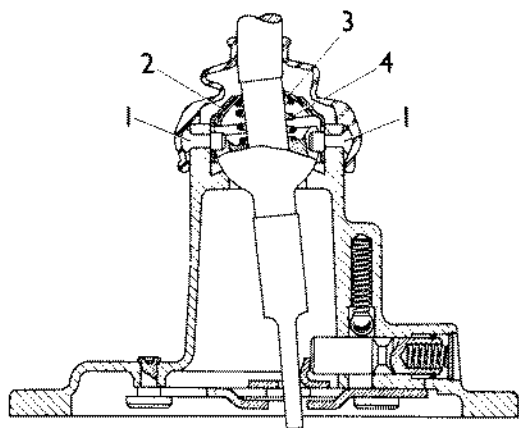
9.4000-10

11. Individual gear selection is provided by a slotted interlock plate (7) which engages the striking forks. A spring loaded plunger (8) prevents accidental engagement of reverse when forward speeds are being selected.

12. The second type of transmission top cover is similar to the first except that the turret has an integral ball seat for the gear shift lever.

TRANSMISSION — HIGHWAY 2

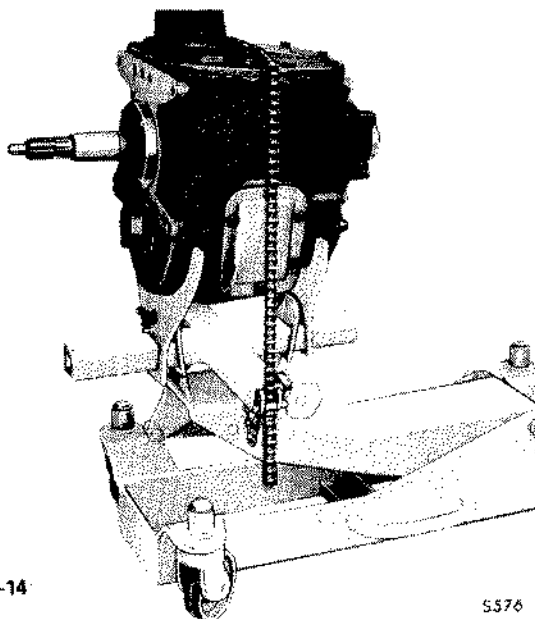
13. The half round ball on the gear shift lever is loaded against the seat by a spring (4) which is held captive by a cup (3) and bayonet retaining cap (2). The lever ball is slotted to engage two pins (1) in the cover turret which prevents rotation of the lever.



9.4000-13

TRANSMISSION-HIGHWAY (REMOVAL)

14. Due to the weight of the transmission which is approximately 66 Kg (145 lb), it is recommended that a cradle is used during removal.



9.4000-14

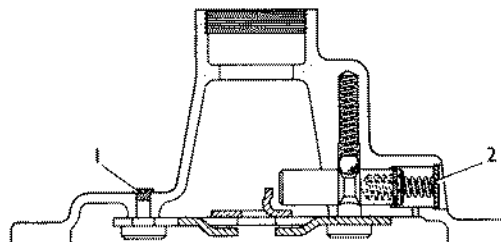
5576

15. The transmission assembly is secured to the clutch housing by three bolts, and one nut in the lower right-hand side of the clutch housing. These should be removed and the transmission lifted away on its cradle.

TRANSMISSION-HIGHWAY (INSPECTION & OVERHAUL)

16. Remove the gear shift lever, either by removing the tab washer and nut and lifting the lever clear, or by depressing and turning the retaining cap anti-clockwise and lifting the lever clear.

17. To remove the interlock plate, chisel off the ends of the pins (1). Reverse stop plunger and spring can be withdrawn after removing the expansion plug (2).

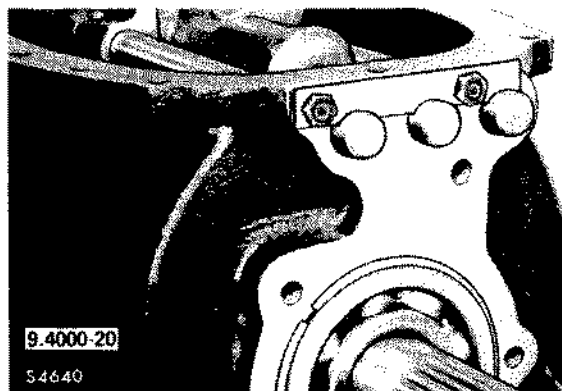


9.4000-17

18. To facilitate disassembly and reassembly of the transmission, bolt two supports to the casing lower attaching lugs.

19. Engage top and reverse gears and remove the coupling flange bolt.

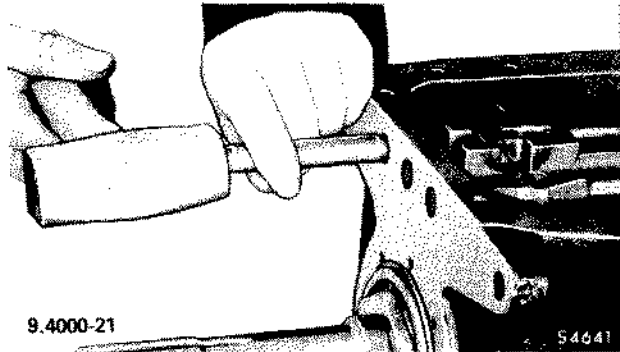
20. The striking fork rods are located in the transmission casing by a retainer bolted to the rear of the casing. Remove this retainer.



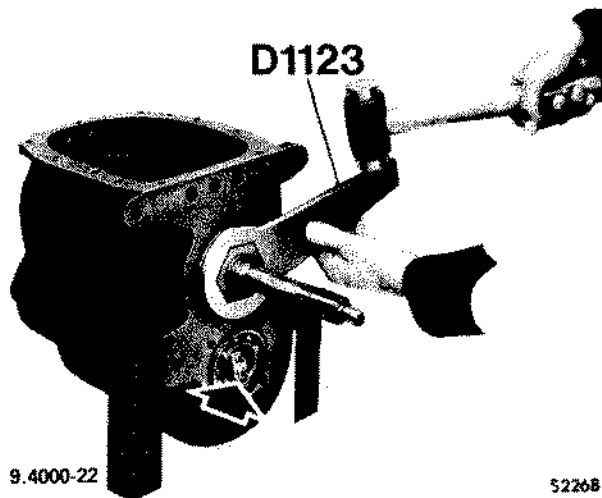
9.4000-20

54640

21. The fork rods must be driven out from the front of the casing. Care must be taken that the locking balls are not lost as the forks become detached.

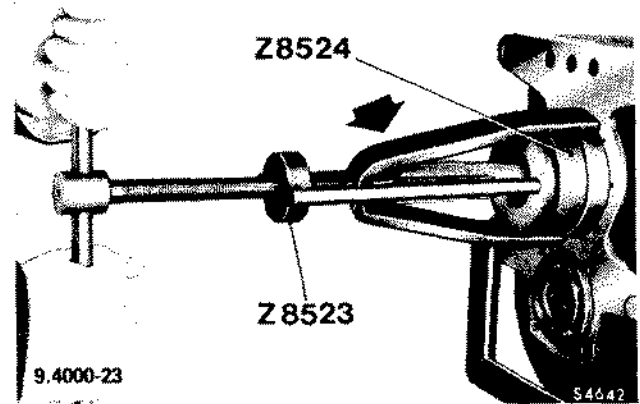


22. To facilitate removal of the pinion left hand threaded nut, and layshaft bearing retainer bolts, engage second and third gears. Use wrench D1123 to unscrew the pinion nut.

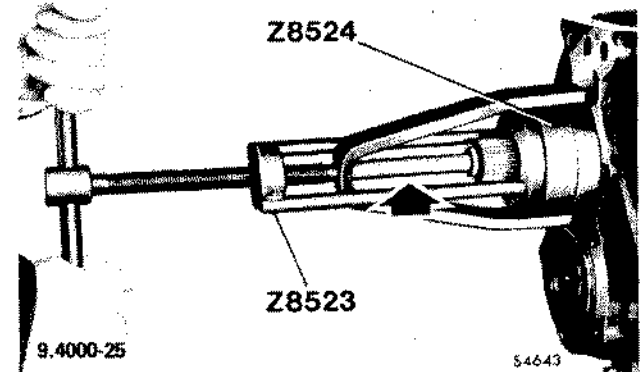


23. Next remove the main drive pinion bearing, to achieve this remove the locating ring from the outer race and assemble adaptor Z8524 to the bearing. Use remover Z8523 to withdraw the bearing off of the shaft and out of the casing. Ensure that the bridge piece (arrowed) is interposed between the remover screw and the casing to relieve the main drive pinion of end thrust.

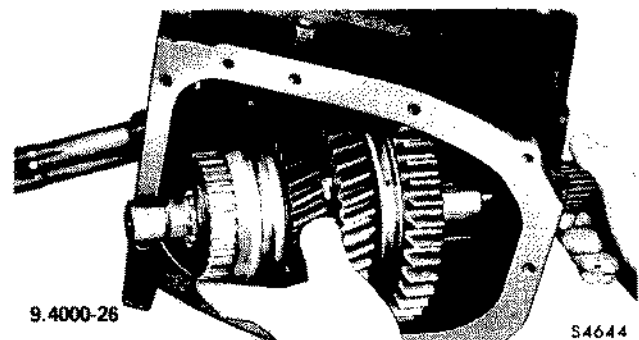
24. After removing the bearing, withdraw the oil thrower to prevent damaging it during the removal of the mainshaft.



25. The mainshaft bearing is removed in a similar manner to the main drive pinion bearing, using adaptor Z8524 and remover Z8523 together with a distance piece (arrowed) and a plug supplied with the remover.

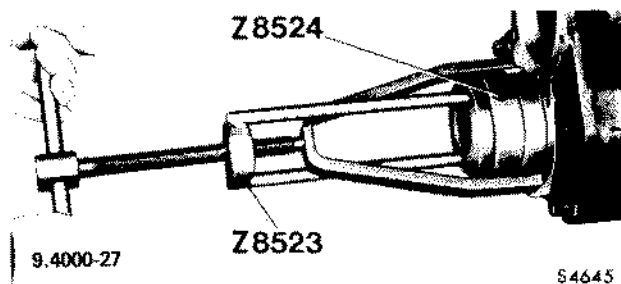


26. To facilitate the removal of the mainshaft, slide first and reverse gear forward on the mainshaft to engage the second gear. Slide the third and fourth clutch rearwards on the clutch hub to engage third gear. Lay the transmission on its side, and with the main drive pinion located as far forward as possible through the casing bore, withdraw the mainshaft assembly through the top of the casing.

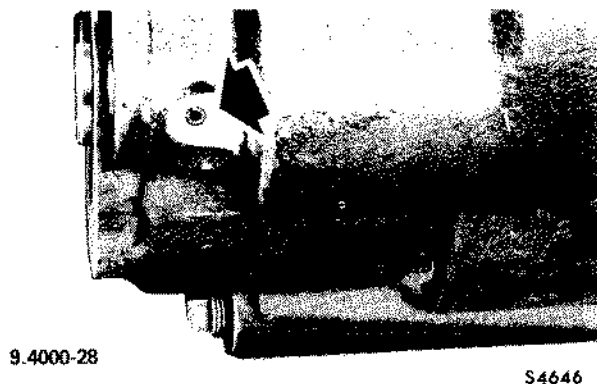


TRANSMISSION — HIGHWAY 4

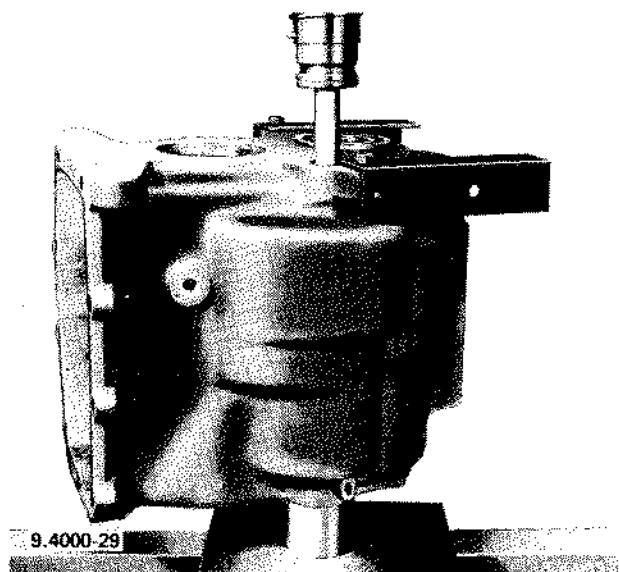
27. Use adaptor Z8524 and remover Z8523 to remove the layshaft rear bearing.



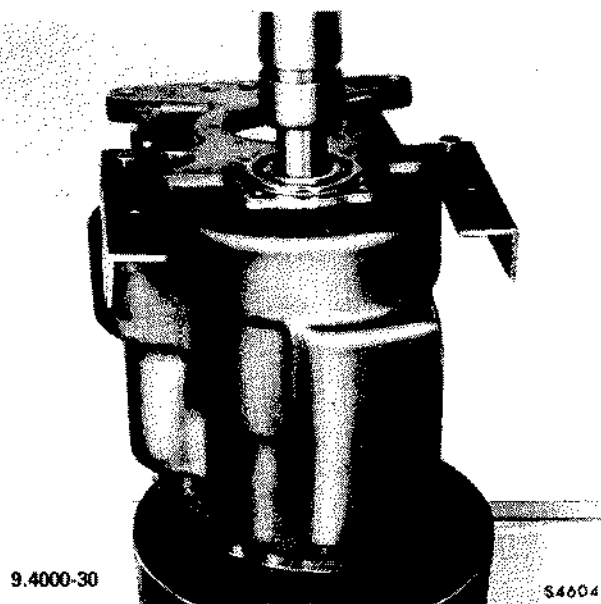
28. The reverse pinion shaft is retained in the casing by a spring pin. This pin must be driven in as far as possible so that it is contained within the pinion shaft.



29. When pressing the reverse pinion shaft out of the casing, support the rear of the casing on a sleeve.

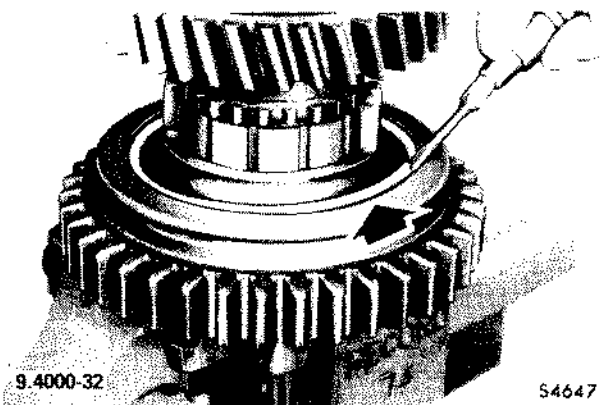


30. The layshaft gear can now be pressed out of front bearing and the assembly lifted out of the casing. The front bearings can then be tapped out from inside of the casing.

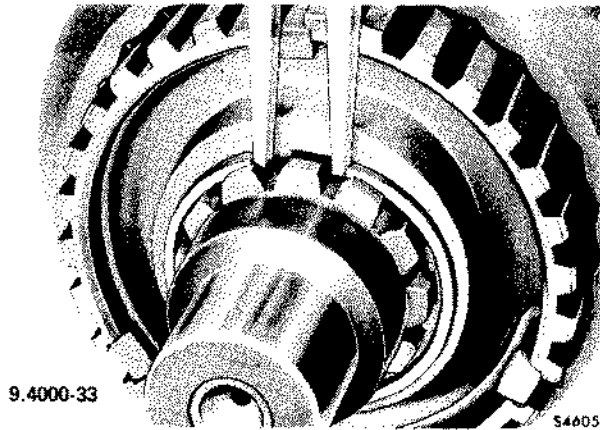


31. Before disassembling the mainshaft, mark the radial position of the third and fourth speed clutch relative to its hub, with a spot of paint. Also mark the position of the first and reverse gear splines in relation to their mating splines on the mainshaft. This will ensure that the components will be reassembled in the same relationship as before.

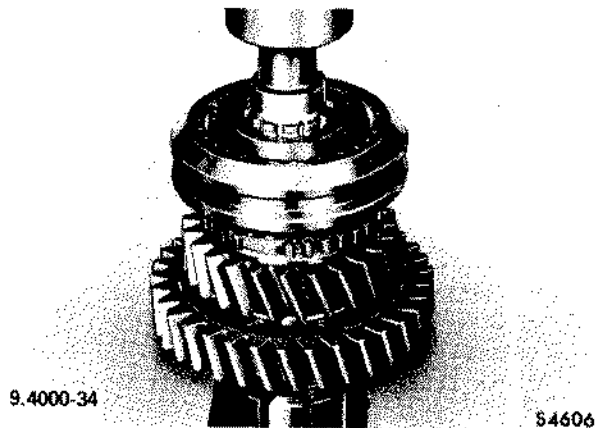
32. The first and reverse gear can be withdrawn off the mainshaft after removing the synchronizing cone retainer.



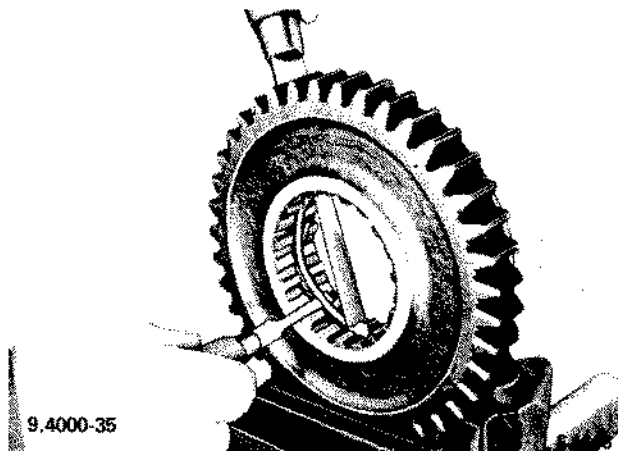
33. The third and fourth speed clutch hub is retained on the front end of the mainshaft by a retaining ring. This can be removed.



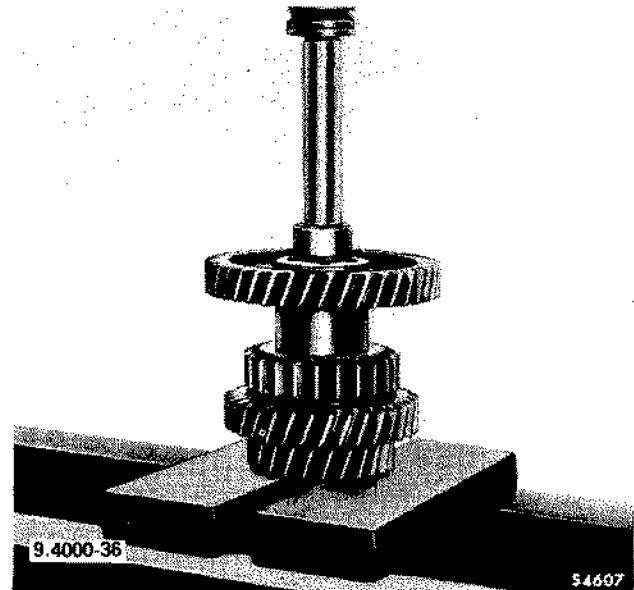
34. To press the clutch hub and third gear sleeve off the mainshaft, support the second gear on a press making sure that the synchronising springs are clear of the press.



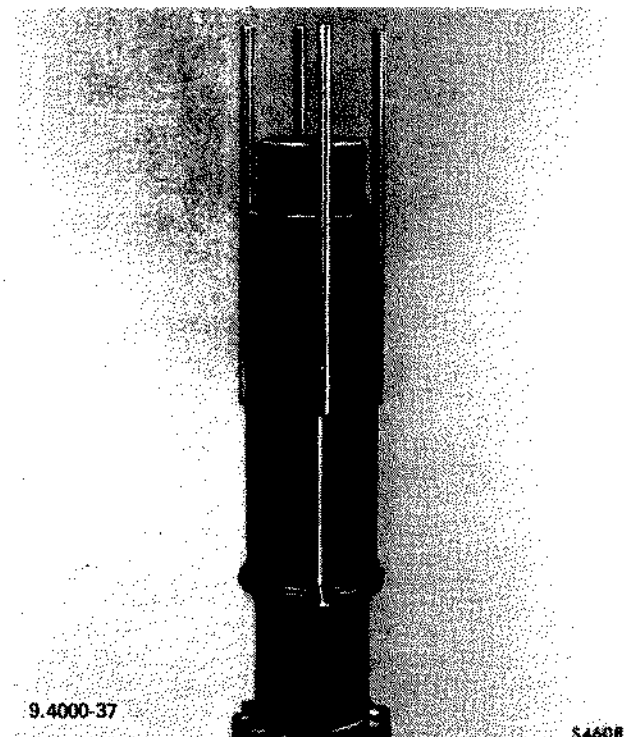
35. Discard the damper ring and compression strip of the first and reverse gear.



36. The layshaft first speed gear is integral with the layshaft. The remaining gears are pressed and keyed to the layshaft. Support the rear face of the second gear on the press and press the layshaft out of the gears. Discard the keys.



37. Before assembling the gears to the layshaft, locate new keys onto the shaft so that each key projects halfway above the ends of the keyways. Retain the keys in this position with stiff grease.

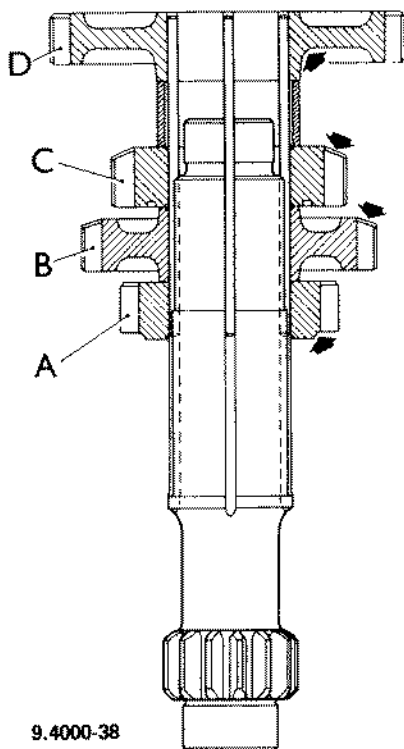


TRANSMISSION — HIGHWAY 6

38. The layshaft gears must be assembled to the layshaft as follows:

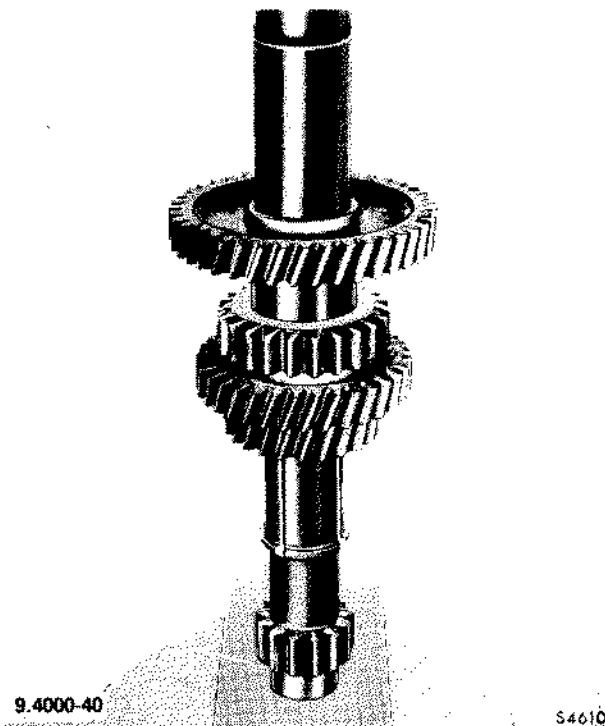
- 'A' — Second gear, with boss to rear of the shaft;
- 'B' — Third gear and 'C' — reverse gear, with the chamfers on the end of teeth to the front of the layshaft;
- 'D' — Driven gear, with the boss to the rear of the shaft.

Ensure that the spacer, between the driven gear and the reverse gear is concentric with the boss of the driven gear.



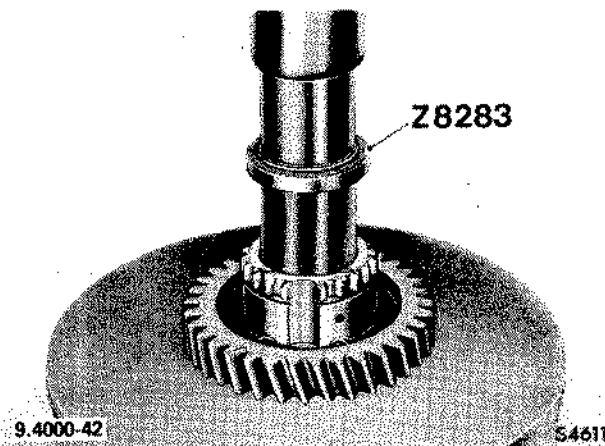
39. Before pressing the gears onto the shaft, the keys must be flush with the driven gear end face.
40. When pressing the gears onto the shaft, use a sleeve to contact the driven gear end face and the ends of the keys. The gears must be pressed onto the shaft until the second gear contacts the layshaft shoulder. During this operation care must be taken to ensure the keys do not jam in the bottom ends of the shaft keyways. The gears and spacer must be in firm contact with each other and the keys must be tapped below the end face of the driven gear, after the gears are finally assembled.

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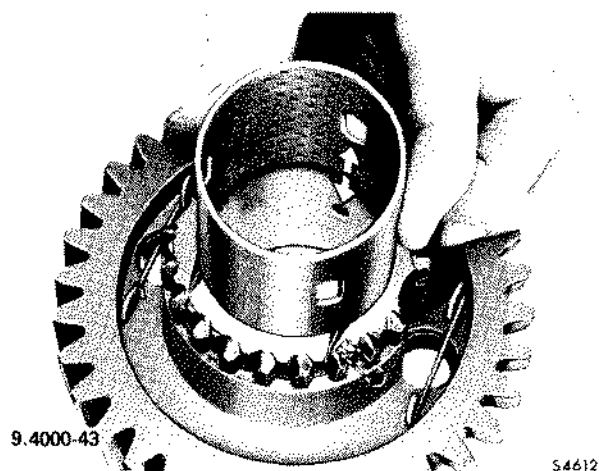


41. The third and fourth speed clutch and hub, and also the first and reverse gear and mainshaft are matched assemblies, therefore components of each assembly must not be renewed individually.

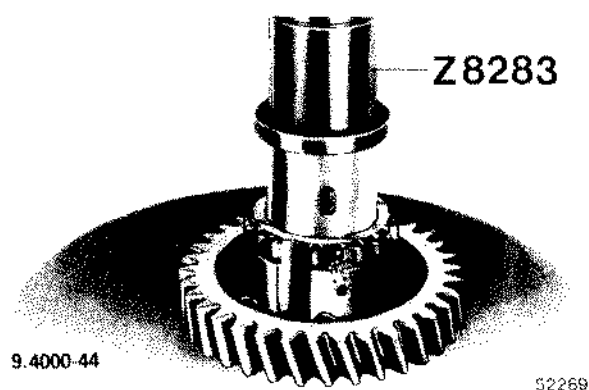
42. Press the bush out of the mainshaft second speed gear, using the long end of remover Z8283.



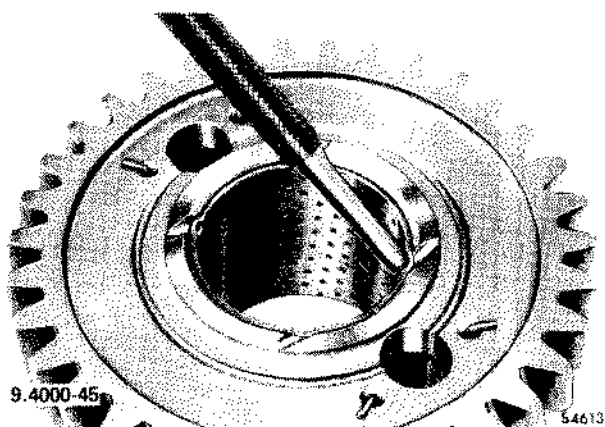
43. The new bush must be located so that the oil holes are aligned with the holes in the gear bore.



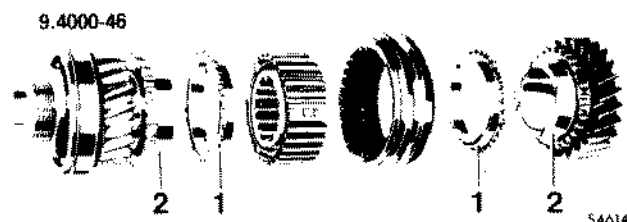
44. Use the short end of installer Z8283 and press the bush into the gear until the collar on the drift contacts the gear. Replacement bushes are pre-finished to size.



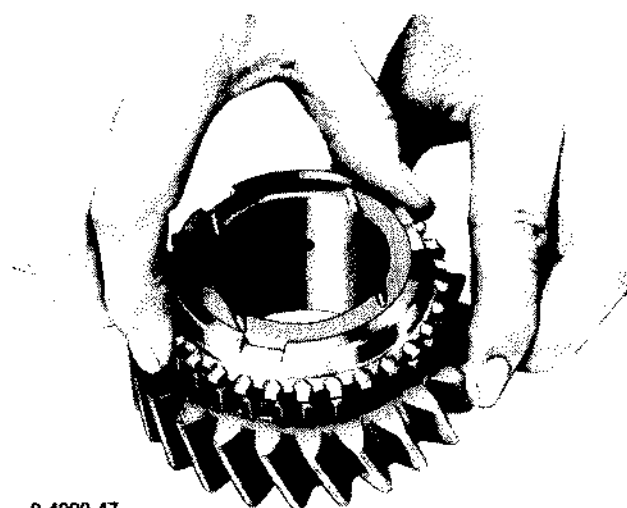
45. After installing, the bush must be staked into the oil grooves in the front end face of the gear.



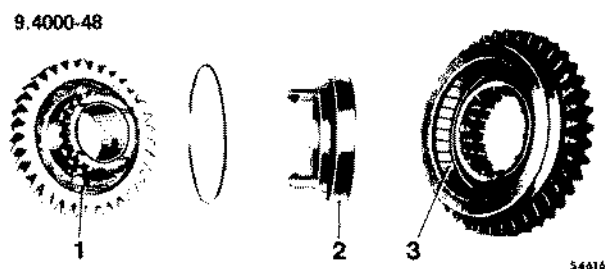
46. For effective synchromesh action, it is essential that friction surfaces of the synchronizing rings (1) and gear cones (2) are in good condition. Mis-shapen synchronizing ring teeth will create baulking trouble.



47. Rocking of the ring on the gear cone indicates ovality in either the ring or the cone, or both, resulting in insufficient grip. The wear on the rings or gear cones can be assessed by comparing frictional grip and the relative location of the ring or cone with that of new components.

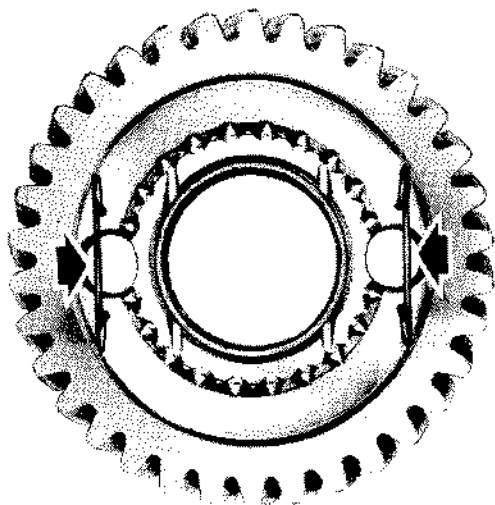


48. Synchromesh operation on the second speed gear depends on the condition of the synchronizing springs (1) in the second speed gear synchronizing cone (2) and the synchronizing insert (3) incorporated in the first and reverse gear.



TRANSMISSION — HIGHWAY 8

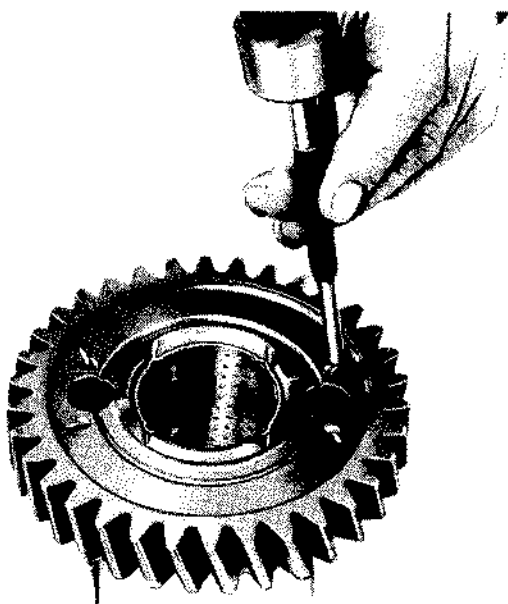
49. The synchronizing springs can be removed by straightening the ends of the springs. In order that the lugs of the first and reverse gear cone can engage the holes in the second gear, new synchronizing springs must be installed so that the straight section of the spring (arrowed) is offset outwards from the centres of the holes in the gear.



9.4000-49

S4617

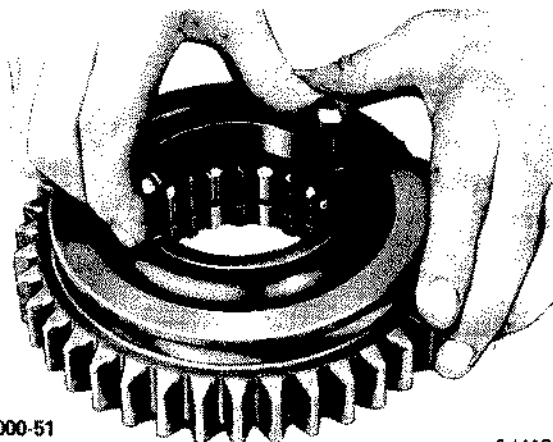
50. To secure the springs in the gear, support the spring eyes on the wood blocks and bend over the ends of the springs. Ensure each spring is secure in the gear and with no end float.



9.4000-50

S4618

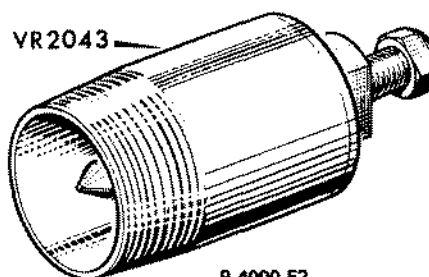
51. Wear on the second gear synchronizing cone and insert can be assessed by comparing the frictional grip and relative location of the cone in the gear insert with that of new components. It is essential that friction surfaces of the insert and cone are in good condition.



9.4000-51

S4619

52. Oil leakage from the transmission rear cover is prevented by a spring loaded seal. To withdraw this seal, use remover VR2043 with the coupling flange bolt installed as a distance piece. Before tightening the thrust screw, screw the threaded body of the remover firmly into the seal.



9.4000-52

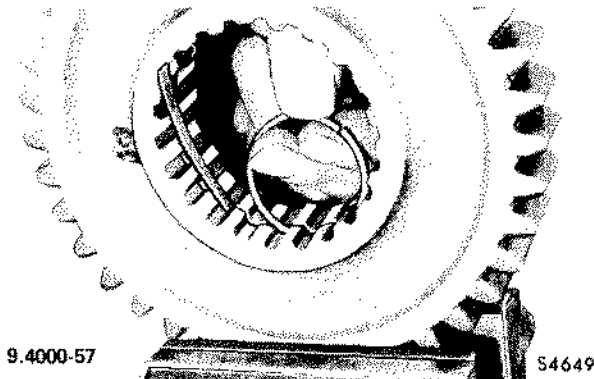
53. When installing the rear seal, install open side inwards, and drive in flush with the rear cover end face. After installing smear the lip of the seal with Rocol anti-scuffing paste.

54. The rear cover seal can be renewed with the transmission in the vehicle. To gain access to the bolt, securing the universal joint flange to the transmission mainshaft on vehicles with multi propeller shafts, it is necessary to remove one of the propeller shaft bearing support bracket bolts. Slacken the remaining bolt and ease the shaft to one side. The front end of the shaft must not hang unsupported, as this will dislodge the bearing rubber cushion.

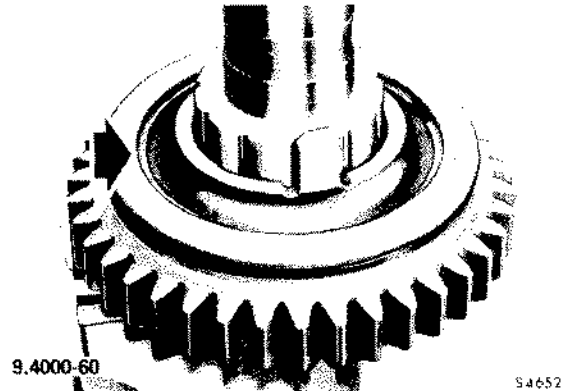
55. The coupling flange retaining bolt must be tightened to a torque of 105 Nm (77 lb ft) and secured with a tab washer.

56. When reassembling the transmission the following points should be adhered to.

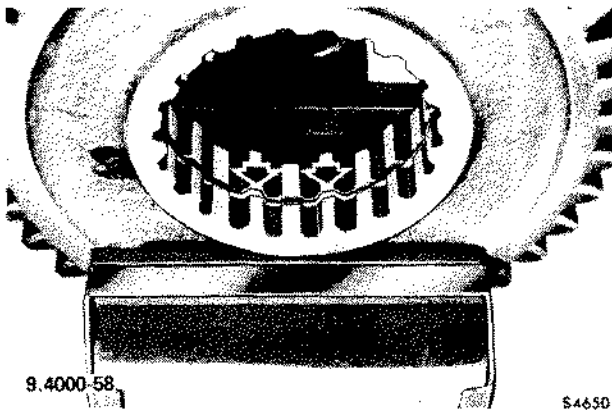
57. When installing compression strip in the bore of the first and reverse gear, ensure that the strip is not twisted. The top speed hub retainer can be used to roll the strip into the groove.



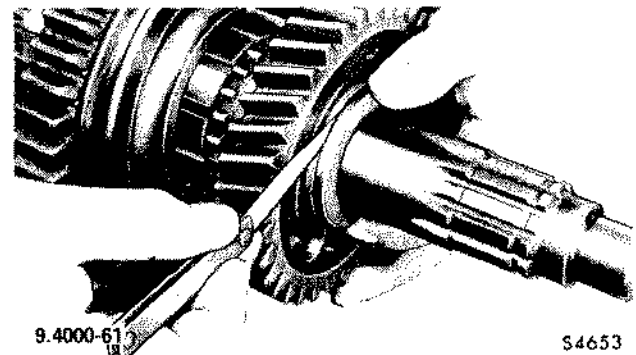
60. After installing the gear onto the shaft, the synchronizing cone must be assembled to the gear and secured with the retainer (arrowed).



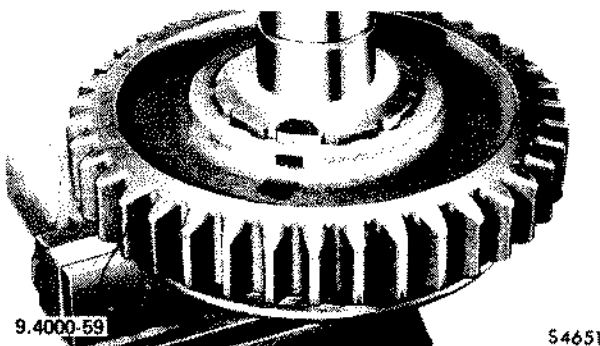
58. After installing the compression strip, the damper rings must be located in the groove so that the centre lugs (arrowed) on the ring are aligned with the high splines in the gear.



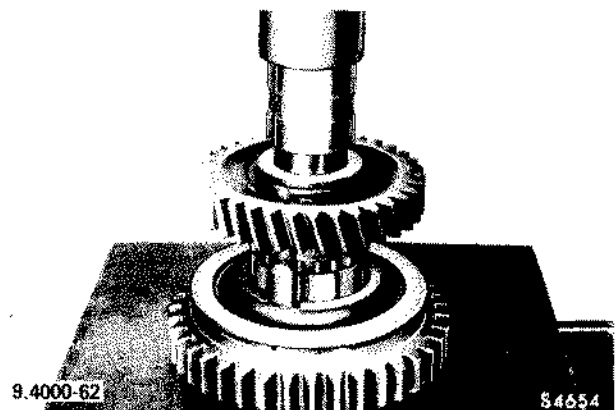
61. After assembling the second gear on the mainshaft, locate a new thrust washer, with the chamfered end of the bore first, against the shoulder on the mainshaft and check that the gear end float is within 0.2286/0.3556 mm (0.009/0.014 ins).



59. When installing first and reverse gear on the mainshaft, the marked spline of the gear and shaft must be realigned. Ensure the lugs of the damper ring engage the splines of the shaft, and tap the gear onto the shaft.

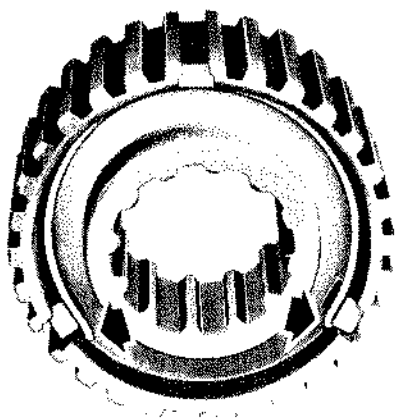


62. When pressing the third gear mainshaft sleeve onto the shaft, avoid excessive pressure when the sleeve contacts the thrust washer as this may distort the sleeve. After installing, ensure the gear rotates freely on the sleeve.



TRANSMISSION — HIGHWAY 10

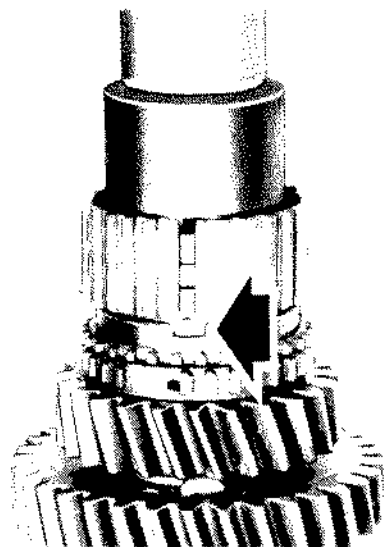
63. When assembling the clutch key springs to the third and fourth speed clutch hub, the springs must be located on the keys so that the ends of both springs are on the same keys. The spring ends must also be clear of the curved surface of the clutch hub.



9.4000-63

S4653

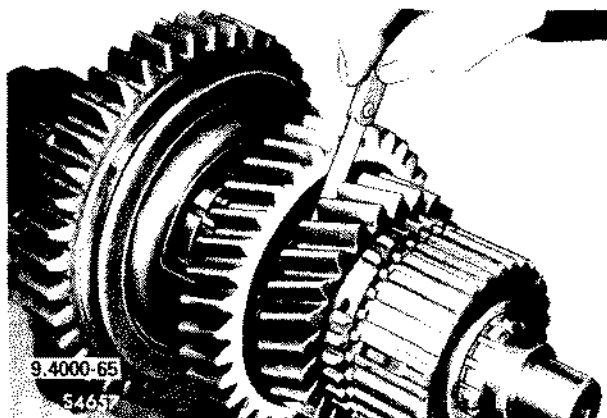
64. The third and fourth clutch hub must be located on the mainshaft so that the longer boss of the hub is towards the spigoted end of the shaft. Align the slots (arrowed) in the synchronizing ring with keys while pressing the hub onto the shaft. Avoid excessive pressure when the hub contacts the third gear sleeve as this may distort the sleeve and result in insufficient clearance for the gear.



9.4000-64

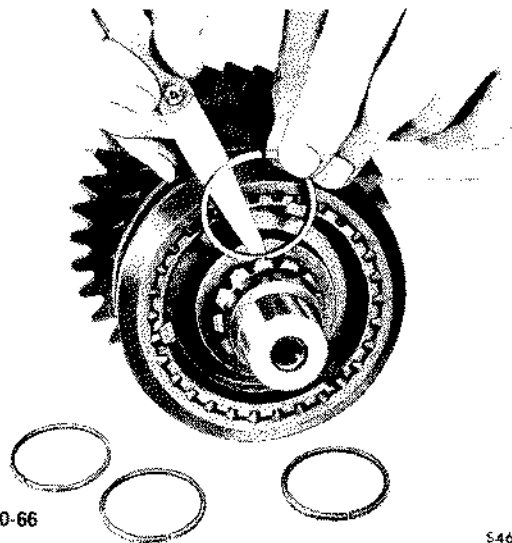
S4656

65. After installing the third and fourth speed clutch hub, check that the third gear end float is within 0.2286/0.3556 mm (0.009/0.014 ins) and that the gear rotates freely. The clutch must be assembled to the hub with the location marks aligned.



9.4000-65
S4657

66. The third and fourth speed clutch hub retaining ring is serviced in four thicknesses. Select a new ring which will give the minimum clearance between the ring and clutch hub; clearance must not exceed 0.1778 mm (0.007 ins).

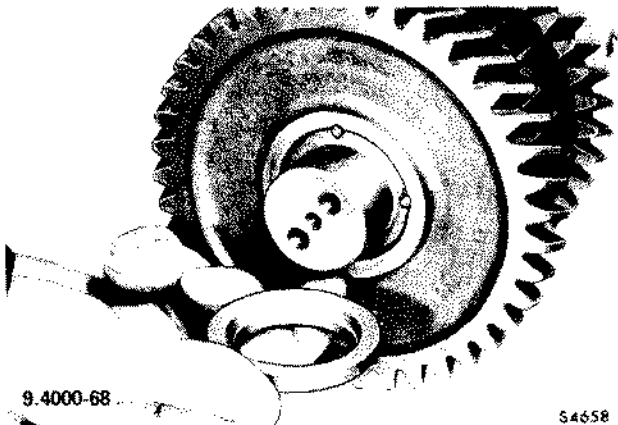


9.4000-66

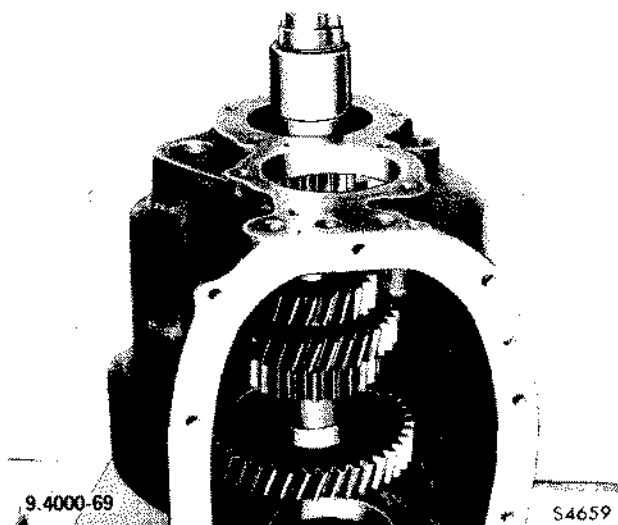
S4623

67. The layshaft front bearing must be pressed into the casing until the bearing locating ring contacts the front face of the casing.

68. The layshaft front bearing spacer must be assembled, bore chamfer first, to the layshaft front spigot. Smear spacer with petroleum jelly to retain it on the spigot while installing the layshaft gear assembly.

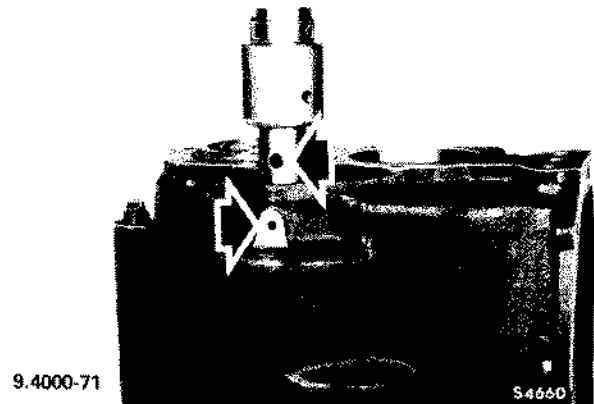


69. To install the layshaft gear assembly, up-end the casing so that the layshaft front bearing rests on the press. After aligning the spigot on the front end of the layshaft with the bearing, press in the layshaft to fully engage the spigot in the bearing.



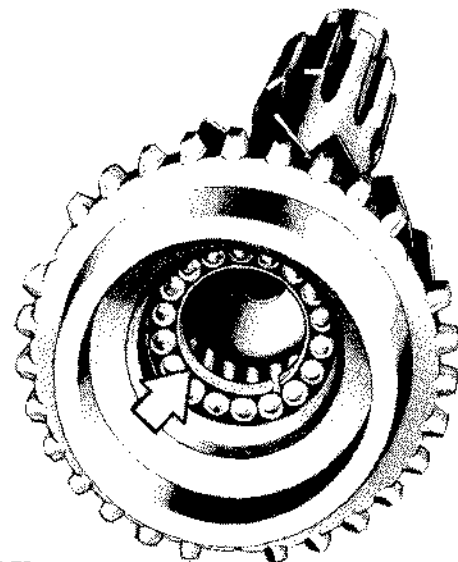
70. The layshaft rear bearing must be installed so that the bearing locating ring contacts the rear face of the casing.

71. Before pressing in the reverse pinion shaft ensure that the retaining pin hole in the rear end of the shaft is aligned with the hole in the casing. The shaft must be secured by a pin driven in flush with the casing.



72. The front end of the mainshaft is supported in the main drive pinion counterbore by 18 bearing rollers.

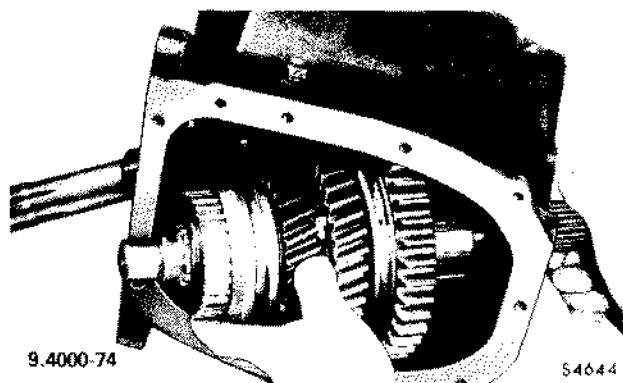
73. Smear the rollers with grease when assembling them to the pinion bore and locate the keep ring (arrowed) midway along the rollers to retain them in position prior to engaging the mainshaft spigot.



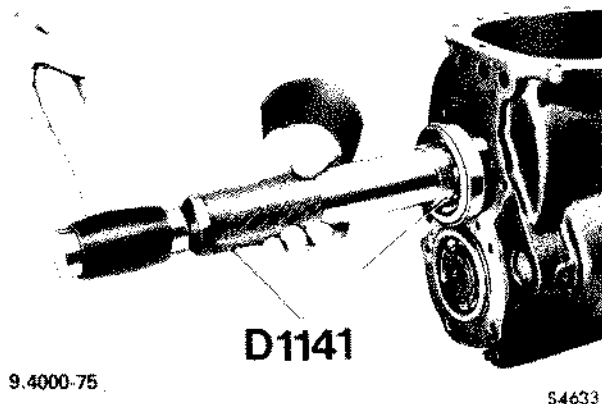
74. To facilitate installation of the mainshaft, lay the transmission casing onto its side. Assemble a synchronizing ring to the main drive pinion cone and insert the pinion shaft as far as possible through the casing bore. Slide the first and reverse gear forward on the mainshaft to engage second gear. Slide the third and fourth clutch rearwards on the clutch hub

TRANSMISSION — HIGHWAY 12

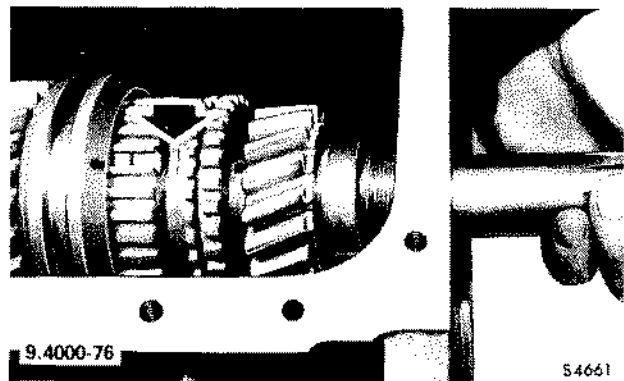
to engage third gear, and place the mainshaft assembly in the casing so that the rear of the shaft is as far as possible through the casing bore.



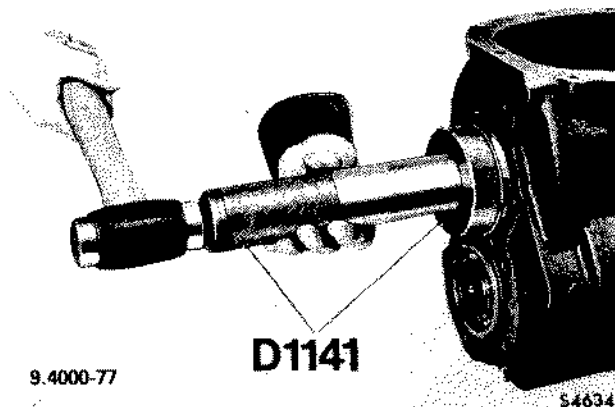
75. The mainshaft rear bearing must be located on the shaft so that the bearing retaining ring is to the rear of the shaft. Use installer D1141 to drive the bearing into contact with the shaft splined hub.



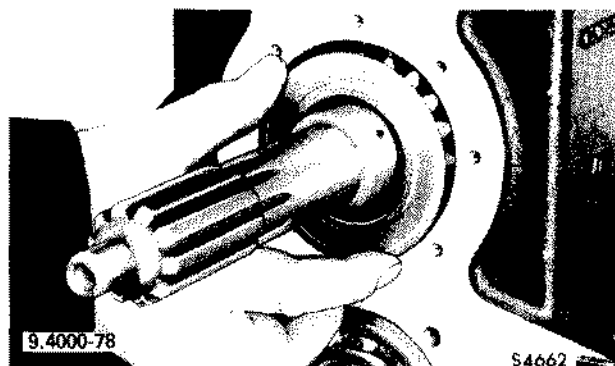
76. When assembling the main drive pinion to the mainshaft spigot ensure that the synchronizing ring slots are aligned with the clutch keys.



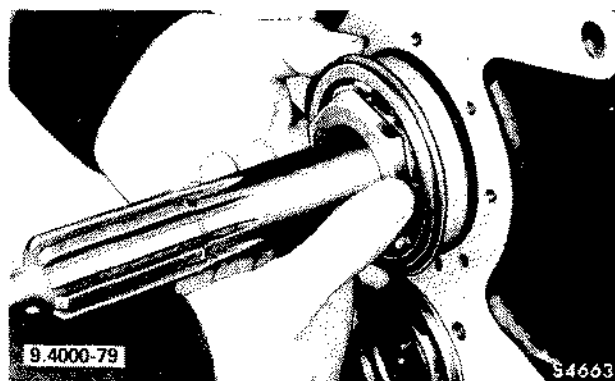
77. To prevent the third and fourth speed clutch contacting the layshaft third gear when installing the mainshaft rear bearing in the casing, the clutch must be located in the neutral position. Use installer D1141 to drive the bearing in until the bearing retaining ring contacts the rear face of the casing.



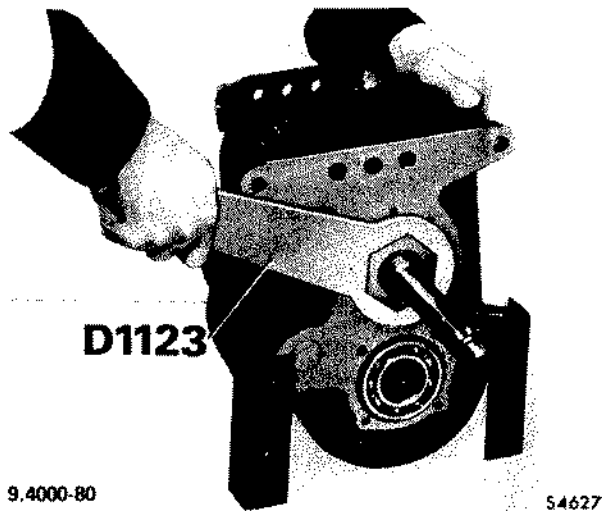
78. The oil thrower is located on the main drive pinion with the concave side to the pinion teeth, and concentric with the pinion shoulder. Use stiff grease to retain the oil thrower in position during the subsequent installation of the bearing.



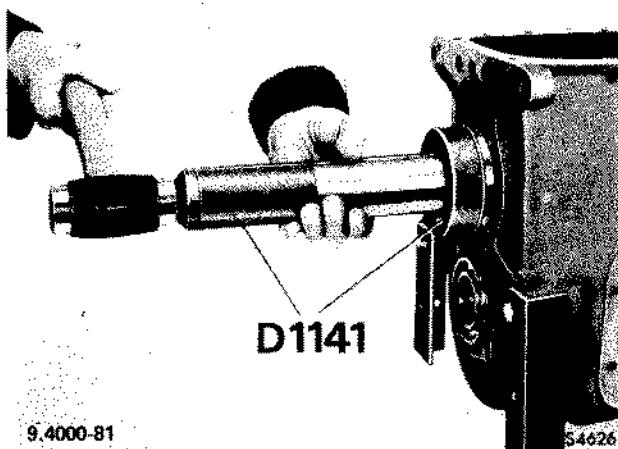
79. To ensure the pinion bearing is located squarely on the shaft and in the casing bore, hold the bearing on the nut spigot and screw the nut on to the shaft until finger tight.



80. After engaging both second and reverse gears, use wrench D1123 to tighten the nut approximately three turns.

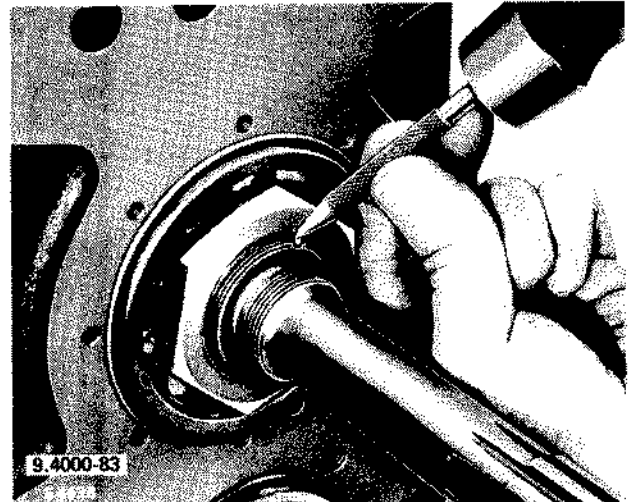


81. Then carefully tap the bearing into the casing with installer D1141.

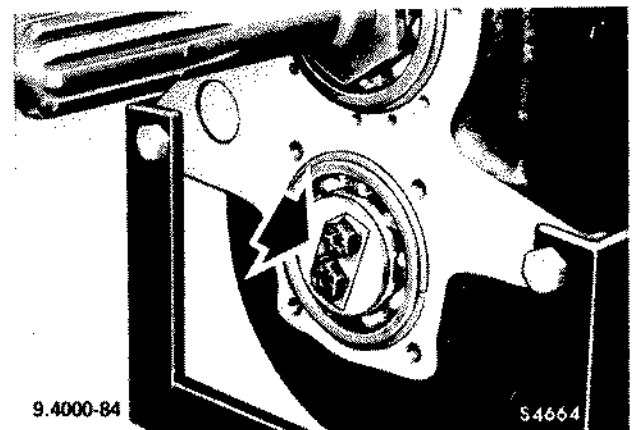


82. Repeat procedure in paragraphs (80 and 81) until the bearing retaining ring contacts the casing. During this operation ENSURE THE FOURTH SPEED SYNCHRONIZING RING IS NOT FORCED INTO CONTACT WITH THE GEAR CONE, otherwise the synchronizing ring will be damaged. Ensure the main drive pinion oil thrower remains in position.

83. After tightening the pinion nut, secure it by staking it into the hole provided in the main drive pinion.

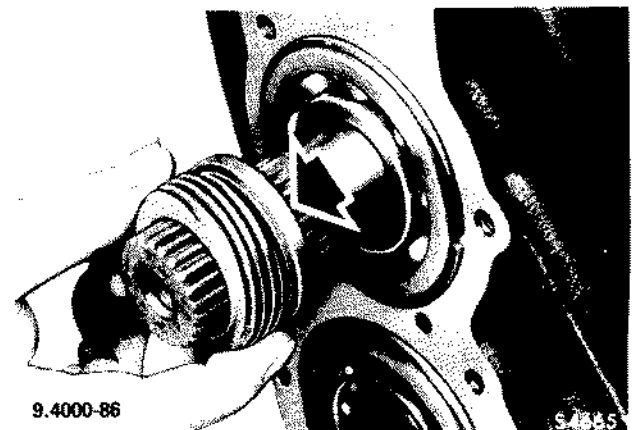


84. When assembling the retainer to the front spigot of the layshaft, ensure the bolts are secured by the locking plate.



85. When assembling the layshaft front cover and gasket, smear the bolts with jointing compound.

86. The speedometer driving gear must be installed on the mainshaft so that the shoulder (arrowed) is towards the bearing.

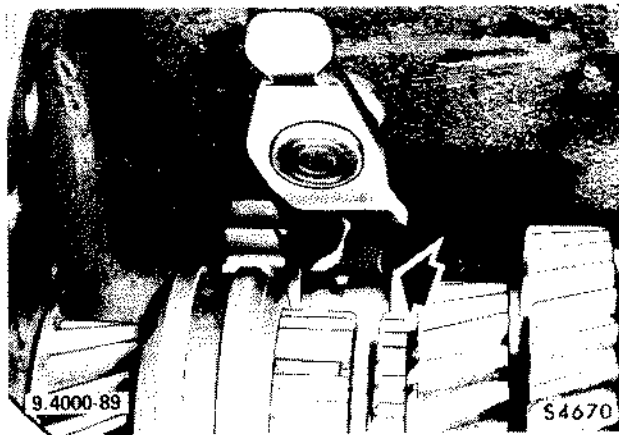


TRANSMISSION — HIGHWAY 14

87. When installing the rear cover use jointing compound on the cover bolts.

88. With both the top and reverse gears engaged, tighten the coupling flange bolt to a torque of 105 Nm (77 lb ft).

89. When installing the reverse striking lever, the lower end of the lever must be fully engaged in the reverse idler gear groove in all positions when operated. The lever shape can be reset. Do not secure the nut of the lever eccentric bolt at this stage.

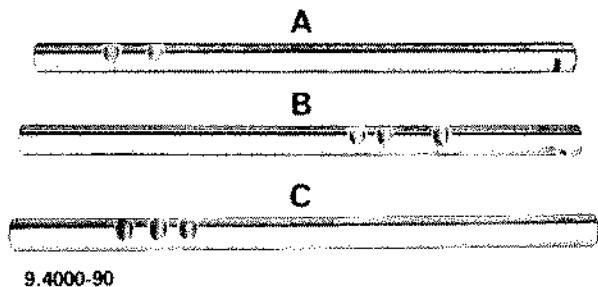


90. The striking fork rods are identified by location and the number of locking slots:

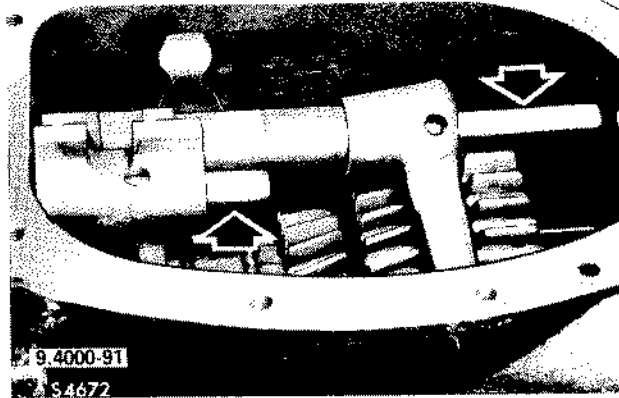
'A' — Reverse, has two locking slots at the front of the rod.

'B' — First and second, has three locking slots at the rear of the rod.

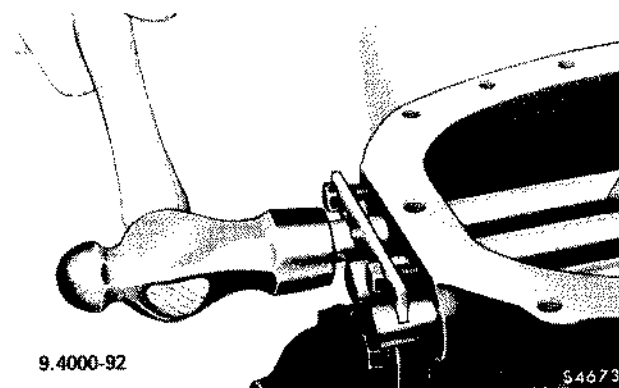
'C' — Third and fourth, has three locking slots at the front of the rod.



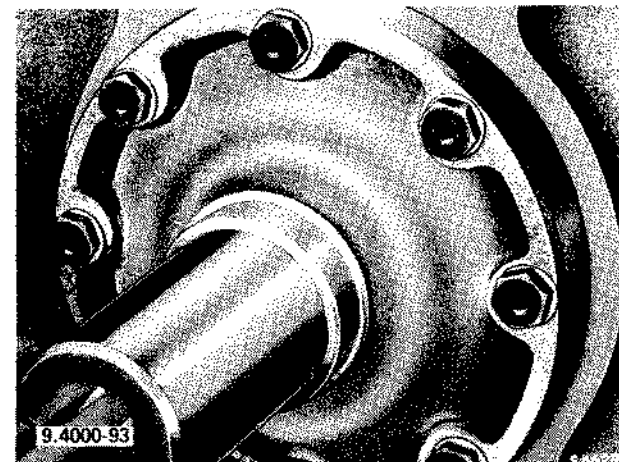
91. To facilitate assembly of the striking forks to the rods, use pilot rods (arrowed) to retain the locking ball and spring in the forks and the reverse lever head when installing rods.



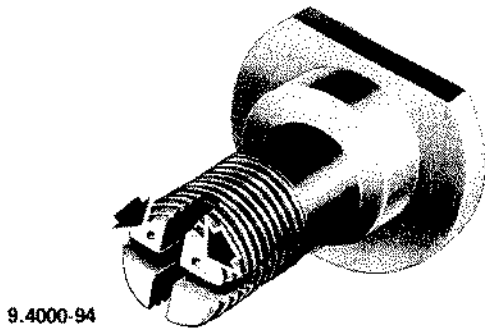
92. Before driving the striking fork rods into the casing, engage top and second gear. Position the retainer in the rod locating grooves so that the chamfered edge of the retainer is to the bottom of the casing and to the rear of the rods. Temporarily install the guide bolts to align the retainer holes with the tapped holes in the casing and drive the rods into the casing.



93. Use new sealing washers on the main drive pinion cover bolts and ensure that the washers do not project beyond the cover flange.

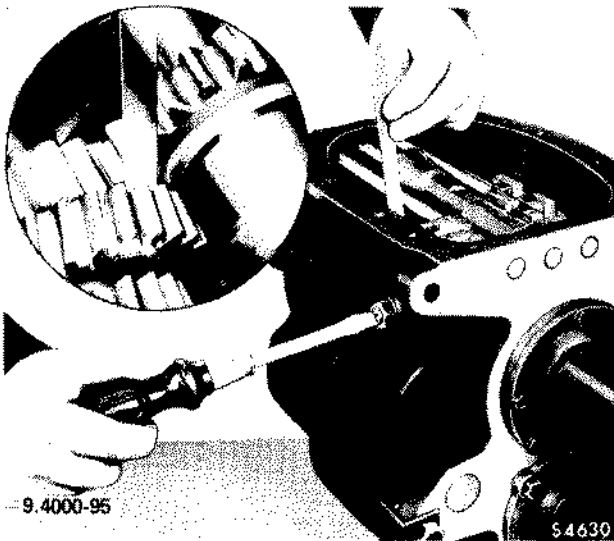


94. To ensure the reverse idler gear fully engages the mainshaft first and reverse gear when in reverse, the striking lever can be adjusted by means of an eccentric pivot bolt. The high side of the eccentric is indicated by punch marks (arrowed).



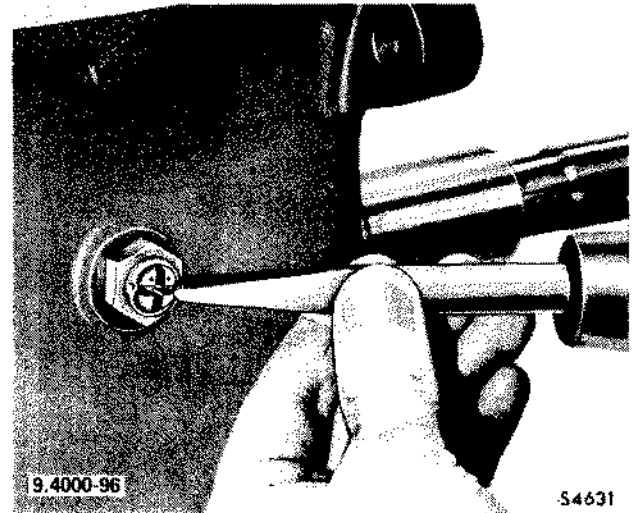
54722

95. To adjust the reverse striking lever, select the reverse gear and rotate the eccentric pivot bolt until the clearance between the reverse gear and the layshaft third speed gear is 1.3-1.5 mm (0.05-0.06 ins).



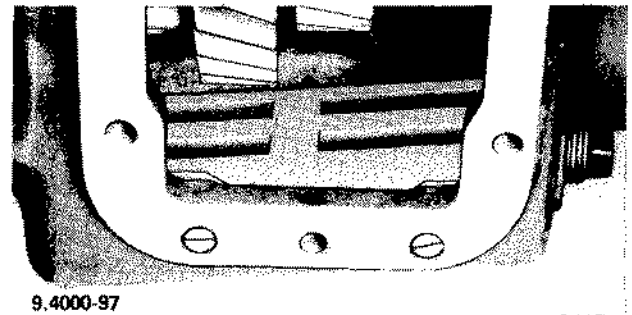
54630

96. After setting the reverse striking lever, do not disturb the pivot bolt when tightening the nut. Secure the nut by staking it into each end of the pivot bolt slots.



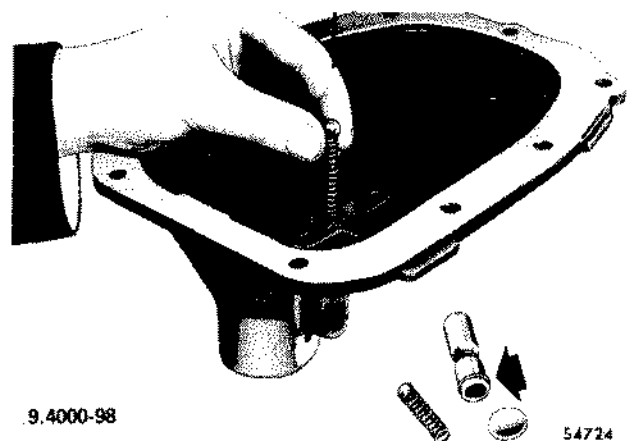
54631

97. Ensure the clip collector is installed in the bottom of the casing before assembling the cover to power take-off aperture.



54674

98. Insert the locking ball and spring in the top cover before installing the reverse stop plunger. Use a short tapered rod to depress the locking ball and spring while inserting the plunger. Ensure the circlip (arrowed) is located on the plunger before installing a new expansion plug.



54724

TRANSMISSION — HIGHWAY 16

99. Special service replacement pins and guides are used to secure the interlock plate to the top cover.



After riveting the plate to the cover, ensure that the plate slides freely on the guides.

100. Before installing the change speed lever, ensure the lower seating is located in the cover turret.

101. After locating the lever, spacer, upper seating and washer in the turret, tighten the retaining nut just sufficiently to eliminate lever slackness and secure the nut with a tab washer.

102. Before installing the transmission, lubricate the front cover sleeve and main drive pinion splines sparingly with grease (specification GM 4530-M).

TRANSMISSION-HIGHWAY (REFITTING)

103. Connect the transmission to the clutch housing ensuring alignment of the main drive. Tighten the clutch housing nuts to a torque of 190 Nm (140 lb ft).

104. Insert the universal joint flange bolts and tighten to a torque of 75 Nm (55 lb ft).

105. Refill the transmission with the recommended oil up to the oil level plug.

106. Reconnect the linkage.

9.0000

SPECIFICATIONS

Dimensions quoted are the manufacturing limits for new parts except where maximum and minimum permissible figures are given.

HIGHWAY TRANSMISSION

Make & Type Bedford Four-Speed
Oil Capacity 3.2 Litres (6.5 Imp Pints)
Weight 66 Kg (145 lb) Approx

GEAR SHIFT LEVER AND CHANGE SPEED LEVER

Inner Tube Outside Diameter 13.26/13.31 mm (0.522/0.524 ins)
Tube Clearance in Bushes 0.025/0.127 mm (0.001/0.005 ins)

MAINSHAFT

Permissible clearance between Clutch Hub & Retaining Ring 0.178 mm (0.007 ins) Maximum
Thrust Washer Thickness 4.45/4.52 mm (0.175/0.177 ins)

MAINSHAFT SECOND SPEED GEAR

Mainshaft Diameter 47.562/47.590 mm (1.8725/1.8735 ins)
Gear Clearance on Shaft 0.025/0.089 mm (0.0010/0.0035 ins)
Gear End Float on Shaft 0.229/0.357 mm (0.009/0.014 ins)

MAINSHAFT THIRD SPEED GEAR AND SLEEVE

Sleeve Diameter 50.711/50.737 mm (1.9965/1.9975 ins)
Gear Clearance on Sleeve 0.051/0.102 mm (0.002/0.004 ins)
Gear End Float on Shaft 0.229/0.356 mm (0.009/0.014 ins)

LAYSHAFT

Rear Journal Diameter 44.996/45.011 mm (1.7715/1.7721 ins)
Journal Clearance in Bearing 0.015/0.061 mm (0.0006/0.0024 ins)

REVERSE IDLER GEAR

Shaft Diameter 30.130/30.155 mm (1.1862/1.1872 ins)
Gear Clearance on Shaft 0.203/0.254 mm (0.008/0.010 ins)

TORQUE WRENCH DATA

Coupling Flange Bolt 105 Nm (77 lb ft)

TRANSMISSION — SPECIFICATIONS 2

RECOMMENDED LUBRICANTS — United Kingdom

Usage	BP	Castrol	Duckhams	Esso	Gulf	Mobil	Petrofina	Shell	Texaco
Transmission	BP Gear Oil SAE 90	Castrol ST	SG 90 Gear Oil	Esso Gear Oil GP85W/140	Trans- mission Oil 90	Mobilube C90	Pontonic WA SAE 90	Dentax 90	Thuban 90
Oil Seals Mainshaft Splines Thrust Washers	Rocol Anti-Scuffing Paste								
Clutch Yoke Cross-Shaft Bushes Transmission Front Cover Sleeve	BP Energ grease L21M	Castrol MS 3 Grease	CG Grease or LBM 10 Grease	Esso Graphite Grease or Esso MP Grease (Moly)	Gulf Graphite Grease No 1 or Gulflex (Moly)	Mobil- grease Super	Fina Marson LM2	Shell Retinax AM	Regent Grease 904 or Molytex Grease 2
Main Drive Pinion Splines Clutch Release Bearing Bush Gear Shift Control Top Linkage	BP Energ grease L2	Castrol LM Grease	LB 10 Grease	Esso Multi- Purpose Grease H	Gulflex A	Mobil- grease MP	Fina Marson HTL2	Shell Retinax A	Marfak All Purpose
Gear Shift Linkage Bushes	Rocol M.204 G Grease								
Range Shift Air Cylinder Piston & Control Valve O-Rings	Dow-Corning 200/60 000								
Range Shift Air Cylinder & Control Valve Bores	Tectyl Valvoline 502-C								
Range Shift Control Switch	Rocol E1A Grease								
Gear Shift Lever Locking Ball and Spring	Duckhams Keenol								

RECOMMENDED LUBRICANTS — Overseas

Usage	SAE Viscosity Number	Specification
Transmission Above 0°C Below 0°C	90 80	GM 4753-M Without EP Additives
Oil Seals Mainshaft Splines Thrust Washers	—	Paste of Heavy Mineral Oil With 25% by Weight of Molybdenum Disulphide
Clutch Yoke Cross-Shaft Bushes Transmission Front Cover Sleeve	—	GM 4530-M
Main Drive Pinion Splines Clutch Release Bearing Bush Gear Shift Control Top Linkage	—	GM 4733-M
Gear Shift Linkage Bushes	—	Special Compound of Molybdenum Disulphide and Extreme Viscosity Fluids
Range Shift Air Cylinder, Piston and Control Valve O-Rings	—	Dow-Corning 200/60 000
Range Shift Air Cylinder and Control Valve Bores	—	Tectyl Valvoline 502-C
Range Shift Control Switch	—	Rocol E1A Grease
Gear Shift Lever Locking Ball and Spring	—	GM 4550-M

SECTION 10

SHEET METAL

There are no Service Instructions for this Section

SECTION 11

ENGINE MOUNTINGS

There are no Service Instructions for this Section

SECTION 12

SPECIAL EQUIPMENT

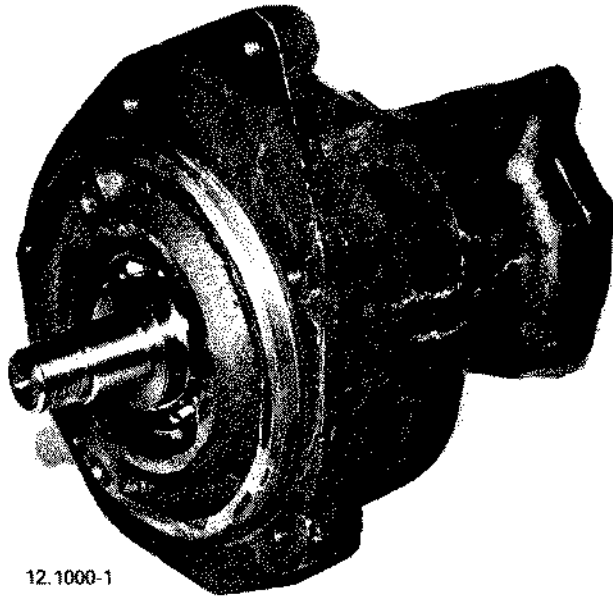
Contents

Timing Gear Shaft	12.1000
Exhauster	12.3000
Air Compressor	12.4000
Hydraulic Pump	12.5000
Cold Starting Aid	12.6000
Sump Pump	12.8000
Special Equipment Specifications	12.0000

12.1000

TIMING GEAR SHAFT**TIMING GEAR SHAFT (DESCRIPTION)**

1. The timing gear shaft and housing is used to connect the fuel injection pump and coupling to the accessory drive gear when neither a compressor or exhauster are required.



12.1000-1

2. The shaft rotates in two bearings and is encased in a housing which is attached between the crankcase front plate and the fuel injection pump carrier bracket.

TIMING GEAR SHAFT (REMOVAL)

3. Remove the fuel injection pump (2.2000) front cover plate (1.3100) and accessory drive gear (1.7200).

4. Disconnect the oil pipe from the carrier bracket ensuring the dirt does not enter into the pipes.

5. Remove the five bolts and washers securing the carrier bracket to the timing shaft housing and also the bolt connecting the carrier bracket to the support bracket. The carrier bracket can now be withdrawn from the timing shaft housing.

6. The bolts and washers securing the housing to the crankcase front plate can next be removed which will allow the shaft and housing assembly to be withdrawn.

TIMING GEAR SHAFT (INSPECTION AND OVERHAUL)

7. Remove the nut and bolt from the coupling and withdraw the coupling from the shaft. The circlip can now be removed from the front of the housing which will allow the shaft and bearings to be withdrawn from the housing.

8. Check the fit of the bearings in the housing and on the shaft. To renew the bearings, remove the circlips and press the bearings off the shaft. Press the new front bearing on first and install its circlip before installing the rear bearing and circlip.

9. Examine the housing for damage to machined faces.

10. Replace the shaft and bearing assembly into the housing. Renew the oil seal after half filling the space between the rear bearing and the oil seal with a lithium soap grease containing 3% molybdenum disulphide.

11. Install the coupling onto the rear end of the shaft and tighten the retaining nut to a torque of 37 Nm (27 lb ft).

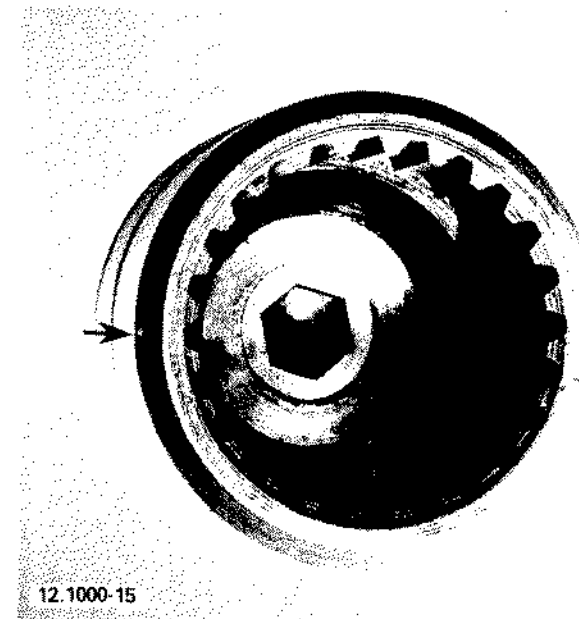
TIMING GEAR SHAFT (REFITTING)

12. Ensure that the faces of the housing and crankcase are free from burrs, install the housing assembly to the crankcase front plate. It is recommended that a new gasket is used when installing the housing. The five bolts should be tightened to a torque of 19 Nm (14 lb ft).

13. **NOTE.** When installing the housing it is advisable to use the front cover retaining bolt as well as the five bolts mentioned above to ensure correct alignment. When the five bolts have been tightened the front cover retaining bolt can be removed.

14. Insert a new oil seal into the carrier bracket and replace the carrier bracket onto its support mounting. Replace the five bolts securing the carrier bracket to the timing gear housing.

15. Replace the fuel injection pump (2.2000) ensuring on DPA pumps that the blind spline on the shaft is aligned with the master spline on the pump.



12.1000-15

16. To check the accuracy of the timing marks on

TIMING GEAR SHAFT 2

the pump and carrier flanges, or after installing a new pump carrier, which would be unmarked, proceed as follows:-

17. Remove the cover plate from the side of the pump. Rotate the engine until the flywheel timing mark (21 deg BTDC) is aligned with the timing aperture pointer and No 1 cylinder is on compression

stroke. Check that the timing mark 'D' on the pump rotor is aligned with the squared end of the circlip.

18. If necessary, adjust the position of the pump on the carrier and scribe a line on the carrier relative to the line on the pump flange.

19. The accessory drive gear (1.7200) and front cover plate (1.3100) can now be replaced.

12.3000

EXHAUSTER

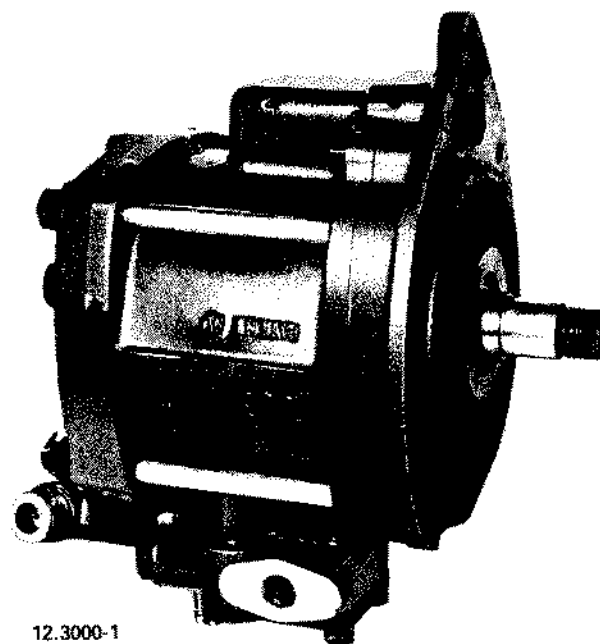
EXHAUSTER (DESCRIPTION)

1. The exhauster is a rotary sliding vane type pump having a six bladed rotor.

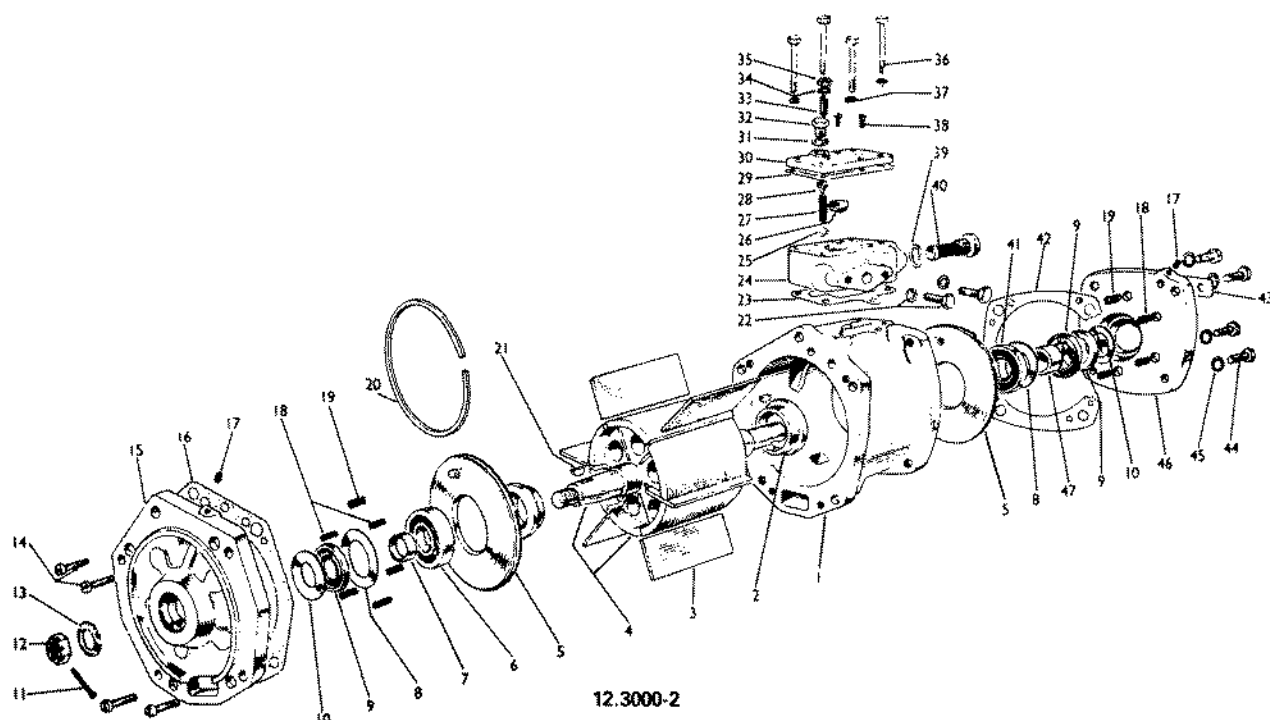
2. Notations in the following paragraphs refer to the exploded drawing below (12.3000-2).

3. The rotor and shaft assembly (4) is supported eccentrically in the body by ball or roller bearings (6) and (41) housed in the body end covers (15) and (46). Arrangement is made by keyways at both ends of the shaft for the accommodation of the fuel pump drive gear and coupling, the gear being retained in position by a tab washer and nut. Seals (9) pressed in the end covers contact hardened steel collars on the shaft to prevent air entering the exhauster body; double seals at open end covers also prevent oil leakage due to initial pressure in the exhauster body under starting conditions.

4. Six similar sized fibre blades (3) are fitted in slots in the rotor. The spaces between the blades are sealed by circular plates (5) held in contact with the ends of the rotor by springs (18) and (19) housed in pockets



12.3000-1



12.3000-2

- | | | | |
|-----------------------------|----------------------------------|--------------------------|-----------------------|
| 1. Exhauster Body | 13. Plain Washer | 25. Snifter Valve Ball | 37. Spring Washer |
| 2. Cam Ring | 14. Cheese Head Screw | 26. Non Return Valve | 38. C/Sk. Head Screw |
| 3. Rotor Blade | 15. Drive End Cover | 27. Snifter Valve Spring | 39. Copper Washer |
| 4. Rotor and Shaft | 16. End Cover Joint | 28. Spring Keeper | 40. Oil Filter Assy. |
| 5. Sealing Plate with peg | 17. Grub Screw | 29. Valve Cover Joint | 41. Rear Bearing |
| 6. Front Bearing | 18. Sealing Plate Spring (small) | 30. Valve Cover | 42. End Cover Joint |
| 7. Shaft Collar | 19. Sealing Plate Spring (large) | 31. Copper Washer | 43. Nameplate |
| 8. Seal Back Plate (inner) | 20. Piston Ring | 32. Hex. Plug | 44. Special Bolt |
| 9. Oil Seal | 21. Woodruff Key | 33. Adjusting Screw | 45. Shakeproof Washer |
| 10. Seal Back Plate (outer) | 22. Bolt with Spring Washer | 34. Copper Washer | 46. Rear End Cover |
| 11. Split Pin | 23. Valve Body Joint | 35. Lock Nut | 47. Shaft Collar |
| 12. Slotted Nut | 24. Valve Body | 36. Hex. Bolt | |

EXHAUSTER 2

in the end covers. A peg riveted to each sealing plate, engages with one of the spring pockets to prevent rotation of the plate.

5. On certain exhausters the sealing plates are drilled with an oil transfer hole which, to ensure its correct situation at assembly, is positioned by one of the six springs and spring pockets being of larger diameter than the remainder.

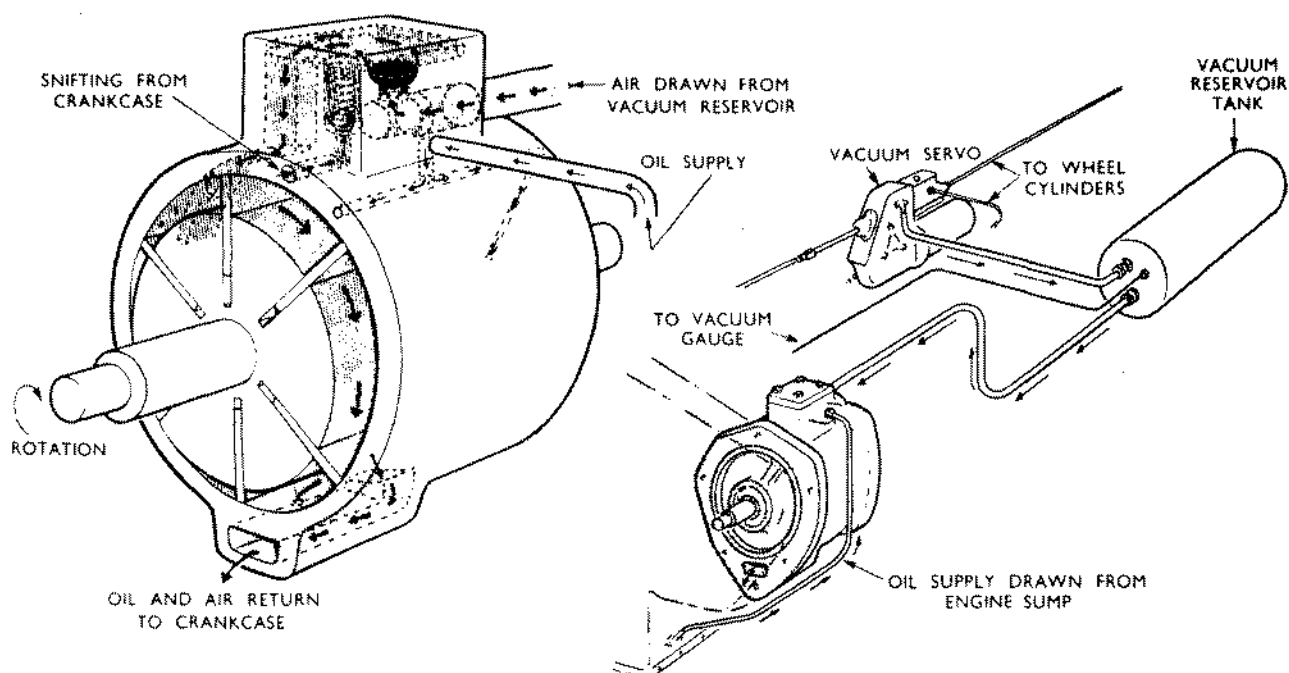
6. Cam rings (2) fitted in the sealing plates and held concentrically with the exhauster body, contact the inner edges of the rotor blades and maintain the blades in close relationship with the body bore. An intake port in the exhauster body aligns with a passage formed in the valve body which is pipe connected to the vacuum reservoir mounted on the chassis frame. The non-return valve is either of the rubber-faced metal type or a hemispherical rubber type. The non-return valve and the snifter valve are located within the valve body attached to the top of the exhauster by set bolts or studs. The snifter valve is connected by passages to the intake port on the one side and on the other side to atmosphere. The outlet port formed in the base of the exhauster body aligns with the aperture in the drive housing or mounting base and connects with the engine casing. At operating speeds the rotor blades are kept in contact with the bore of the body by centrifugal force, but at engine idling speed, particularly when the oil is cold, the blades have insufficient centrifugal force to keep them in their true position. This is overcome by the action of the cam rings (2) which contact the inside edges of the blades, forcing them

to move out radially in their grooves and thus maintain contact with the bore of the body.

7. When the rotor turns, the spaces between the rotor blades decrease because of the eccentric mounting of the rotor in the exhauster body, and the air between them is compressed (see 12.3000-7 below). As the point of maximum compression is reached, the air is expelled through the outlet port, together with the lubricating oil, into the engine crankcase. After passing the outlet port the spaces between the rotor blades increase and a depression is thereby created which is filled by air drawn from the vacuum reservoir. This air is then compressed and expelled.

8. Where a snifter valve is fitted the withdrawal of air from the reservoir continues until 635 mm (25 ins) of mercury is obtained, at which point the snifter valve is lifted off its seat to admit air. This action limits the maximum vacuum and prevents unnecessary heating of the exhauster. When the vacuum in the reservoir is greater than the vacuum generated by the exhauster, due to the slowing down or stopping of the engine, the non-return valve drops on its seat and prevents loss of vacuum from the reservoir.

9. The exhauster is dependent upon an adequate supply of oil for lubrication of the bearings and moving parts and to provide a seal between the rotor blades and the bore of the body. The exhauster draws its own lubricant from the engine sump, or if mounted independently of the engine, from a combined oil separator and reservoir.



12.3000-7

Diagram showing operation of Exhauster and associated components.

LUBRICATION FROM THE ENGINE SUMP

10. The oil inlet port is connected by a cross-drilling to the end covers. The vacuum created in the end covers is utilised to draw oil into the exhauster. The oil lubricates all parts and is ejected through the outlet port to the engine sump together with the air evacuated from the reservoir. Adequate crankcase ventilation must be available to prevent a build-up of pressure. If a filter is not fitted to the exhauster a sump filter should be incorporated well below the oil level and at a distance of up to a maximum of twelve inches below the centre line of the exhauster drive shaft.

11. Premature failure of an exhauster can often be traced to a fault in the lubrication system, the main causes usually being a partially blocked filter or an indented pipe line, either of which can result in a restricted and reduced oil flow. A defective oil pipe joint will also affect operational efficiency by admitting air to the system and consequently diminishing or interrupting the oil supply.

EXHAUSTER (REMOVAL)

12. Remove the front cover plate (1.3100), accessory drive gear ((1.7200), fuel injection pump (2.2000) and carrier bracket (12.1000).

13. Disconnect the pipes from the exhauster and plug the open pipe ends to prevent entry of foreign matter.

14. Remove the bolts and lockwashers securing the exhauster and lift away the assembly.

EXHAUSTER (INSPECTION AND OVERHAUL)

15. To get the best service from the exhauster the following periodic inspection and preventive maintenance should be carried out.

WEEKLY

16. Check the vacuum lines and fittings. Vacuum leakage may occur through the non-return valve if the valve seat is dirty or pitted.

17. A check should be made for oil leaks at the exhauster particularly at the joint between the end covers and body and around the protruding end(s) of the rotor shaft. If seepage around the rotor shaft is severe, oil will be thrown from the shaft while the exhauster is running. Check the oil supply and discharge lines for leaks at fittings and connections. Rubber connecting hoses, if used, may become hardened due to the hot oil, with cracking and leaking a consequence.

MONTHLY

18. Clean the oil filter of the exhauster.

19. Check all mounting studs and end cover retaining bolts for tightness.

YEARLY

20. The exhauster should be removed for dismantling and detailed examination of component parts as described below.

21. Unscrew the oil filter (40). Mark the valve body (24) and cover (30) in relation to the exhauster body to ensure correct location at reassembly. Remove the bolts (36) or nuts, and lockwashers and lift off the

body and cover. The valve body cover on certain exhausters may be held separately by two countersunk-head screws which, after removal, permit the non-return valve and snifter valve to be withdrawn.

22. Detach the front and rear end covers (15) and (46) by releasing the bolts or nuts (according to the type of exhauster) and tap covers evenly from the body; remove the six sealing plate springs from each end cover. Retain the seal back plates (8) with the end covers.

23. Remove both sealing plates (5) from the body by working them outwards over the bearings, then withdraw the rotor assembly (4).

24. Mark the rotor blades in relation to the rotor to facilitate reassembly in the same relative positions if blades are suitable for further service.

25. **NOTE.** Further dismantling of the rotor assembly need be undertaken only if, after inspection, it is found necessary to renew the bearings, shaft collars or cam rings.

26. The following cleaning operations should be observed:-

27. Wash the bearings in thin flushing oil or white spirit and blow dry with compressed air directed through the bearings. Spinning the bearings with the compressed air should be avoided otherwise damage to balls and races will occur. Lubricate the bearings with light machine oil and protect against dirt ready for inspection.

28. Wash the remaining components in clean paraffin and blow dry with compressed air.

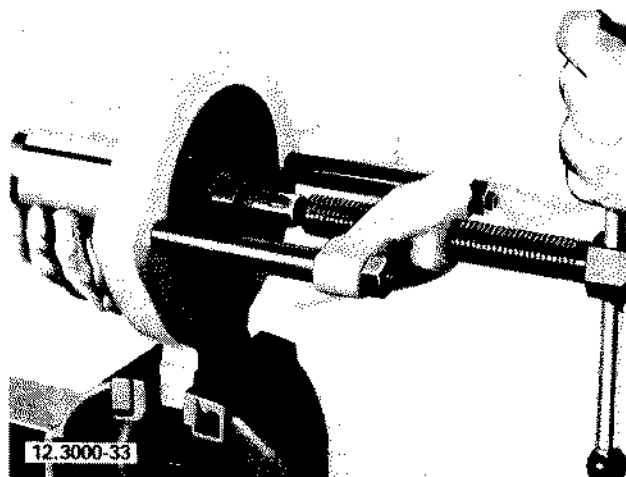
29. Clean the oilways in the end covers and exhauster body with compressed air.

30. Rotate each bearing slowly to check for roughness and examine for wear, pitting, discolouration and cracked races. Premature failure may have been caused by end thrust on the rotor shaft or shortage of oil.

31. Inspect the cam ring contact faces for wear. Check the fit of the cam rings in the sealing plates.

32. Inspect the rotor shaft oil seal collars for wear. To renew:-

33. Withdraw the bearings from the shaft as shown below using bearing drag D1039 and Adaptor Set

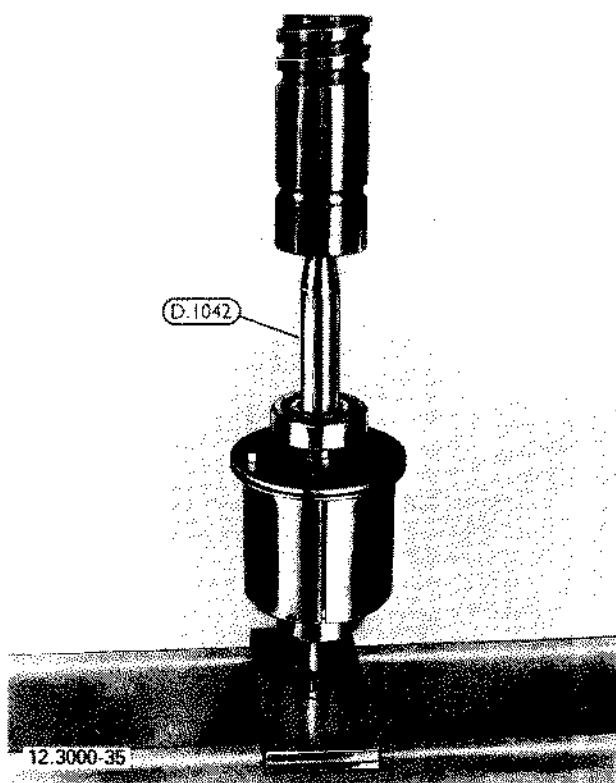


EXHAUSTER 4

D1040. Place the drag in a vice and supporting the rotor assembly, insert it through the drag; position the split adaptor between the bearing and the cam ring and extract the bearing and shaft collar by screwing in the bolt against the end of the rotor shaft.

34. Assemble the cam rings over the rotor shaft with the flange facing outwards.

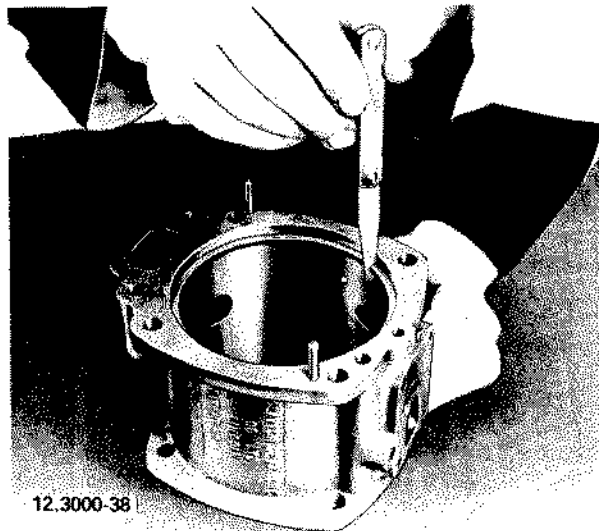
35. Using the Installer D1042, press on the new bearings until they contact their locating shoulders, as shown in 12.3000-35. When the internal diameter of the bearing is larger than that of the shaft collar it is recommended that the Installer is replaced by a tube of suitable length and bore, or that a washer, sufficiently large to just slip over the exhaustor shaft, is placed between the bearing and the Installer.



36. **NOTE.** The rotor assembly should be supported on the bed of the press by a tubular spacer placed over the shaft end and not by the rotor or the shaft itself.

37. Using the same Installer, press the seal collars on the shaft until they contact the bearings.

38. Inspect the sealing plates for wear or scoring. Spring rings should only be removed from the sealing plates if the rings or plates need replacing and should normally last the life of the exhaustor. If a new spring ring is fitted, first locate the ring in the exhaustor body and check that the gap does not exceed 0.4826 mm (0.019 ins). If sealing plate is drilled with an oil transfer hole, ascertain that this is unobstructed.

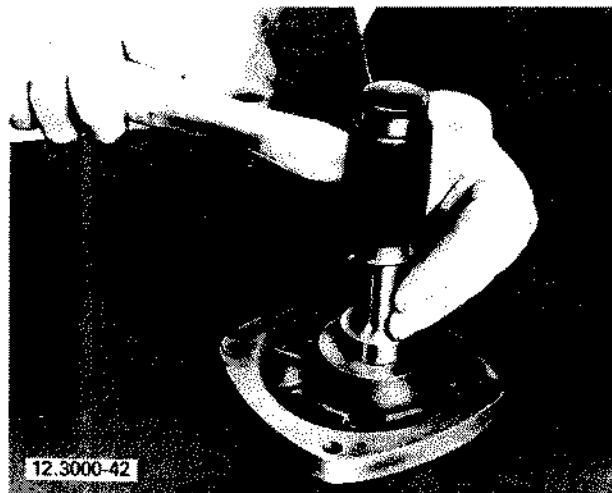


39. Inspect the rotor and shaft for cracks or damage. With cast-iron rotors a degree of looseness on the shaft may eventually develop. This is permissible if slight and will not affect the efficiency of the machine.

40. Check the fit of the blades in the rotor slots. Examine the inner edges of the blades for wear. If stepped at the point of contact with the cam rings, the blades should be renewed. The rotor blades are either of steel or fibre. A replacement blade must be of the same material as the original, otherwise the whole set must be replaced.

41. Examine the oil seals carefully. Wear or deterioration is caused primarily by dirty oil and grit, and ineffective seals should be replaced.

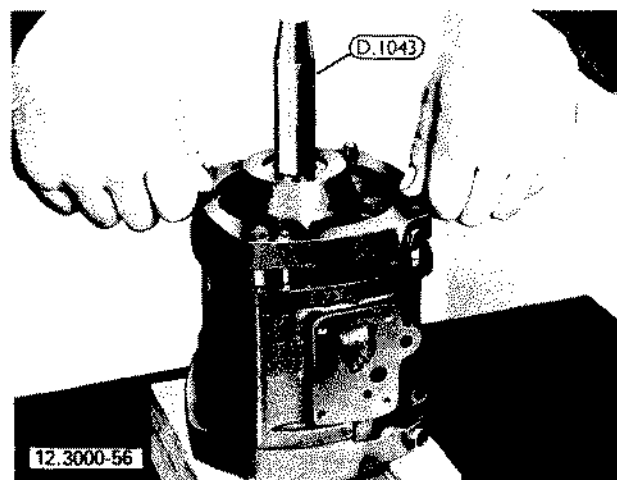
42. Lift out the seal inner back plate, using a punch to avoid damaging the seal outer back plate, drive out the seal(s).



43. If undamaged, replace the seal outer back plate in the end cover seal housing.
44. Press into position the new oil seal with the lip facing the outer back plate. Where a second seal is fitted the lip must face inwards.
45. Lightly smear one side of the seal inner back plate with grease and locate in the end cover against the seal.
46. Examine the body for longitudinal ripples or lines. If these are only slight the body is still serviceable, if excessive the body should be renewed.
47. Check the snifter valve spring. Examine the ball for wear or pitting.
48. The rubber non-return valve (either disc type or hemispherical) should be renewed if the condition of the rubber is impaired.
49. The oil filter gauze should be examined for damage.
50. All parts not specifically mentioned should be inspected and renewed as necessary.

REASSEMBLY

51. Lubricate all moving parts with clean engine oil and renew all gaskets.
52. Replace the rotor blades in the rotor slots making sure, if possible, that they are located in their original positions, check for freedom of movement.
53. Slide the rotor assembly into the exhauster body. Pass the sealing plates over the races and locate them on the cam rings inside the bore of the body.
54. Correctly position the end cover gaskets with grease. Replace sealing plate springs in pockets of end covers and retain in position with grease. All springs and spring pockets are of uniform size except on models where the sealing plates are drilled with an oil transfer hole, when it will be found that one spring and the spring pocket accommodating the sealing plate peg, are of increased diameter.
55. Place installer D1042 on the front end of the rotor shaft. Assemble the drive end cover to the body, taking care to align the sealing plate locating peg with the appropriate spring pocket in the end cover. Secure the end cover.
56. Invert the exhauster. Place Installer D1043 on the rear end of the rotor shaft and assemble the rear end cover to the body, taking care to align the sealing plate locating hole with the appropriate spring pocket in the end cover. On exhausters having a blank end cover this can be easily assembled without the aid of any special tool.
57. Tighten the end covers in position by the method applicable to the exhauster under assembly. Check rotor for ease of rotation.
58. Replace keys and couplings.
59. On exhausters not fitted with a valve body, replace the snifter valve in the body, ensuring that the ball contacts the small end of the spring. The ball can be reseated by tapping it on its seat using a brass drift.
60. If exhauster is of the type having the non-return valve, snifter valve and oil filter combined in the valve body, replace the non-return valve and ascertain its correct seating. Replace the snifter valve



ball and spring, with the ball contacting the small end of the spring.

61. With a smear of grease on the faces locate new gaskets on the valve body and cover, and observing the alignment marks previously made, assemble the valve cover to the body and secure with the two counter-sunk headed screws. Position the complete valve assembly on the exhauster, assemble the retaining bolts and nuts and tighten. Screw in the oil filter, taking care to replace the copper washer.

62. If the snifter valve is of the adjustable type assemble the components in their correct sequence, ensuring that the ball contacts the small diameter end of the spring.

63. Screw in the adjuster a few turns.

64. Connect the exhauster to the vacuum reservoir which should be equipped with a reliable gauge.

65. Run the exhauster at 200 rpm and allow the vacuum gauge to attain a steady reading. Screw in the adjuster gradually, allowing the gauge reading to settle after each adjustment, until the snifter valve is operating at the correct pressure of 635 mm (25 inches) of mercury. Lock the adjuster in position and secure the lock nut with the tab washer.

EXHAUSTER (REFITTING)

66. Ensure that the exhauster flange and timing gear faces are free from burrs, and that all traces of the old gasket have been removed.

67. Place the exhauster in position using a new gasket.

68. Temporarily install the exhauster bottom attaching bolt to ensure correct alignment before tightening the retaining bolts. Tighten to 20-24 Nm (15-18 lb ft).

69. Install the exhauster gear with the timing marks in alignment as detailed in section 1.7200.

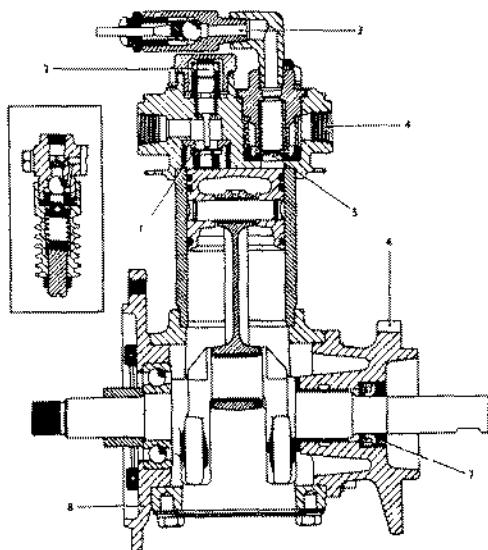
70. Install the carrier bracket (12.1000), fuel injection pump (2.2000) and front cover plate (1.3100).

12.4000

AIR COMPRESSOR

AIR COMPRESSOR (DESCRIPTION)

1. Two types of air compressor are used, SC6 and SC9, the SC9 having a larger capacity.
2. Both types are similar in design and comprise a single cylinder air cooled unit mounted behind the engine timing case on the left hand side and driven by the crankshaft through the idler gear.



12.4000-2

- | | |
|----------------------|-----------------------|
| 1. Air Intake Valve | 5. Air Delivery Valve |
| 2. Unloader Valve | 6. Rear End Cover |
| 3. Safety Valve | 7. Oil Seal |
| 4. Air Delivery Port | 8. Drive End Cover |

Inset. Governor Valve Assembly

3. The compressor cylinder head is an aluminium die casting secured by four nuts to studs which are screwed into the crankcase. The head is spigot mounted on a cast iron cylinder which is similarly located in the crankcase. The cylinder head embodies an intake valve and a delivery valve each consisting of a spring-loaded steel disc locating on a detachable valve seat. The intake valve seat is retained by a push fit valve spring guide, and the delivery valve seat by a spring locating in the valve cap. A gauze type air cleaner is attached to the air intake port. An unloader valve, in the form of a spring-loaded plunger, is located above the intake valve and incorporates an extension which projects into the intake port directly over the centre of the intake valve disc. The unloader valve chamber is connected by a drilling to a governor valve bolted to the side of the cylinder head.

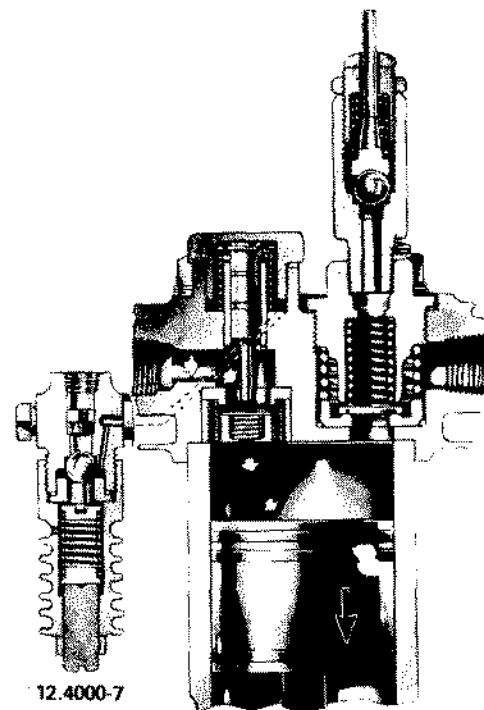
4. The aluminium alloy piston is attached to the connecting rod by a fully floating pin retained by circlips. The piston carries three rings, two stepped compression rings at the top of the skirt and one

scraper ring at the bottom. The aluminium die-cast connecting rod is fitted with a steel backed lead bronze lined bush at the small end and a split shell-type white metal lined steel bearing at the big end. The one piece forged steel crankshaft is supported in the crankcase by a single row ball bearing and a plain bush. The ball bearing is located in the drive end cover whilst the bush is pressed into the rear cover. A white metal faced steel thrust washer is located against the rear face of the crankshaft to control end float, and a rubber seal assembled to the outer end of the rear cover prevents oil leakage.

5. The compressor lubrication is by pressure feed from the engine lubrication system via a pipe connected between the compressor rear end cover and the engine main oil gallery. The oil is fed to the end cover bearing, through a drilling in the crankshaft to the connecting rod big end bearing and on SC9 compressors the plain bearing in the crankcase. The piston pin and cylinder wall are splash lubricated and also the ballrace crankshaft bearing on the SC6 unit. Surplus oil returns to the engine crankcase through drain holes in the drive end cover.

6. A safety valve and governor valve are supplied as loose items. The suggested location for the safety valve is on the air reservoir and the governor valve in the line between the air reservoir and compressor. A tapping taken off the governor valve goes to the pressure gauge.

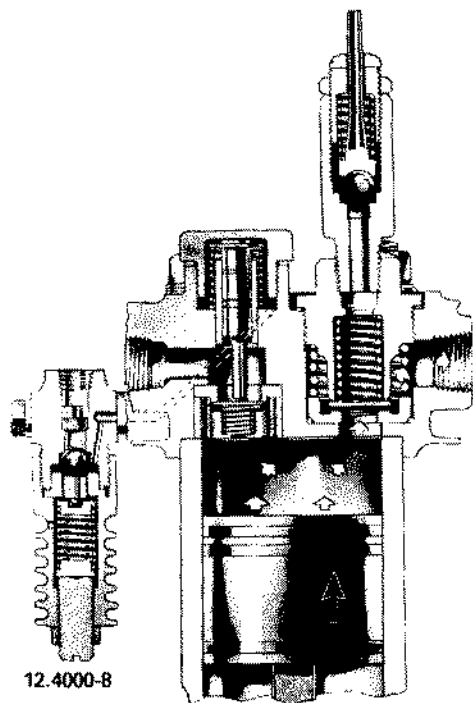
7. During the down stroke of the piston, vacuum is created above the piston which unseats the inlet valve allowing air drawn from the air cleaner to enter the upper space in the cylinder.



12.4000-7

AIR COMPRESSOR 2

8. As the piston starts the upward stroke, the enclosed air is compressed and the pressure created, combined with the action of the inlet valve spring, closes the inlet valve. The air above the piston is further compressed until the pressure lifts the delivery valve and the compressed air is discharged through the line to the reservoir. On the piston down-stroke, the delivery valve reseats, preventing the compressed air from returning to the cylinder, and the same cycle is repeated.



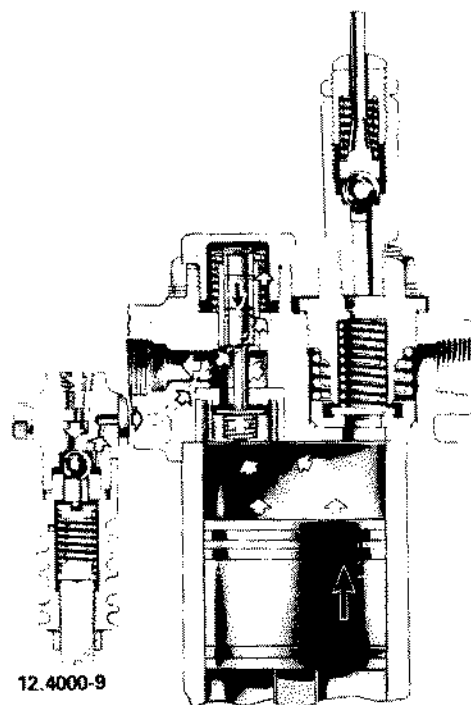
9. When the air pressure in the reservoir reaches the setting of the governor valve, compressed air from the reservoir passes through the governor into the cavity above the unloader plunger in the cylinder head. The air pressure depresses the unloader plunger which, in turn, lifts the inlet valve off its seat. During each upstroke of the piston, air is merely passed back to the air cleaner.

10. When the air pressure in the reservoir falls below the governor setting, the governor releases the air pressure above the unloader plunger. The unloader spring lifts the unloader plunger and the inlet valve spring returns the inlet valve to its seat and compression of air is resumed.

AIR COMPRESSOR (PREVENTIVE MAINTENANCE)

EVERY MONTH

11. Remove, dismantle and clean the air cleaner or filter. Replace if necessary.



12. Make a visual check of all joints, unions etc., for leakage or looseness and rectify where necessary.

13. Visually check that all pipe lines are secure and free from corrosion and damage; note that loose pipe line connections should be tightened only sufficiently to prevent leakage. If the cylinder head has recently been removed, check that the cylinder head nuts are fully tightened to a torque of 20-22 Nm (15-16 lb ft).

14. Check that the compressor is securely mounted.

EVERY SIX MONTHS

15. Clean the compressor oil supply line.

16. SC6 units only. Remove the delivery valve cap and the delivery valve seat retaining spring and check for presence of excessive carbon. Withdraw and check the condition of the delivery valve. If excessive carbon is found, disconnect the air lines from the cylinder head taking precautions to prevent ingress of dirt. Remove and clean the cylinder head; also check the compressor discharge line for carbon and clean or replace the line where necessary.

17. SC9 units only. Disconnect the compressor delivery line and check the line and the delivery port in the cylinder head for presence of excessive carbon. Clean or replace the delivery line if necessary. If excessive carbon is found in the cylinder head, disconnect the air lines from the cylinder head taking precautions to prevent dirt from entering the air lines. Remove and dismantle the cylinder head, thoroughly clean all parts and blow out the head passages with compressed air. Check the condition of the valves and seats. Reassemble the cylinder head and reconnect the air lines.

EVERY TWO YEARS OR 161,000 KILOMETRES (100,000 MILES)

18. This is the overhaul period. When a complete overhaul of the compressor is necessary, it must be performed in a fully equipped workshop. If these facilities do not exist a factory replacement unit service is available in the United Kingdom and certain other countries. This provides new or reconditioned units fully tested and guaranteed.

19. For organisations with complete workshop facilities, and overseas organisations that do not have a factory replacement service, a major repair kit should be purchased in advance. This contains all items required during overhaul and ensures safe operation for a further period.

20. Periodically between major overhauls, service checks should be carried out to ensure that the compressor is securely mounted and that the air cleaner is in good condition. The following tests should also be carried out to ensure the compressor is working efficiently.

OPERATING TESTS

21. With the compressor running, check for oil leaks.

22. Reduce the pressure in the reservoir by operating the brakes and check that the governor valve and unloader mechanism are functioning at the correct pressure. (If possible the engine gauge should be replaced by a master gauge during this test).

23. If air leakage in the remainder of the system is not excessive, failure of the compressor to maintain the normal air pressure in the system usually denotes loss of efficiency due to wear. Another sign of wear is excessive oil passing through to the reservoir or condenser and drain valve unit. If either condition develops, and inspection shows the remainder of the system to be in good condition, the compressor must be overhauled or replaced.

AIR LEAKAGE TESTS

24. Excessive leakage past the delivery valve can be detected with the engine stopped by applying 689 KPa (100 PSI) air pressure to the delivery port and carefully listening for the sound of escaping air.

25. If this test is satisfactory, charge the air pressure system to normal maximum operating pressure and stop the engine. Check once more for audible leaks, which if present indicate leakage at the unloader plunger.

26. Leakage at the delivery valve can be remedied by cleaning, lapping or replacing the valve and/or the baseplate if the valve seat is defective. Unloader plunger leakage can be remedied by replacing the plunger sealing ring or plunger.

AIR COMPRESSOR (REMOVAL)

27. Prior to removing the compressor from the engine release all air pressure from the system and clean all grease and dirt from around the unit, ensuring first that the vehicle cannot move.

28. Disconnect the battery cables. Remove the radiator assembly (5.3000) if it is engine mounted and the timing gear case cover (1.3100). Withdraw the compressor drive gear (1.7200). Remove the fuel

injection pump (2.2000) and disconnect the air and oil pipes from the compressor taking precautions to prevent dirt from entering the compressor and pipes.

29. Remove the five bolts and washers securing the carrier bracket to the air compressor end cover and also the bolt securing the carrier bracket to the bracket support. The carrier bracket can now be withdrawn from the compressor. Remove the six bolts securing the air compressor to the crankcase front plate and withdraw the unit from the engine.

AIR COMPRESSOR (INSPECTION AND OVERHAUL)

30. Before dismantling remove grease and dirt from the exterior of the compressor and mark the following items to show the correct relationship ready for reassembly: cylinder head and crankcase; end covers and crankcase; crankshaft and crankcase.

31. Remove the nuts and washers securing the cylinder head and lift off the assembly, if only the head is being overhauled take care not to disturb the cylinder. Remove the cylinder head gasket. The head assembly can now be dismantled as follows:

32. Remove the air filter.

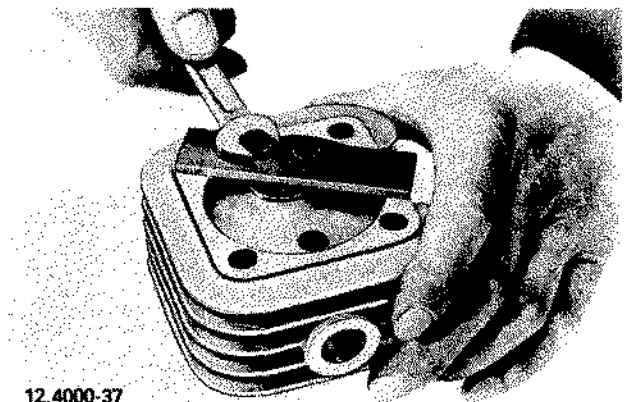
33. Remove the governor valve and safety valve. These can be dismantled separately at a later stage if necessary.

34. Unscrew the safety valve and intake port adaptors.

35. Remove the delivery valve cap and washer, and withdraw the valve spring and valve seat retaining spring. Invert the head and tip out the delivery valve, valve seat and sealing ring. If necessary the valve seat can be shaken from its position by bumping the head on a flat piece of wood.

36. Remove the unloader valve cap and washer and withdraw the valve assembly.

37. Withdraw the intake valve spring guide, using an extractor made from two ¼" UNF bolts and a metal plate.



12.4000-37

38. Remove the intake valve and valve spring, and shake out the valve seat.

39. Mark the cylinder in relation to the crankcase and withdraw the cylinder and sealing ring.

AIR COMPRESSOR 4

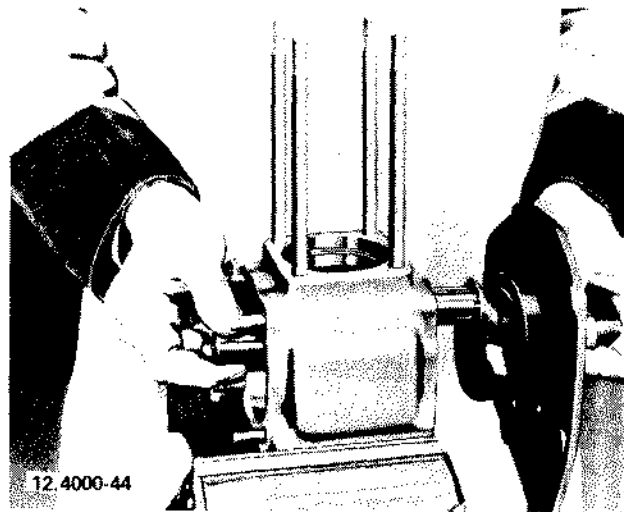
40. Remove the crankcase bottom or side cover and gasket. Mark the connecting rod in relation to the crankcase, knock back the tabs of the lock plate and unscrew the cap bolts. Withdraw the connecting rod and piston assembly.

41. Remove the rings from the piston and the circlips securing the piston pin. Push out the pin and remove the piston from the rod.

42. Remove the nuts and lockwashers securing the rear end cover and withdraw the cover and gasket. Remove the thrust washer from the inner face of the cover.

43. Remove the drive keys from the crankshaft.

44. Remove the locking wire from the drive end cover bolts, unscrew the bolts and withdraw the cover and crankshaft assembly.



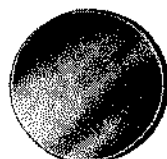
45. Tap the crankshaft and bearing from the cover.

46. Discard those items which will be renewed from the repair kit.

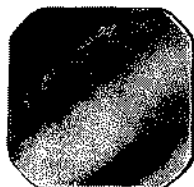
47. Clean all components in a cleaning solvent and blow dry with compressed air. Remove traces of carbon and any remaining particles of old joints from all surfaces.

48. Clean the intake and delivery valves by lapping them on a sheet of crocus cloth held on a flat surface. Renew the valves if scored. The difference between the intake and delivery valves are shown below.

INTAKE



DELIVERY



49. Examine the valve seats for scratches and pitting. If necessary, lap with fine carborundum paste. If the pitting is severe, use a seat reamer and finish off by lapping.

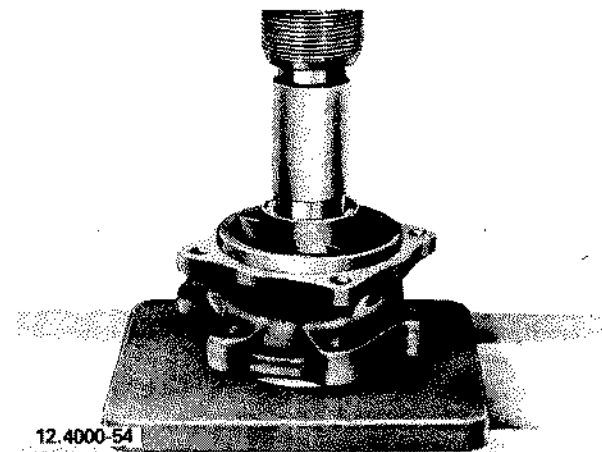
50. Renew the delivery valve spring and check the remaining springs for weakness.

51. Examine the head for cracks and damage and the unloader valve guide for wear. Check that the unloader valve is a good sliding fit in the guide.

52. Examine the crankcase, side covers, bottom covers and end covers for cracks and damage. Replace if necessary.

53. Check the condition of the rear end cover oil seal and renew if necessary. To renew the seal drive, drive out the old seal from the cover using a suitable drift, and press in the new seal so that the seal lip is towards the inside of the cover.

54. The crankshaft should be a neat sliding fit in the plain bearings. If worn excessively the bush must be renewed, by pressing out the old bush using a suitable drift and then pressing in the new bush until its outer edge is flush with the bottom of the cover bore chamfer. Fine bore the bush to the specified diameter and concentric with the end cover spigot to within 0.05 mm (0.002 ins).



55. Check the condition of the drive end bearing. Check also for a light press fit in the end cover. To renew the bearing press off or withdraw the old bearing from the crankshaft with a suitable drag and then press on the new bearing using a sleeve to contact the bearing inner race.

56. Check that the oilways in the crankshaft are clear, using a piece of wire, if necessary, and flush with cleaning solvent. Check that the oilways in the end-cover are clear and clean.

57. Check the cylinder bore for excessive wear, out-of-round or scoring. If scored or out-of-round more than 0.05 mm (0.002 ins) or tapered more than 0.076 mm (0.003 ins), the cylinder should be replaced. The original bores should be 66.69-66.70 mm (2.6255-2.6260 ins) for SC6 units and 85.00-85.03 mm (3.3465-3.3475 ins) for SC9 units, while the clearance for the pistons is 0.08-0.13 mm (0.0032-0.0052 ins) for SC6 units and 0.19-0.23 mm (0.0075-0.009 ins) for SC9 units.

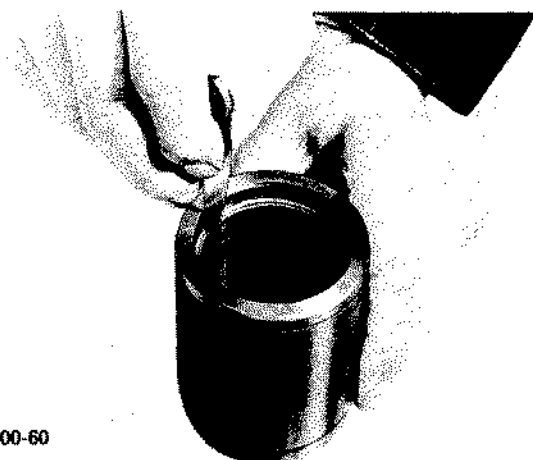
for SC9 units. Check for wear in the cylinder bore and rectify in accordance with the following table:-

Wear in Bore	Remedy
Up to, but not exceeding 0.127 mm (0.005 ins)	Fit New Standard Rings
Wear exceeding 0.127 mm (0.005 ins)	Fit New Cylinder, New Piston and Standard Rings

58. Examine the piston for scores, cracks and damage of any kind. Replace if necessary.

59. Check the fit of the compression rings in the ring grooves. The clearance should be 0.015-0.066 mm (0.0006-0.0026 ins) for SC6 units and 0.033-0.084 mm (0.0013-0.0033 ins) for SC9 units.

60. Install the ring in the cylinder and check that the gap is 0.003-0.007 mm (0.0762-0.1778 ins) for SC6 units and 0.254-0.381 mm (0.01-0.015 ins) for SC9 units.



12.4000-60

61. Check the fit of the gudgeon pin in the piston and connecting rod. The gudgeon pin should be a finger push fit in the piston and the clearance in the connecting rod bush should not exceed 0.038 mm (0.0015 ins).

62. Inspect the connecting rod for cracks and damage, and the bearing for correct fit on the crankshaft journal. The clearance between the rod journal and bearing must not be more than 0.0762 mm (0.003 ins).

63. Inspect the crankshaft for wear and check the threads, shaft ends, keyways and drive keys for damage. The crankpin diameter should be within the limits 22.187-22.200 mm (0.8735-0.8740 ins) for SC6 units and 31.725-31.737 mm (1.2490-1.2495 ins) for SC9 units.

64. Examine the thrust washers for wear.

65. Before reassembling the compressor lubricate all working parts with clean engine oil to prevent possible damage until the oil supply is functioning.

66. The crankshaft and end covers must be reassembled and as there are differences between the SC6 and SC9 units, paragraphs 67 to 69 refer to the SC6 units and paragraphs 70 to 73 refer to SC9 units.

67. Place the joint on the drive-end cover and install

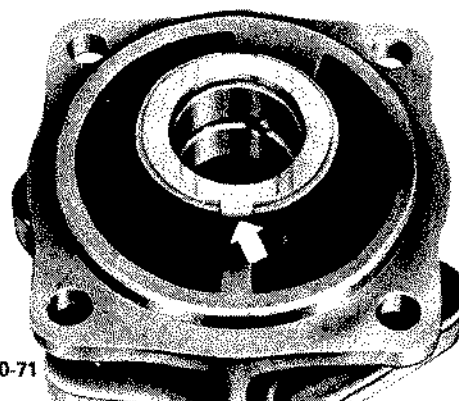
the crankshaft, complete with ball bearing into the cover. Insert the crankshaft into the crankcase and align the positioning marks made on the cover and crankcase during dismantling. Ensure that the joint is correctly positioned and does not cover the oil drain holes. Fit the locking strips in line with the cylinder head studs and with the tabs facing inwards. Securely tighten the setscrews. Bend up the locking strip tabs. Fit the distance piece so that the chamfered end abuts the ball race.

68. Aligning the positioning marks made during dismantling, fit the rear end-cover complete with joint, and fit the spring washers and nuts.

69. Check the crankshaft to ensure free rotation and then tighten the nuts.

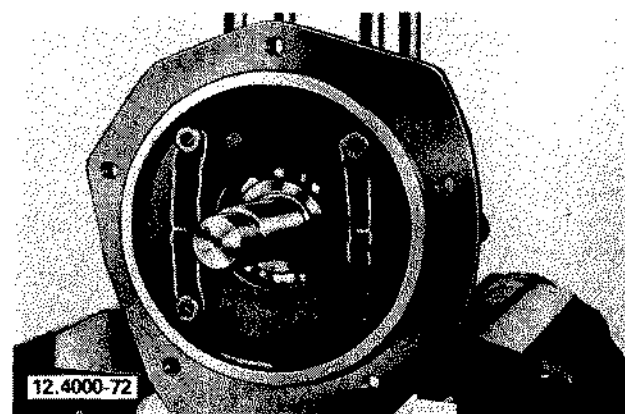
70. Position one of the thrust washers in the crankcase with the steel side facing towards the plain bearing and the tab located in the slot provided.

71. Insert the threaded end of the crankshaft into the plain bearing in the crankcase. Place the thrust washer on the cover with the steel side facing towards the plain bearing and the tab located in the slot (arrowed).

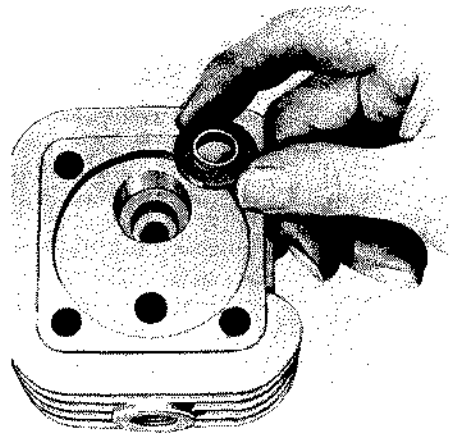


12.4000-71

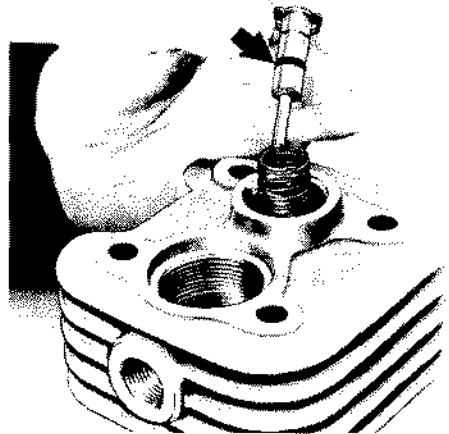
72. Aligning the positioning marks made during dismantling, fit the end-cover complete with joint, and fit the spring washers and set screws. Check the crankshaft to ensure free rotation and then tighten the set screws. Finally, secure the drive end cover bolts with locking wire as shown below.



12.4000-72



2. inlet valve on the seat and the spring
 3. Position the shim on the spring and
 spring and shim.
 4. e valve spring guide and, holding the
 down against the resistance of the
 the face of the cylinder head in three
 1 the guide.
 5. ealing ring on to the delivery valve seat.
 6. seat, using a wrench inserted in the
 le through the centre of the fitting, and
 7. ly.
 8. delivery valve on the seat and position
 9. Screw in the valve cap together with the
 10. r and tighten securely.
 11. ealing ring and circlip on to the unloader
 12. lightly smear the sliding surfaces of the
 13. nger and the bore of the plunger guide
 14. cylinder head with 'Dow-Corning MS
 15. sert the spring and plunger. Screw in the
 16. together with the sealing washer and
 17. ly.



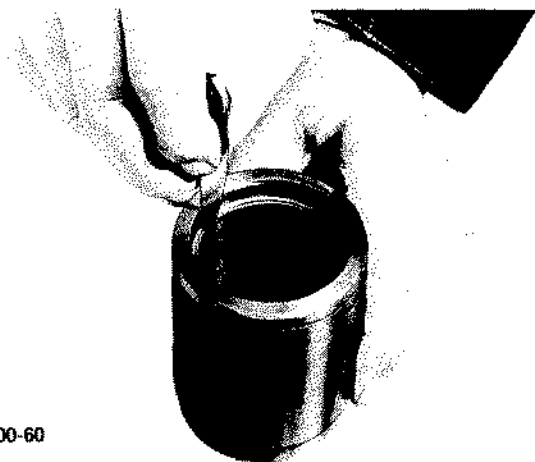
for SC9 units. Check for wear in the cylinder bore and rectify in accordance with the following table:-

Wear in Bore	Remedy
Up to, but not exceeding 0.127 mm (0.005 ins)	Fit New Standard Rings
Wear exceeding 0.127 mm (0.005 ins)	Fit New Cylinder, New Piston and Standard Rings

58. Examine the piston for scores, cracks and damage of any kind. Replace if necessary.

59. Check the fit of the compression rings in the ring grooves. The clearance should be 0.015-0.066 mm (0.0006-0.0026 ins) for SC6 units and 0.033-0.084 mm (0.0013-0.0033 ins) for SC9 units.

60. Install the ring in the cylinder and check that the gap is 0.003-0.007 mm (0.0762-0.1778 ins) for SC6 units and 0.254-0.381 mm (0.01-0.015 ins) for SC9 units.



12.4000-60

61. Check the fit of the gudgeon pin in the piston and connecting rod. The gudgeon pin should be a finger push fit in the piston and the clearance in the connecting rod bush should not exceed 0.038 mm (0.0015 ins).

62. Inspect the connecting rod for cracks and damage, and the bearing for correct fit on the crankshaft journal. The clearance between the rod journal and bearing must not be more than 0.0762 mm (0.003 ins).

63. Inspect the crankshaft for wear and check the threads, shaft ends, keyways and drive keys for damage. The crankpin diameter should be within the limits 22.187-22.200 mm (0.8735-0.8740 ins) for SC6 units and 31.725-31.737 mm (1.2490-1.2495 ins) for SC9 units.

64. Examine the thrust washers for wear.

65. Before reassembling the compressor lubricate all working parts with clean engine oil to prevent possible damage until the oil supply is functioning.

66. The crankshaft and end covers must be reassembled and as there are differences between the SC6 and SC9 units, paragraphs 67 to 69 refer to the SC6 units and paragraphs 70 to 73 refer to SC9 units.

67. Place the joint on the drive-end cover and install

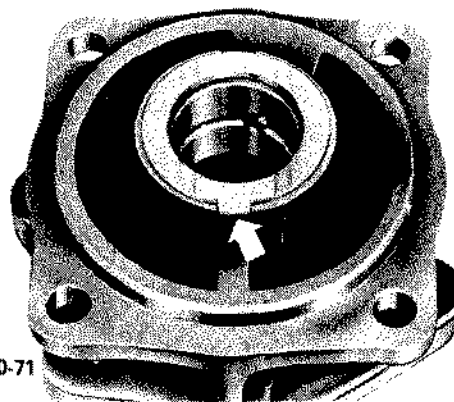
the crankshaft, complete with ball bearing into the cover. Insert the crankshaft into the crankcase and align the positioning marks made on the cover and crankcase during dismantling. Ensure that the joint is correctly positioned and does not cover the oil drain holes. Fit the locking strips in line with the cylinder head studs and with the tabs facing inwards. Securely tighten the setscrews. Bend up the locking strip tabs. Fit the distance piece so that the chamfered end abuts the ball race.

68. Aligning the positioning marks made during dismantling, fit the rear end-cover complete with joint, and fit the spring washers and nuts.

69. Check the crankshaft to ensure free rotation and then tighten the nuts.

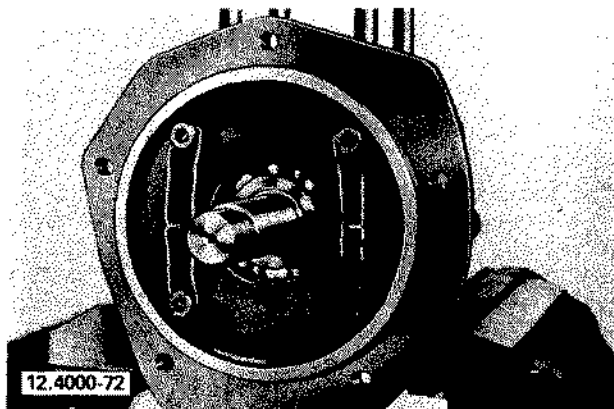
70. Position one of the thrust washers in the crankcase with the steel side facing towards the plain bearing and the tab located in the slot provided.

71. Insert the threaded end of the crankshaft into the plain bearing in the crankcase. Place the thrust washer on the cover with the steel side facing towards the plain bearing and the tab located in the slot (arrowed).



12.4000-71

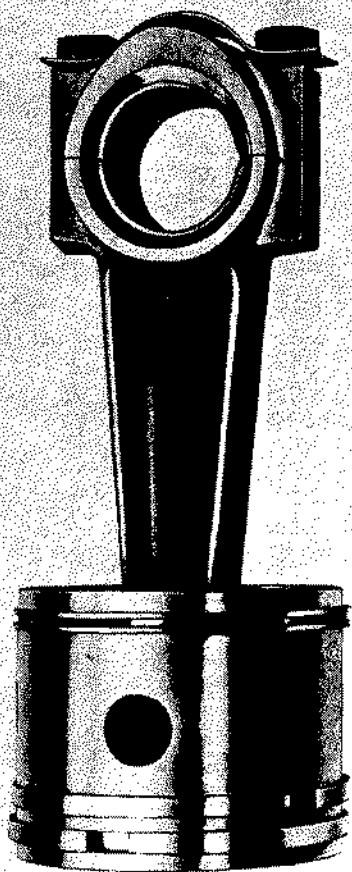
72. Aligning the positioning marks made during dismantling, fit the end-cover complete with joint, and fit the spring washers and set screws. Check the crankshaft to ensure free rotation and then tighten the set screws. Finally, secure the drive end cover bolts with locking wire as shown below.



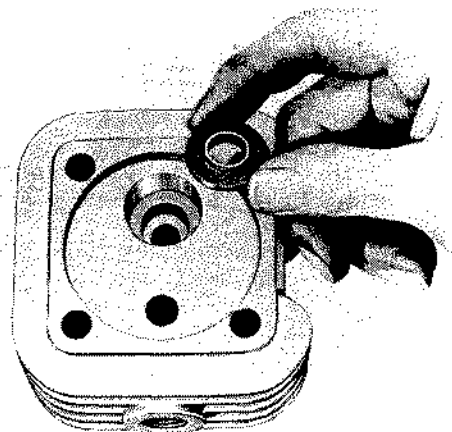
12.4000-72

AIR COMPRESSOR 6

73. Fit the drive keys on the crankshaft.
74. Refit the piston rings ensuring that all compression rings are fitted with the internal recesses facing towards the piston crown, and assemble the piston to the connecting rod.
75. Ensure that the big end bearing inserts are correctly located in the connecting rod and bearing cap, and assemble the connecting rod on the crankshaft as originally fitted. Fit the locking strap and replace and tighten the connecting rod bolts to a torque of 5.1-5.4 Nm (3.75-4 lb ft) on SC6 units and 12-15 Nm (9-11 lb ft) on SC9 units.

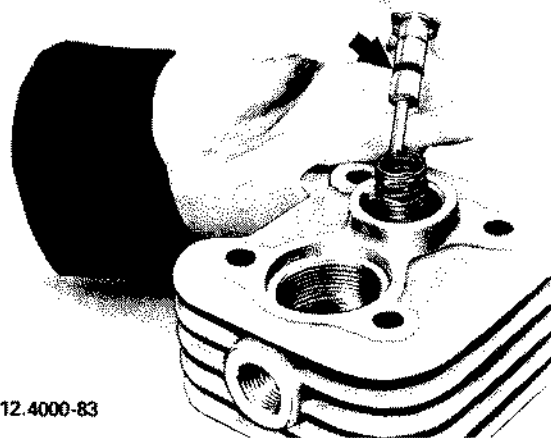


76. Space the piston ring gaps. Place the cylinder, complete with sealing ring over the piston and insert the end into the crankcase.
77. As the cylinder head and valves have various differences, reassembly of the SC6 unit is described in paragraphs 78 to 84 and the SC9 unit in paragraphs 85 to 89 inclusive.
78. Heat the cylinder head and, when the head is sufficiently hot, insert the inlet valve seat so that the flat side abuts the shoulder in the bore.



12.4000-78

79. Place the inlet valve on the seat and the spring on the valve. Position the shim on the spring and centralise the spring and shim.
80. Insert the valve spring guide and, holding the guide firmly down against the resistance of the spring, stake the face of the cylinder head in three places around the guide.
81. Fit the sealing ring on to the delivery valve seat. Screw in the seat, using a wrench inserted in the hexagonal hole through the centre of the fitting, and tighten securely.
82. Place the delivery valve on the seat and position the springs. Screw in the valve cap together with the sealing washer and tighten securely.
83. Fit the sealing ring and circlip on to the unloader plunger and lightly smear the sliding surfaces of the unloader plunger and the bore of the plunger guide bush in the cylinder head with 'Dow-Corning MS 200' fluid. Insert the spring and plunger. Screw in the unloader cap together with the sealing washer and tighten securely.



12.4000-83

84. Place the joint on the cylinder and correctly position the cylinder head on the studs. Fit the nameplate, plain washers, spring washers, and nuts onto the studs and tighten the nuts progressively to a torque of 20-22 Nm (15-16 lb ft).

85. Insert the shim washer into the recess in the baseplate. Place the smaller spring on the shim washer. Place and centralise the inlet valve disc on the spring and the delivery valve disc on its seat in the baseplate.

86. Press the delivery valve spring into its recess in the manifold and position the manifold on the joint and baseplate. (If necessary, insert a dowel or pencil through the unloader plunger guide bush in the manifold to hold the inlet valve below the surface of the baseplate before positioning the manifold). Check that the valve discs are correctly positioned and then fit the spring washers and setscrews.

87. Securely tighten the setscrews. Lift the valves off their seats several times to ensure that they are fitted correctly.

88. Fit the sealing ring on to the unloader plunger and lightly smear the sliding surfaces of the unloader plunger and bore of the plunger guide bush in the manifold with 'Dow-Corning MS 200' fluid. Insert the spring and plunger complete with the spring circlip. Screw in the unloader cap together with the washer and tighten securely.

89. Place the joint on the cylinder and correctly position the cylinder head on the studs. Fit the spring washers and nuts on the studs and tighten the nuts progressively to a torque of 20-22 Nm (15-16 lb ft).

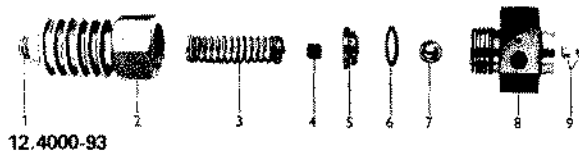
90. Apply clean engine oil over the crankshaft and on the cylinder wall.

91. Fit the crankcase bottom or side cover together with gasket, spring washers and setscrews. Securely tighten the setscrews.

92. Before refitting the governor valve and safety valve they should be dismantled and inspected for wear.

AIR COMPRESSOR GOVERNOR

93. Unscrew the valve cap (2) from the governor body (8) and remove the valve spring and seats (3), valve guide (4), valve seat (5), shim (6) and ball valve (7).



- | | |
|----------------------------|--------------------|
| 1. Adjusting Screw | 5. Ball Valve Seat |
| 2. Valve Cap | 6. Shim |
| 3. Valve Spring and Seats | 7. Ball Valve |
| 4. Ball Valve Guide | 8. Governor Body |
| 9. Air Filter and Retainer | |

94. Using a suitable piece of rod push out the air filter and retainer (9).

95. Do not disturb the adjuster and locknut unless new parts are required.

96. Wash all parts in cleaning solvent and blow out the air passages with compressed air.

97. Examine the body and cap for cracks and damage and the ball valve seats for wear.

98. Check the ball for scratches and discolouration.

99. Check the spring for corrosion and weakness.

100. Renew the filter.

101. If a new governor body is required the ball valve must be bedded in as follows:-

a. Insert the ball and seat into the body without the shim.

b. Compress the ball and seat in the body, using a ½ inch BSP steel union nut, until the flange of the seat contacts the end of the body.

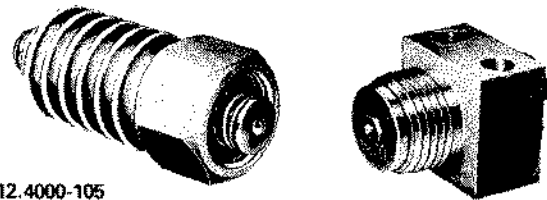
c. Unscrew the nut and extract the seat and ball. Remove any burrs from the seat bore.

102. Reassemble the components noting the following points in paragraphs 103, 104 and 105.

103. Install the filter retainer so that it locates against the filter at the bottom of the body bore.

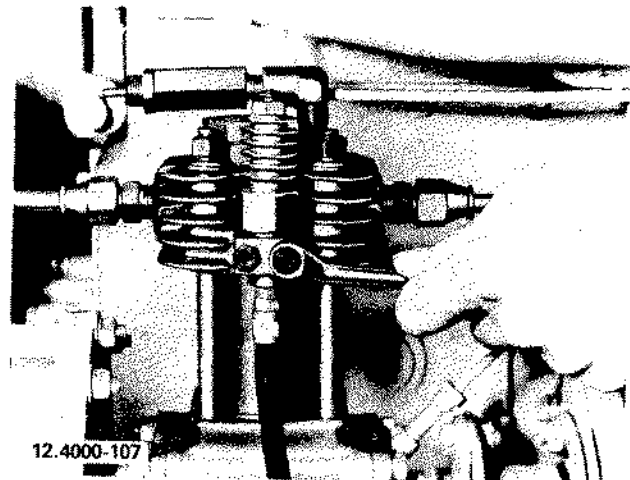
104. Install the shim under the flange of the valve seat.

105. Ensure that the dimple in one end of the ball valve guide is related to the pip of the spring seat as shown below.



106. Using a new gasket between the governor body and the cylinder head, and ensuring that the centre drilling registers with that in the head refit the governor valve.

107. Tighten the governor valve securing bolts.



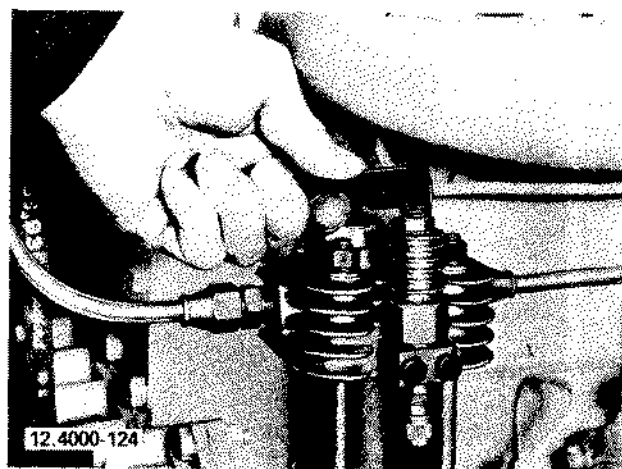
AIR COMPRESSOR 8

AIR COMPRESSOR SAFETY VALVE

- 108. Slacken the locknut and unscrew the adjusting screw.
- 109. Withdraw the release pin and valve spring, and tip out the ball valve.
- 110. Wash all parts in cleaning solvent and blow out the valve body with compressed air.
- 111. Check the ball for scratches and discolouration and the valve seat for wear.
- 112. Examine the body for cracks or damage.
- 113. Check the spring for corrosion and weakness.
- 114. Reassemble, do not tighten the valve adjusting screw at this stage.
- 115. Refit the safety valve to the compressor heads. If the valve attaching elbow (where fitted) has been disturbed, tighten it so that when the valve is installed, the end of the air release pin is towards the intake port.

AIR COMPRESSOR (REFITTING)

- 116. Ensure that the oil drain holes are clear for oil to return to the engine crankcase.
- 117. Replace the air compressor to the crankcase front plate and tighten the six bolts. It is recommended that a new gasket is fitted when remounting.
- 118. Refit the carrier bracket (12.1000), fuel injection pump (2.2000), compressor drive gear (1.7200) and engine front cover (1.3100). If the radiator is engine mounted refit as described in 5.3000. Reconnect the battery cable.
- 119. Before connecting the oil supply line to the compressor, clean the supply line and, if possible, run the engine for a few seconds to be sure that the oil is flowing freely and ensure that the air cleaner or filter is clean and properly installed.
- 120. With the compressor running check for oil and air leaks.
- 121. The governor valve and safety valve should now be adjusted.

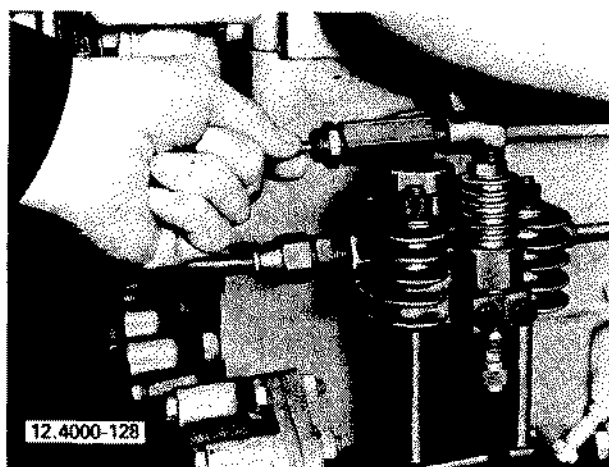


GOVERNOR VALVE ADJUSTMENT

- 122. Remove the drain plug from the bottom of the air reservoir and install an air pressure gauge.
- 123. Start the engine and charge the system until the air pressure reaches the specified limit of 710-737 KPa (103-107 PSI).
- 124. Slacken the locknut on the governor valve adjusting screw, and with the engine running, adjust the screw until the valve operates within the limits specified. Tighten the locknut.
- 125. Stop the engine and exhaust the air pressure system by pulling on the safety valve air release pin.
- 126. Recharge the system and check the accuracy of the valve adjustment.
- 127. Slowly unscrew the air pressure gauge and install the reservoir drain plug and washer.

SAFETY VALVE TEST

- 128. The safety valve may be tested for operation by pulling the exposed end of the valve release pin when the system is fully charged. The outward movement of the pin releases the spring load from the ball valve and allows air to escape. If the valve does not blow-off, the ball is stuck on its seat and the valve assembly must be disassembled for cleaning.



SAFETY VALVE ADJUSTMENT

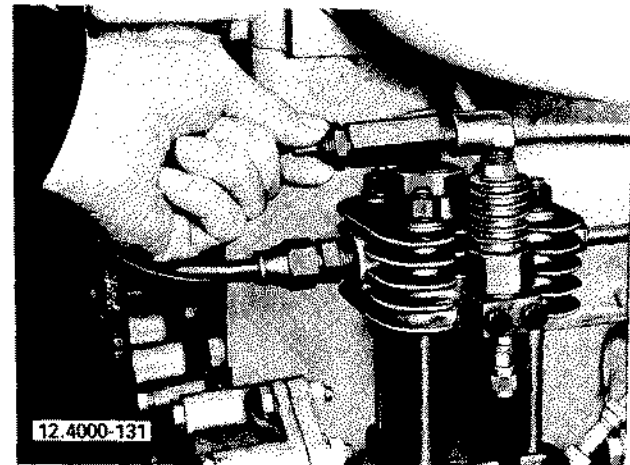
- 129. Remove the drain plug from the bottom of the air reservoir and install an air pressure gauge.
- 130. Disconnect the governor air feed pipe from the reservoir and install a suitable plug in place of the pipe connector.

131. Slacken the locknut on the safety valve adjusting screw and with the engine running adjust the screw until the valve blows-off at the specified pressure of 1000-1068 KPa (145-155 PSI). Tighten the screw locknut.

132. Stop the engine and exhaust the air pressure system by pulling on the safety valve air release pin (See 12.4000-128).

133. Recharge the system and check the accuracy of the valve adjustment.

134. Slowly unscrew the air pressure gauge and install the reservoir drain plug and washer. Refit the governor air feed pipe.

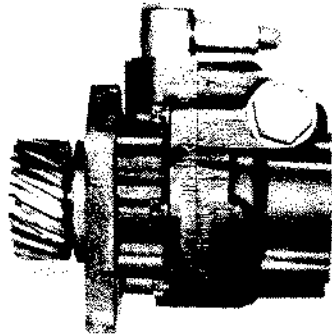


12.5000

HYDRAULIC PUMP

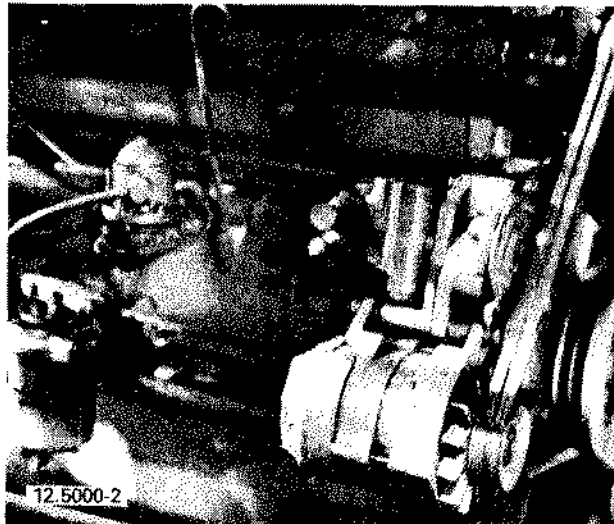
HYDRAULIC PUMP (DESCRIPTION)

1. The hydraulic pumps used on 220 and 330 cu in engines are of the roller pump type manufactured by Hobourn Eaton Manufacturing Company Ltd.



12.5000-1

2. The pump is attached to the rear face of the crankcase front plate on the right hand side of the engine and driven by a gear which engages the camshaft gear.



12.5000-2

3. The pump consists of a cast iron body and end cover, each fitted with a steel backed bronze bush in which the pump drive shaft rotates. A ball bearing retained by a circlip is mounted at the front end of the pump cover and supports the shaft at the drive end.

4. Located between the ball bearing and plain bush is a spring loaded lip type neoprene oil seal.

5. The pump contains six (6) roller vanes inserted between the arms of the carrier which is keyed to the pump shaft. The carrier and rollers rotate in a white metal bush pressed into the pump cover.

6. A combined flow control and relief valve is fitted in the top of the pump cover secured by a valve retaining cap and 'O' ring seal. The oil relief valve limits the oil pressure in the system to 6890 KPa (1000 PSI) and the oil control valve regulates the volume of oil circulated through the hydraulic system. An oil supply chamber at the front of the vane carrier bush connects with a port in the pump cover which in turn is attached to a hose adaptor bolted to the pump body.

7. Two neoprene 'O' type sealing rings fitted in a recess in the pump cover form a seal between the mating faces of the body and the cover.

8. The pump body is dowelled and bolted to the pump cover.

OPERATION

9. The pressure delivered by the pump is controlled by the relief valve which is set to open at a predetermined pressure. This allows oil to circulate within the pump until the pressure drops below the valve operating pressure. The oil flow control valve regulates the output volume. As the pressure is built up within the pump, oil is directed through small delivery holes to the delivery pipeline. As the pressure within the pump increases the valve maintains the correct output volume and excess oil is allowed to leak past the valve recirculating within the pump.

HYDRAULIC PUMP (REMOVAL)

10. Disconnect the cables from the battery.

11. Thoroughly clean the exterior and surrounding area of the pump assembly.

12. Place a tray underneath the engine to catch the oil which will drain out when disconnecting the hydraulic hoses.

13. Slacken the clip and disconnect the hose from the adaptor on the side of the pump. Plug the end of the hose to prevent further drainage of oil.

14. Disconnect the hose at the banjo connector on top of the pump, taking care not to lose the copper washers.

15. Remove the three (3) screws securing the pump to the timing gear case. The pump and gear assembly can now be withdrawn from the engine.

HYDRAULIC PUMP (INSPECTION AND OVERHAUL)

16. Overhaul of the pump consists of cleaning of components and replacing worn parts, for example, pump shaft bushes, bearing vane carrier and rollers.

17. To dismantle the pump, clamp the body in a vice, remove the bolt and tab washer from the end of the shaft and using a suitable drag withdraw the gear from the shaft. The key can be removed from the shaft using a pair of pliers.

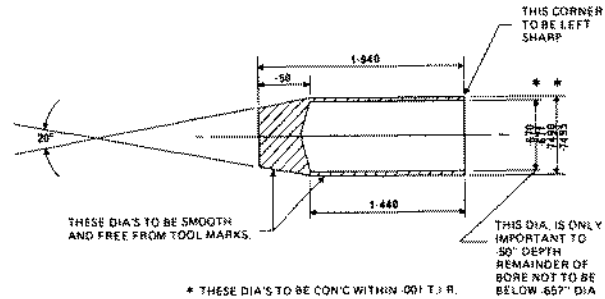
18. Remove the adaptor screw, adaptor, fibre washer and gasket from the top of the pump cover.

HYDRAULIC PUMP 2

19. **NOTE.** The venturi flow director which is pressed into the pump cover must not be removed.
20. The four (4) allen screws holding the mounting plate to the pump must next be unscrewed and using a hide faced mallet, knock the mounting plate from the pump shaft.
21. Separate the pump body from the pump cover by removing the six allen screws.



22. Remove the pump from the vice and separate the cover from the body; keep vertical to prevent components from falling out.
23. The drive pin must be removed next from the shaft, then by gently tapping the shaft at the body end, the shaft and bearing can be withdrawn.
24. Remove and discard the 'O' ring seals from the grooves in the pump body.
25. Extract the roller vanes and carrier and lift out the cam insert and cam locking peg from the pump body.
26. Remove the valve cap, valve and valve spring from the top of the pump body taking care that the components do not spring out when unscrewing the valve cap.
27. Place all parts of the valve assembly where they will not be damaged or subjected to contamination.
28. Withdraw the shaft seal from the pump cover ensuring that no damage is caused to the shaft bearing bush.
29. Wash all the pump components in a suitable solvent and dry with an air line or wipe clean with a lint free cloth.
30. During assembly operations, extreme caution should be used to prevent any dirt from entering the pump. All parts should be lightly oiled before assembly.
31. Check the pump body and cover for wear and renew either part if the faces or bushes are worn.
32. Grease the lip of a new shaft seal and using a suitable tool, install the seal into the pump cover taking care that no damage is done to the lip of the seal.

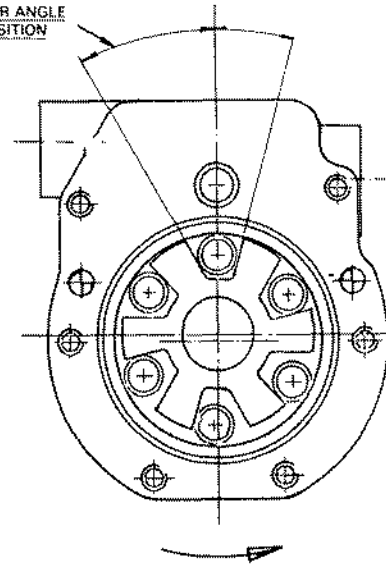


12.5000-32

* THESE DIA'S TO BE CON'C WITHIN .001 T.Y.R.
Tool for installing seal.

33. Inspect the cam and cam locking peg, and replace if they are worn or damaged. Install the cam locking peg in the slot of the pocket, then place the cam in the pocket with the slot over the locking peg. Ensure that the cam is seated on the pocket face.
34. Check the vane carrier for wear and place it into the cam, ensuring that the greater angle is in the leading position.

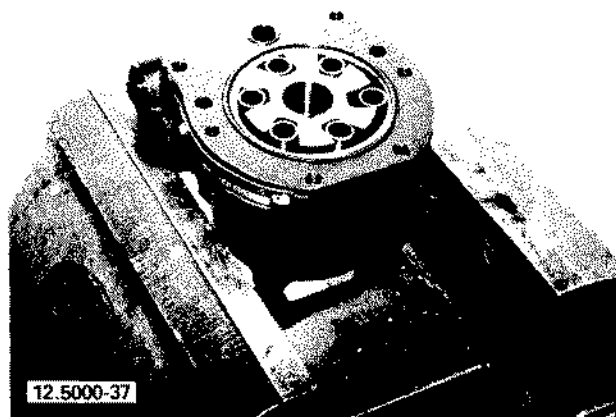
NOTE:- GREATER ANGLE
IN LEADING POSITION



12.5000-34

35. Inspect the rollers, paying particular attention to the finish on the ends, and replace if they are scored, damaged or out of round. Place a straight edge across the cam surface and using feeler gauges, check the end clearance which should not exceed 0.05 mm (0.002 ins). If the end clearance is in excess of this figure the vane carrier or rollers must be replaced.
36. Inspect the shaft and bearing assembly. If the bearing balls are loose or if excessive grease has seeped out of the bearing, the bearing must be replaced. Insert the shaft and bearing assembly from the seal side of the pump cover, using an oil seal inserting tool, ensuring that there are no sharp edges on the shaft to cut the seal lip.

37. Install two new 'O' rings (arrowed) into the grooves in the pump cover joint face of the pump body.



38. Align the vane carrier bore with the shaft bushing bore in the pump body, place the vane carrier drive pin in the shaft and insert the shaft into the carrier bore and the pump body bushing bore, bringing the body and cover together. Secure the

body to the cover with the five screws and tighten evenly to a torque of 19-22 Nm (14-16 lb ft). Check that the shaft rotates freely after tightening the screws.

39. Replace the flow control valve spring into its bore after testing the spring tension which should be 3.6-4.1 kg (8-9 lb) at 20.83 mm (0.82 ins) long. If not it must be replaced.

40. Insert the valve into the bore so that the exposed ball end enters last, ensuring that the valve is not sticking.

41. Replace the 'O' ring on the valve cap and install the valve cap and 'O' ring into the pump, tightening to a torque of 41-48 Nm (30-35 lb ft).

42. Install a new gasket in the groove on top of the pump cover housing and replace the adaptor, fibre washer and adaptor screw.

43. Install the mounting plate onto the shaft bringing the mounting plate and pump together. Secure with the four screws.

44. Place the driving gear key into the shaft, assemble the driving gear, tab washer and bolt onto the end of the shaft and tighten the bolt to a torque of 20-27 Nm (15-20 lb ft).

HYDRAULIC PUMP (REFITTING)

45. Place the pump assembly into position on the rear face of the crankcase front plate and insert the three retaining screws.

46. Remove the oil plugs and reconnect the hoses onto their appropriate adaptors.

47. Reconnect the battery cables.