The FERGUSON SYSTEM
TRADE MARK

Ferguson

SERVICE MANUAL

SPECIFICATION AND DATA

TRACTORS TYPE TE—A20 and TE—D20

This specification initially gives data of the basic normal-width tractor, less engine ; specifications of engines then follow.

Details applicable to tractors which deviate from this standard, e.g. narrow-width models, are given in Section T, under the title of 'Special Type Tractors.'

TRACTOR, LESS ENGINE

Overall Dimensions.

Wheel Base 70" (1778 mm.) Track : Front adjustable in 4" steps (102 mm) from 4ft. to 6ft. 8 ins. (1219 to 2032 mm.)
,, Rear ,, ,, ,, ,, ,, 4ft. to 6ft. 4 ins. (1219 to 1930 mm.)

Turning circle : with brakes 16 ft. (4876 mm) without brakes 20 ft. (6095 mm).

Ground clearance 13" (330 mm.) Overall length 9 ft. 7 ins. (2921 mm.) Overall width 5 ft. 4 ins. (1625 mm.)
Overall height 4 ft. 8 ins. (1320 mm.) Weight (dry) 2500 lb. (1134 kg). Tyres front 4.00 × 19. Tyres rear 10.00 × 28.

Fill-Up Data.

Engine Sump 12 pints (6.8 litres)
Air Cleaner ¾ pint (.45 litres)
Cooling System 20 pints (11.3 litres)
Transmission casing 5 gallons (22.8 litres)
Belt Pulley ½ pint (.28 litres)
Fuel tank-TE-A20 : 8 gallons (36 litres)
-TE-D20 : 7 gallons (31.5 litres) and 1 gallon (4.5 litres)
Steering Box 5 pints. (2.9 litres)
Front Hubs (each) ⅝ pint (.30 litres)
Tyre pressures : Front 26 lb. per sq. inch
Rear 12 lb. per sq. inch

Component Details	Dimensions New		Clearance New		Permissible Worn Clearance or Dimension		Remarks
	Ins.	mms.	Ins.	mms.	Ins.	mms.	
Hydraulic Pump.							
Housing Bore for Control Valve Bush	.999 1.000	25.375 25.400					
			—.001 —.0025	—.025 —.064			
Control Valve Bush Ext. Dia.	1.001 1.0015	25.425 25.438					
Control Valve Bush Int. Dia.	.5925 .5030	15.959 15.062					
			.0005 .0012	.013 .031			
Control Valve Dia.	.5918 .5920	15.032 15.037					

Torque Loadings—Valve Chamber Clamp Bolts 70 lbs. ft. (9.675 kg.m). Pump Assembly Securing Bolts 45 lbs. ft. (6.25 kg.m).

Hydraulic Lift Assy.
Fork retraction spring—Free length inside hooks 4.88" (123.952 mm). Length under 12 lbs. (5.443 kg) load 6.94" (176.276 mm).

Component Details	Ins.	mms.	Ins.	mms.	Ins.	mms.	Remarks
Hydraulic Cylinder Bore	2.4995 2.5010	63.487 63.525					
			.0015 .0040	.038 .102	.006	.152	
Hydraulic Cylinder Piston Dia.	2.497 2.498	63.424 63.449					
Piston Ring Groove Width	.1255 .1265	3.188 3.213					
			.0015 .0035	.038 .089	.005	.126	
Piston Ring Width	.124 .123	3.150 3.124					
Piston Ring Gap (Closed)	.007 .013	.178 .330			.018	.457	
Linkage Check Chain Length.	**8.015 7.980**	**203.581 202.692**					**Length of check chain taken between inside faces of end links.**

Component Details	Dimensions New Ins.	Dimensions New mms.	Clearance New Ins.	Clearance New mms.	Permissible Worn Clearance or Dimension Ins.	Permissible Worn Clearance or Dimension mms.	Remarks
Check Chain Shackle Length	1.189 1.205	30.201 30.607					This dimension taken from pin hole centre to inside face.
Check Chain Assy. Total Length	10.358 10.425	263.093 264.795			10.7	271.76	This length between pin hole centres.
Transmission.							
Shifter Mechanism.							
Shifter Rail Dia.	.7465 .7475	18.961 18.987	.0015 .0035	.038 .089	.006	.152	
Shifter Rail Bore in Casing	.749 .750	19.025 19.050					
Plunger Spring Details.	Axial load 12 ± 1 lb. Load may be increased in increments of 3 lbs. (1.361 kg) by fitting 1/16" (1.588 mm) shims up to a maximum of 5/16" (7.938 mm) giving max. load of 27 lbs. (12.247 kg). Free length 1.571" (39.903 mm). Solid length .832" (21.133 mm). Nominal fitted length 1.32" (33.528 mm).						
Thickness of Shifter Forks at Pressure Faces.	.372 .368	9.449 9.347	.008 .016	.203 .406	.025	.634	
Width of Groove in Coupling Connectors	.380 .384	9.652 9.754					
Mainshaft.							
First Gear Bushing Bore.	2.0620 2.0635	52.375 52.413	.0015 .0052	.038 .132	.007	.177	
Mainshaft Dia. at Position of 1st Gear	2.0605 2.0583	52.337 52.281					
2nd Gear Bushing Bore.	2.0620 2.0635	52.375 52.413	.0015 .0052	.038 .132	.007	.177	
External Dia. of Bearing Connector	2.0605 2.0683	52.337 52.281					
Countershaft.							
3rd. Gear Bushing Bore.	2.0620 2.0635	52.375 52.413	.0015 .0052	.038 .132	.008	.203	
Ext. Dia. of Countershaft 3rd. Gear Bush	2.0605 2.0583	52.337 52.281					
4th. Gear Bushing Bore	2.0635 2.0620	52.413 52.375	.0052 .0015	.132 .038	.007	.177	
Ext Dia. of Connector Bearing.	2.0605 2.0583	52.377 52.281					
Reverse Gear Bushing Bore	1.1250 1.1256	28.575 28.590	.002 .003	.051 .076	.008	.203	
Reverse Shaft Dia.	1.123 1.122	28.524 28.499					
End Float—Main & Countershaft.			See Remarks				Fit shims behind mainshaft bearing retainer and P.T.O. Shaft bearing support to give preload of 7 to 12 lbs. ins. (.081—.138 kg.m). on main and countershafts.

Component Details	Dimensions New Ins.	Dimensions New mms.	Clearance New Ins.	Clearance New mms.	Permissible Worn Clearance or Dimension Ins.	Permissible Worn Clearance or Dimension mms.	Remarks

Backlash(A)—Sliding Coupling and Mating Teeth on Gear Wheels
.008″ .203 mm
.010″ .254 mm

(B)—Sliding coupling and mating teeth on connectors—
.0005″ .013 mm.
.0015″ .038 mm.

(C)—
Gear teeth—
.004″ .102 mm.
.008″ .203 mm.

Power Take-off Shaft.

Rear splines 6 × 1.92″ (48.77 mm) long × 1.121″ (28.47 mm) dia. × .922″ (23.42 mm) dia. × .275″ (6.99 mm) wide.
1.123″ (28.52 mm) .932″ (23.67 mm) .277″ (7.04 mm)
21/64″ (8.33 mm) dia. hole at distance of ½″ (12.7 mm) from shaft end.
End Cover Int. Dia. 2½″ (63.5 mm).

Clutch.

Component Details	Ins.	mms.	Ins.	mms.	Ins.	mms.	Remarks
Release Shaft Dia.	.997 .996	25.324 25.298					
			.004 .0065	.102 .165	.010	.254	
Bush Bore.	1.001 1.0025	25.425 25.464					

Clutch Springs. 9 green springs each of 105 lb. (47.627 kg) to 115 lb. (52.199 kg).

9 orange springs each of 90 lb. (40.823 kg) to 100 lb. (45.358 kg).

Orange springs superseded green springs after Tractor Serial No. 32872.

Free movement of pedal should be ⅜″ (9.5 mm). This dimension taken between upper side of pedal and underside of footrest bracket. Movement of release lever ends ½″ (13 mm). Variation in release lever height should not exceed .015″ (.381 mm).

Rear Axle.

Backlash — Crown wheel and pinion .004″ (.102 mm). Half shaft end float .008″ (.203 mm).
.025″ (.634 mm). .020″ (.508 mm).
Clearance between crown wheel and thrust pads .013″ (.033 mm).
.020″ (.508 mm).

Front Axle.

Component Details	Ins.	mms.	Ins.	mms.	Ins.	mms.	Remarks
Centre Trunnion Bushing Int. Dia. Fitted.	1.756 1.764	44.602 44.806					
			.008 .017	.203 .432	.035	.088	
Centre Pin Dia.	1.747 1.748	44.347 44.399					
Bore of Outer Axle for Spindle Bushes	1.3735 1.3745	34.887 34.912					
			±.001	±.025			
Ext. Dia. Spindle Bushes.	1.3735 1.3745	34.887 34.912					
Int. Dia. Spindle Bushes	1.249 1.250	31.725 31.750					
			.003 .005	.076 .127	.010	.254	
Spindle Dia.	1.246 1.245	31.648 31.623					

Steering.

Backlash—Screw adjustment against rear faces of segments to give minimum backlash without binding.

Distances between ball centres and vertical plane through drop arm crankshaft centre 2.17″ (55.12 mm) with steering wheel in straight ahead position.

Pulley Attachment.

Pulley width 6½″ (165 mm) Dia. 9″ (229 mm). Gear Ratio to P.T.O. Shaft 1.86 to 1. Backlash between driving gears .004″ (.102 mm)
.020″ (.508 mm)

PETROL ENGINE, PART No. 57963

(Manufactured by the Standard Motor Co.)

ENGINE—80 mm bore, fitted to tractors Type TE-A20, TE-C20.

Stroke 92 mm. Piston Displacement 112.9 cu. ins. (1850 c.c.) Compression ratio 5.77 to 1.

Maximum belt horse power—23.9.

Tightening Torque—Cylinder Head Nuts 60 to 65 lbs. ft. (8.25—8.95 kg. metres).
Big End Nuts 42 to 46 lbs. ft. (5.8—6.4 kg. metres).
Main Bearing Nuts 90 to 100 lbs. ft. (12.4—13.8 kg. metres).
Flywheel Cap Screws 42 to 46 lbs. ft. (5.8—6.4 kg. metres).

Component Details	Dimensions New		Clearance New		Permissible Worn Clearance or Dimension		Remarks
	Ins.	mms.	Ins.	mms.	Ins.	mms.	
Crankshaft.							
Journal Diameter	2.4795 2.4790	62.979 62.967					
			.0025 .0010	.064 .025	.006 dry	.152	Similar tolerances for reground crankshaft to .020″, .030″, .040″ (.508, .762, 1.016 mm) undersize.
Bearing Diameter (Fitted)	2.4815 2.4805	63.030 63.015					
Crankshaft End Float.							
Centre Journal Length.	1.7507 1.7498	44.468 44.445					
			.0117 .0048	.297 .122	.010 dry	.254	Crankshaft end float controlled by thickness of thrust washers.
Centre Bearing Cap width + 2 thrust washers.	1.7450 1.7390	44.323 44.171					
Big End.							
Crankpin Diameter	2.0861 2.0866	52.987 53.000					
			.0024 .0006	.061 .015	.006	.152	Similar tolerances for reground crankshaft to .020″, .030″, .040″ (.408, .762, 1.016 mm) undersize.
Bearing Diameter	2.0985 2.0872	53.302 52.015					
Connecting Rod End Float.							
Crankpin Length	1.1890 1.1870	30.201 30.150					
			.0115 .0075	.292 .191			
Con-Rod Width	1.1795 1.1775	29.959 29.909					
Ovality—Journals & Crankpins.					0.002	.051	Minimum diameter to be such that the permissible worn clearance for bearings is not exceeded.
Taper—Journals & Crankpins.					0.002	.051	
Small End.							
Bore for Bush	1.0000 .9995	25.4 25.387					
			—.0035 —.0050	+.09 —.13			Heat piston in boiling water for removal and fitting of gudgeon pin.
Bush, Ext. Dia.	1.0045 1.0035	25.514 25.489					
Bush, Int. Dia.	.8752 .8738	22.230 22.220					
			+.00035 —.00030	+.009 —.008			These clearance figures taken at 68°F.
Gudgeon Pin, Dia.	.87510 .87485	22.228 22.221					
			+.00045 —.00005	+.011 —.001			
Gudgeon Pin Holes in Piston	.8853 .87505	22.233 22.226					

Component Details	Dimensions New Ins.	Dimensions New mms.	Clearance New Ins.	Clearance New mms.	Permissible Worn Clearance or Dimension Ins.	Permissible Worn Clearance or Dimension mms.	Remarks
Pistons & Sleeves.							
Piston Dia.—(Thrust Side Top Skirt)	3.1461 3.1472	79.908 79.939					Sleeves and pistons graded F.G.H. in steps of .0004" (.010 mm).
			.0028 .0034	.071 .086			
Sleeve Bore (Parallel)	3.1492 3.1503	79.99 80.018					
			.0013 .0019	.033 .048			
Piston Dia. (Thrust Side Bottom Skirt)	3.1476 3.1487	79.949 79.977					
Top Land Diameter	3.133 3.131	79.578 79.527	.0162 .0193	.412 .490			Piston fitted with three rings above gudgeon pin, one ring below. On engines S101E to S56962E a plain bottom scraper ring fitted below gudgeon pin.
Ring Groove Width Top and 2nd.	.0957 .0947	2.431 2.405					
			.0030 .0010	.076 .025	.005	.127	
Compression Ring Width Top & 2nd.	.0937 .0927	2.380 2.355					
Ring Groove Width (3rd.)	.1895 .1885	4.813 4.788					Similar tolerances for oversize pistons +.020" (.508 mm). Oversize rings + .010" (.245 mm) + .020" (.508 mm) + .030" (.762 mm). Replacement sleeves available as standard size, and rebored + .020" (.508 mm).
			.0030 .0010	.076 .025	.005	.127	
Scraper Ring Width (3rd.)	.1875 .1865	4.763 4.737					
Ring Groove Width (4th.)	.1580 .1570	4.013 3.987					
			.0030 .0010	.076 .025	.005	.127	
Scraper Ring Width (4th.)	.1560 .1550	3.962 3.937					
Ring Gap (Closed)			.010 .006	.25 .15			
Clearance Between :							
Sleeve & Upper Block			.045 .015	1.143 .381			Dimensions taken respectively at top flange and spigot of sleeve.
Sleeve & Lower Block			.003 .0005	.076 .013			
Stand-out of Sleeve			.003 .0055	.076 .140			Desired clearance when assembled.
Water Pump & Thermostat.							
Housing Bore for Bearing	1.1813 1.1807	30.005 29.990					
			+.0007 —.0004	+.018 —.010			
Bearing Case, Ext. Dia.	1.1811 1.1806	30.000 29.987					
Oil Pump.							
Approximate capacity at 50 lbs. per square inch (3.52 kg/sq. cm.) is 3.95 gallons (16.94 litres) per minute at 2,000 r.p.m. (Engine)							
Outer Rotor, outside dia.	1.598 1.599	40.589 40.615					
			.001 .003	.025 .075			
Housing, internal dia.	1.601 1.600	40.665 40.640					
Rotor depth—outer and inner :	0.9995 0.9985	25.387 25.362					
			.0005 .0015	.013 .038			A combined worn clearance of .004" (.101mm) indicates need of cover and housing face lapping.
Housing depth	1.001 1.000	25.403 25.400					

Component Details	Dimensions New Ins.	Dimensions New mms.	Clearance New Ins.	Clearance New mms.	Permissible Worn Clearance or Dimension Ins.	Permissible Worn Clearance or Dimension mms.	Remarks
Inner rotor, major dia.	1.171 1.172	29.743 29.769					
Inner rotor, minor dia.	.729 .731	18.517 18.567					
Clearance on rotors			.004 .0005	.102 .013			Where clearance exceeds .010" (.253 mm) new parts should be fitted.
Camshaft.							
Front Journal Dia.	2.0590 2.0595	52.299 52.311					
			.0045 .0025	.114 .051	.0065	.164	Max. wear on camshaft journals .003" (.076 mm) and .0035 (.088 mm) in cylinder block.
Bore in Block	2.0635 2.0620	52.413 52.375					
2nd Journal Dia. 3rd. ,, ,, Rear ,, ,,	1.71575 1.71525	43.580 43.567					
			.0045 .0025	.114 .051	.0065	.164	
Bore in Block	1.71975 1.71825	43.683 43.645					
Locating Groove	.1885 .1865	4.788 4.737					
			.0065 .003	.165 .076			This clearance determines camshaft end float.
Locating Plate	.1835 .1820	4.661 4.623					
Tappets & Valves.							
Tappet Bore in Block	.9380 .9373	23.825 23.807					
			.0013 .0002	.033 .005			
Tappet Dia.	.9371 .9367	23.802 23.792					
Valve Tip Clearance							
Inlet			.010	.254			
Exhaust			.012	.305			
Valve Guide Bore Dia.	.313 .312	7.950 7.925					
Inlet Valve Stem Dia.	.311 .310	7.899 7.874	.001 .003	.025 .076			
Exhaust Valve Stem Dia.	.309 .308	7.849 7.823	.003 .005	.076 .127			
Guide projection above spring seat.	9/16"	14.3					

Valve seating angle on valve head 45°. Valve seat angle in cylinder head 44½°.

Valve Springs.

Free length 1.716" (43.586 mm). Fitted load 38 lbs + 2 lb. (17.237 kg ± .907 kg).
Fitted length 1.25 (31.75 mm). Full lift load 60 lb. (27 kg) approx.

Flywheel.

					Remarks
Spigot dia. (for Starter Gear Ring)	13.406 13.403	340.512 340.436			Flywheels balanced individually. Held to crankshaft by 4 set screws locked in pairs. Single dowel. Locating holes in flywheel 90° apart, in crankshaft 180° apart.
			—.031 —.023	—.787 —.584	
Starter Gear Ring Inside Dia.	13.380 13.375	339.852 339.725			

Run-out of clutch contact face at outer dia. should not exceed .003" (.076 mm),

Clearance between starter pinion and ring gear, Engine Serial No.SIE—S67028E, .156" (3.962 mm).
Engine Serial No. S67029E onwards .114" (2.896 mm).
Face-up starter mounting flange or fit shims to suit.

Component Details	Dimensions New		Clearance New		Permissible Worn Clearance or Dimension		Remarks
	Ins.	mms.	Ins.	mms.	Ins.	mms.	

Carburettor.

Zenith Type 24 T—2.

Choke Tube	17
Main Jet	120
Adj. Needle	12
S.R. Jet	50
Progression	120
Needle Seating	1.5 mm
Air Jet	2.0
S.R. Bottom Feed	1.5

Zenith Type 24T—2 (Min./Max. Adj. Jet)

Choke Tube	17
Main Jet	100
Adj. Needle	1.00 drilled
S.R. Jet	50
Progression	120
Needle Seating	1.5 mm
Petrol level at 4′ 6″ Head	15 mm
Inter-con	1mm drilled
Air Jet	2.0
Petrol Inlet Boss Stamped M-M	

Holley.

Discharge Nozzle.	.104″ (2.642 mm) with 4 holes .040″ (1.016 mm) dia.
Float Needle Seat	.081″ (2.057 mm). dia. .083″ (2.108 mm) dia.
Main Jet	.035″ (.889 mm) dia.
High Speed Bleed	.0293″ (.744 mm) dia.
Upper Idle Restriction	.046″ (1.168 mm) dia.
Idle Discharge Hole	.052″ (1.321 mm) dia.
Second Idle Discharge Hole	.046″ (1.168 mm) dia.
Venturi	21/32″ (16.669 mm) dia.
Fuel Level at 3/4 (.341 kgm) fuel pressure	9/16″ ± 1/32″ (14.274 ± .787 mm) to top face of fuel bowl.
Float cut-off position	7/16″ (11.13 mm) measured between upper casting face and outer float top.

Governor.

Governor lever spring: Free length: inside hooks 3.8″ (96.5 mm). End Play .005″ (.127 mm) .010″ (.254 mm) Rate: 18 lbs/in ± 5%. No of coils: 26.

Load at 1″ (25.4 mm) deflection: 25 lbs. (11.34 kg) ± 1 lb. (.454 kg.) Initial wound-in load: 7 lbs. (3.175 kg).

Control Rod: Free length: inside hooks 2.687″ (68.25 mm). Rate: 64 lbs./in ± 5%. No of coils: 11½.

Compensating Spring: Load at ½″ (12.7 mm) deflection: 38 lbs. (17.237 kg) ± 1½ lbs. (.681 kg). Initial wound-in load: 6 lbs. (2.722 kg).

VAPORISING OIL ENGINE, PART No. 500038

(Manufactured by the Standard Motor Co.)

ENGINE—85 mm bore, fitted to tractors Type TE-D20, TE-E20.

Stroke 92 mm. Piston Displacement 127 cu. ins. (2088 c.c.) Compression ratio 4.8 to 1.

Maximum belt horse power—23.9.

Tightening Torque—Cylinder Head Nuts 60 to 65 lbs. ft. (8.25—8.95 kg. metres).
Big End Nuts 42 to 46 lbs. ft. (5.8—6.4 kg. metres).
Main Bearing Nuts 90 to 100 lbs. ft. (12.4—13.8 kg. metres).
Flywheel Cap Screws 42 to 46 lbs. ft. (5.8—6.4 kg. metres).

Component Details	Dimensions New		Clearance New		Permissible Worn Clearance or Dimension		Remarks
	Ins.	mms.	Ins.	mms.	Ins.	mms.	
Crankshaft.							
Journal Diameter	2.4795 2.4790	62.979 62.967					
			.0025 .0010	.064 .025	.006 dry	.152	Similar tolerances for re-ground crankshaft to .020", .030", .040" (.508, .762, 1.016 mm) undersize.
Bearing Diameter (Fitted)	2.4815 2.4805	63.030 63.015					
Crankshaft End Float.							
Centre Journal Length.	1.7507 1.7498	44.468 44.445					
			.0117 .0048	.297 .122	.010 dry	.254	Crankshaft end float controlled by thickness of thrust washers.
Centre Bearing Cap width + 2 thrust washers.	1.7450 1.7390	44.323 44.171					
Big End.							
Crankpin Diameter	2.0861 2.0866	52.987 53.000					
			.0024 .0006	.061 .015	.006	.152	Similar tolerances for re-ground crankshaft to .020", .030", .040" (.508, .762, 1.016 mm) undersize.
Bearing Diameter	2.0985 2.0872	53.302 52.015					
Connecting Rod End Float.							
Crankpin Length	1.1890 1.1870	30.201 30.150					
			.0115 .0075	.292 .191			
Con-Rod Width	1.1795 1.1775	29.959 29.909					
Ovality—Journals & Crankpins.					0.002	.051	Minimum diameter to be such that the permissible worn clearance for bearings is not exceeded.
Taper—Journals & Crankpins.					0.002	.051	
Small End.							
Bore for Bush	1.0000 .9995	25.4 25.387					
			—.0035 +.0050	+.09 —.13			Heat piston in boiling water for removal and fitting of gudgeon pin.
Bush, Ext. Dia.	1.0045 1.0035	25.514 25.489					
Bush, Int. Dia.	.8752 .8738	22.230 22.220					
			+.00035 —.00030	+.009 —.008			These clearance figures taken at 68°F.
Gudgeon Pin, Dia.	.87510 .87485	22.228 22.221					
			+.00045 —.00005	+.011 —.001			
Gudgeon Pin Holes in Piston	.8853 .87505	22.233 22.226					

Component Details	Dimensions New Ins.	Dimensions New mms.	Clearance New Ins.	Clearance New mms.	Permissible Worn Clearance or Dimension Ins.	Permissible Worn Clearance or Dimension mms.	Remarks
Pistons & Sleeves.							
Piston Dia.—(Thrust Side Top Skirt)	3.3429 3.3438	84.905 84.933					Sleeves and pistons graded F.G.H. in steps of .0004" (.010 mm).
Sleeve Bore (Parallel)	3.3460 3.3471	84.988 85.016					
Piston Dia. (Thrust Side Bottom Skirt)	3.3442 3.3453	84.943 84.971					
Top Land Clearance			.017 .019	.432 .483			
Ring Groove Width Top 2nd and 3rd.	.0797 .0807	2.024 2.050					
			.0030 .0010	.076 .025	.005	.127	
Compression Ring Width Top 2nd & 3rd.	.0787 .0777	1.999 1.974					
Ring Groove Width (4th.)	.1895 .1885	4.813 4.788					Similar tolerances for oversize pistons +.020" (.508 mm).
			.0030 .0010	.076 .025	.005	.127	Oversize rings + .010" (.245 mm) + .020" (.508 mm) + .030" (.762 mm).
Scraper Ring Width (4th.)	.1875 .1865	4.763 4.737					Replacement sleeves available as standard size, and rebored + .020" (.508 mm).
Ring Groove Width (5th.)	.1580 .1570	4.013 3.987					
			.0030 .0010	.076 .025	.005	.127	
Slotted Scraper Ring Width (5th.)	.1560 .1550	3.962 3.937					
Ring Gap (Closed)			.010 .006	.25 .15			
Clearance Between :							
Sleeve & Upper Block			.045 .015	1.143 .381			Dimensions taken respectively at top flange and spigot of sleeve.
Sleeve & Lower Block			.003 .0005	.076 .013			
Stand-out of Sleeve			.003 .0055	.076 .140			Desired clearance when assembled.
Water Pump & Thermostat.							
Housing Bore for Bearing	1.1813 1.1807	30.005 29.990					
			+.0007 —.0004	+.018 —.010			
Bearing Case, Ext. Dia.	1.1811 1.1806	30.000 29.987					

Oil Pump.

Approximate capacity at 50 lbs. per square inch (3.52 kg/sq. cm.) is 3.95 gallons (16.94 litres) per minute at 2.000 r.p.m. (Engine)

Component Details	Dimensions New Ins.	Dimensions New mms.	Clearance New Ins.	Clearance New mms.	Permissible Worn Clearance or Dimension Ins.	Permissible Worn Clearance or Dimension mms.	Remarks
Outer Rotor, outside dia.	1.598 1.599	40.589 40.615					
			.001 .003	.025 .075			
Housing, internal dia.	1.601 1.600	40.665 40.640					
Rotor depth—outer and inner :	0.9995 0.9985	25.387 25.362					
			.0005 .0015	.013 .038			A combined worn clearance of .004" (.101mm) indicates need of cover and housing face lapping.
Housing depth	1.001 1.000	25.403 25.400					

Component Details	Dimensions New Ins.	Dimensions New mms.	Clearance New Ins.	Clearance New mms.	Permissible Worn Clearance or Dimension Ins.	Permissible Worn Clearance or Dimension mms.	Remarks
Inner rotor, major dia.	1.171 1.172	29.743 29.769					
Inner rotor, minor dia.	.729 .731	18.517 18.567					
Clearance on rotors			.004 .0005	.102 .013			Where clearance exceeds .010" (.253 mm) new parts should be fitted.
Camshaft.							
Front Journal Dia.	2.0590 2.0595	52.299 52.311					
			.0045 .0025	.114 .051	.0065	.164	Max. wear on camshaft journals .003" (.076 mm) and .0035 (.088 mm) in cylinder block.
Bore in Block	2.0635 2.0620	52.413 52.375					
2nd Journal Dia. 3rd. " " Rear " "	1.71575 1.71525	43.580 43.567	.0045 .0025	.114 .051	.0065	.164	
Bore in Block	1.71975 1.71825	43.683 43.645					
Locating Groove	.1885 .1865	4.788 4.737					
			.0065 .003	.165 .076			This clearance determines camshaft end float.
Locating Plate	.1835 .1820	4.661 4.623					
Tappets & Valves.							
Tappet Bore in Block	.9380 .9373	23.825 23.807					
			.0013 .0002	.033 .005			
Tappet Dia.	.9371 .9367	23.802 23.792					
Valve Tip Clearance							
Inlet			.010	.254			
Exhaust			.012	.305			
Valve Guide Bore Dia.	.313 .312	7.950 7.925					
Inlet Valve Stem Dia.	.311 .310	7.899 7.874	.001 .003	.025 .076			
Exhaust Valve Stem Dia.	.309 .308	7.849 7.823	.003 .005	.076 .127			
Valve Head Diameter : Inlet	1.176 1.172	29.570 29.769					
Exhaust	1.051 1.047	26.695 26.594					
Guide projection above spring seat.	9/16"	14.3					

Valve seating angle on valve head 45°. Valve seat angle in cylinder head 44½°.

Valve Springs.
Free length 1.716" (43.586 mm). Fitted load 38 lbs ± 2 lb. (17.237 kg ± .907 kg).
Fitted length 1.25 (31.75 mm). Full lift load 60 lb. (27 kg) approx.

Component Details	Dimensions New Ins.	Dimensions New mms.	Clearance New Ins.	Clearance New mms.	Permissible Worn Ins.	Permissible Worn mms.	Remarks
Flywheel.							
Spigot dia. (for Starter Gear Ring)	13.406 13.403	340.512 340.436					Flywheels balanced individually. Held to crankshaft by 4 set screws locked in pairs. Single dowel. Locating holes in flywheel 90° apart, in crankshaft 180° apart.
			—.031 —.023	—.787 —.584			
Starter Gear Ring Inside Dia.	13.380 13.375	339.852 339.725					

Run-out of clutch contact face at outer dia. should not exceed .003" (.076 mm).

Clearance between starter pinion and ring gear, Engine Serial No.SIE—S67028E, .156" (3.962 mm).
Engine Serial No. S67029E onwards .114" (2.896 mm).
Face-up starter mounting flange or fit shims to suit.

Carburettor.

Zenith Type 24T—2 (Min./Max. Adj. Jet) Choke Tube : 17. Main Jet : 105. Adj. Needle : 1.25 drilled. S.R. Jet : 60. Progression : 120. Needle Seating : 1.5 mm. Petrol level at 4′ 6″ Head : 15 mm. Inter-con : 1mm drilled. Air Jet : 2.0. Petrol Inlet Boss and adjusting needle head Stamped V.O.

Governor.

Governor lever spring: Free length: inside hooks 3.8″ (96.5 mm). End Play .005″ (.127 mm) .010″ (.254 mm) Rate: 18 lbs/in ± 5%. No of coils: 26.

Load at 1″ (25.4 mm) deflection: 25 lbs. (11.34 kg) ± 1 lb. (.454 kg.) Initial wound-in load: 7 lbs. (3.175 kg).

Control Rod: Free length: inside hooks 2.687″ (68.25 mm). Rate: 64 lbs./in ± 5%. No of coils: 11½.

Compensating Spring: Load at ½″ (12.7 mm) deflection: 38 lbs. (17.237 kg) ± 1½ lbs. (.681 kg). Initial wound-in load: 6 lbs. (2.722 kg).

DIESEL ENGINE

(Manufactured by the Standard Motor Co.)

ENGINE—3$\frac{3}{16}$" (80.96 mm) bore × 4" (101.6 mm) stroke, 4 cylinders, fitted to Tractors Type TE-F20.

Displacement 127.68 cu. ins. (2092 cc.) Compression Ratio 17 : 1 Firing Order 1, 3, 4, 2.

Maximum Belt Horse Power—26 at 2,000 r.p.m.

Tightening Torques :—
- Cylinder Head Nuts 75 to 80 lb. ft. (10.4—11.1 kg.m)
- Big End Nuts 65 to 70 lb. ft. (9—9.7 kg.m)
- Oil Pump Attachment 16 to 18 lb. ft. (2.2—2.5 kg.m)
- Flywheel Set Screws 90 to 100 lb. ft. (12.4—13.8 kg.m)
- Main Bearing Socket Screws 25 to 30 lb. ft. (3.5—4.1 kg.m)
- Centre Bearing Housing to Block 39 to 42 lb. ft. (5.4—5.8 kg.m)
- Clutch Fixing Screws 26 to 28 lb. ft. (3.6—3.9 kg.m)
- Injector Attachment 12 to 14 lb. ft. (1.6—1.9 kg.m)

Component Details	Dimensions New ins.	Dimensions New mms.	Clearance New ins.	Clearance New mms.	Remarks
Main Bearing Housings : Front					For checking external dia. of all Housings—break housing and assemble on a mandrell 2.9180"/ 2.9183" (74.117/74.125 mm.) dia. without bearings. Tighten Socket Screws 29—31 lb. ft. (4—4.3 kg.m).
Housing Spigot Ext. Dia.	5.0615 5.0605	128.562 128.537			
			.0030 .0005	.076 .013	
Bore in Cylinder Block	5.0635 5.0620	128.613 128.575			
Centre					
Housing Ext. Dia.	6.8115 6.8105	173.012 172.987			
			.0035 .0005	.089 .013	
Bore in Cylinder Block	6.8140 6.8120	173.076 173.025			
Rear					
Housing Spigot Ext. Dia.	6.8735 6.8725	174.587 174.562			
			.004 .001	.102 .025	
Bore in Cylinder Block	6.8765 6.8745	174.663 174.613			
Main Bearings. Housing Bores, Front, Centre and Rear.	2.9165 2.9170	74.079 74.092			For checking bore dia. assemble both halves with ring dowels fitted and tighten screws to 29—31 lb. ft. (4—4.3 kg.m).
Radial thickness of Bearings, Front, Centre and Rear	.08250 .08225	2.096 2.089			Front and rear Main Bearing Liners are identical but centre is .100" (2.54 mm.) wider.
Bearing Bore Dia. Front, Centre and Rear	2.7540 2.7530	69.952 69.926			With Bearings fitted into Housings tighten to specified torque setting.
			.0040 .0025	.102 .064	Desired clearance when assembled.
Crankshaft. Journal Dia.	2.7505 2.7500	69.863 69.850			Similar tolerances for reground Crankshaft to .010", .020", .030", .040" (.254, .508, .762, 1.016 mm.) undersize.
Crankshaft End Float Rear Journal Length	1.7507 1.7498	44.468 44.445			
			.0117 .0048	.297 .122	
Rear Bearing Housing width	1.559 1.557	39.599 39.548			
Thrust Washer thickness	.093 .091	2.362 2.311			

Component Details	Dimensions New ins.	mms.	Clearance New ins.	mms.	Remarks
Big End.					
Crankpin Dia.	2.3115	58.712			Similar tolerances for reground crankshaft to .010″, .020″, .030″, 040″, .060″ (.254, .508, .762, 1.016, 1.524 mm.) undersize.
	2.3110	58.699			
			.0035	.089	
			.0020	.051	
Bearing Bore Dia.	2.3145	58.789			
	2.3135	58.763			
Con. Rod Bore Dia.	2.4575	62.421			For checking bearing bores—assemble Con. Rod and tighten to specified setting.
	2.4570	62.408			
Bearing Shell thickness	.07175	1.822			
	.07150	1.816			
Connecting Rod End Float.					
Crankpin Length	1.4390	36.551			For service purposes :— Max. permissible variation in Con. Rod total weights 1½ ozs. (42.52 gms.). Metal may be removed from web on bearing cap for fine weight adjustment. Con. Rod assembly weight graded—N, P, Q, S, T, U—in 1½ oz. stages.
	1.4370	36.500			
			.0105	.267	
			.0065	.165	
Con. Rod Width	1.4305	36.335			
	1.4285	36.284			
Small End.					
Bore for Bush	1.126	28.600			
	1.125	28.575			
			—.0050	—.127	
			—.0025	—.064	
Bush External Dia.	1.1300	28.702			
	1.1285	28.664			
Bush Internal Dia.	1.0002	25.405			Specified clearance using drawing sizes, but bore of Bush machined to suit Gudgeon Pin for the required fit.
	.9998	25.395			
			+.00035	+.009	
			—.00035	—.009	
Gudgeon Pin Dia.	1.00015	25.404			Specified clearance using drawing sizes but desired fit of gudgeon pin in Piston obtained by selective assembly. Heat piston in hot oil for fitting.
	.99985	25.396			
			+.0003	+.008	
			—.0003	—.008	
Gudgeon Pin Holes in Piston.	1.00015	25.404			
	.99985	25.396			
Pistons, Sleeves and Inserts.					
Wellworthy Type Pistons.					
Original Piston Skirt Dia. (Round and Parallel).	3.183	80.848			Ungraded up to Engine No. SA.7739E.
	3.182	80.823			
			.0070	.178	
			.0050	.127	
Sleeve Bore (Parallel).	3.1890	81.001			Replacement sleeves available as standard size only, (i.e. no provision made for reboring and fitting oversizes).
	3.1880	80.975			
1st Modification—Engine No. SA.774OE — SA.9205E.					
Piston Skirt Dia. (Round and Parallel). —F. Grade	3.1834	80.858			Pistons and Sleeves graded F & G.
	3.1829	80.846			
—G. Grade	3.1838	80.868			
	3.1834	80.858			
			.0056	.142	
			.0047	.120	
Sleeve Bore (Parallel). —F. Grade	3.1885	80.988			Replacement Pistons and Sleeves available at standard size only (i.e. no provision for oversizes).
	3.1880	80.975			
—G. Grade	3.1890	81.001			
	3.1885	80.988			
			.0056	.142	
			.0047	.120	

Component Details	Dimensions New ins.	Dimensions New mms.	Clearance New ins.	Clearance New mms.	Remarks
Wellworthy Type Pistons—*continued.*					
2nd Modification—Engine No. SA.9206E—SA.23082E.					
Piston Skirt Dia.—Top —F. Grade (Oval ground tapered skirt)	3.1833 3.1829	80.856 80.846			Alternative to B.H.B. type Pistons.
—G. Grade	3.1838 3.1834	80.868 80.858			Grade to be measured at top of skirt thrust side.
3rd Modification—Engine No. SA.23083E and future.					
Piston Skirt Dia.—Top —F. Grade (Oval ground tapered skirt)	3.1837 3.1833	80.866 80.856			
—G. Grade	3.1842 3.1838	80.879 80.868			
			.0052 .0043	.132 .110	
Sleeve Bore —F. Grade (Parallel) —G. Grade	See 1st Modification.				
Ovality—Top of Skirt	.005 .004	.127 .102			
—Bottom of Skirt	.001 .000	.025 .000			
Piston Head Dia. (Parallel).	3.158 3.155	80.213 80.137			Piston Head Dia. up to SA.15104E — 3.1625"/3.1595" (80.328/80.252 mm.)
			.02300 .01925	.584 .489	
Cylinder Insert Lower Internal Dia.	3.17800 3.17725	80.721 80.702			
B.H.B. Type Pistons (Introduced as an alternative at Engine No. SA.21735E).					
Original					
Piston Skirt Dia.—Top —F. Grade (Oval ground tapered skirt)	3.1838 3.1834	80.868 80.858			Grade to be measured at top of Skirt Thrust side.
—G. Grade	3.1843 3.1839	80.882 80.871			
			.0051 .0042	.129 .107	
Sleeve Bore —F. Grade (Parallel). —G. Grade	See under Wellworthy type Piston—1st Modificaton.				
1st Modification—Engine No. SA.21914E—SA.29605E.					
Piston Skirt Dia.—Top —F. Grade (Oval ground tapered Skirt).	3.1842 3.1838	80.879 80.868			
—G. Grade	3.1847 3.1843	80.892 80.882			
			.0047 .0038	.120 .096	
Sleeve Bore —F. Grade (Parallel) —G. Grade	As above.				
2nd Modification—Engine No. SA.29606E and future.			.0052 .0043	.135 .110	
Piston Skirt Dia.—Top —F. Grade (Oval ground tapered skirt).	3.1837 3.1833	80.866 80.856			
—G. Grade	3.1842 3.1838	80.879 80.868			
Ovality—Top of Skirt	.0122 .0098	.310 .249			
—Bottom of Skirt	.0024 .0008	.061 .020			
Piston Head Dia. (Parallel)	3.1583 3.1543	80.221 80.120			
			.0237 .01895	.602 .481	
Cylinder Insert Lower Internal Dia.	3.17800 3.17725	80.721 80.702			

Component Details	Dimensions New ins.	Dimensions New mms.	Clearance New ins.	Clearance New mms.	Remarks
Ring Groove Width (Top, 2nd & 3rd).	.0832 .0822	2.113 2.088			Piston Rings :— Three Compression Rings and one slotted Scraper Ring all above Gudgeon Pin. Chromium plated top Compression Ring—deleted on the Wellworthy Piston at Engine No. SA8309E and re-introduced at Engine No. SA.28867E.
			.0055 .0035	.140 .089	
Compression Ring Width (Top, 2nd & 3rd)	.0787 .0777	1.999 1.974			
Ring Groove Width (4th).	.1602 .1592	4.069 4.044			
			.005 .003	.127 .076	2nd and 3rd Compression Rings; tapered periphery rings introduced at Engine No. SA. 28867E, marked "T" denoting the taper and must be fitted with "T" upwards.
Slotted Scraper Ring Width (4th).	.1562 .1552	3.967 3.942			
All rings—fitted gap			.014 .009	.356 .229	
Lower Block Dia. for Sleeve.	3.4073 3.4068	86.546 86.532			For service purposes, oversize Piston Rings, +.010" (.254 mm.) only, available for fitting in existing worn Cylinder Sleeve bores.
			.0021 .0008	.053 .020	
Sleeve External Dia.	3.4060 3.4052	86.512 86.492			
Upper Block Recess Dia. for Inserts and Sleeve Flange.	3.65725 3.65625	92.894 92.868			
			.00245 .00045	.062 .011	
Cylinder Insert Lower External Dia.	3.6558 3.6548	92.857 92.832			
Cylinder Insert Upper— Width of Slot. (See Remarks).	1.265 1.255	32.131 31.877			When upper insert is fitted in bore 3.6565" (92.875 mm.) dia. When in free state, gap increases by .03" (.762 mm.) nominally.
Cylinder Insert Upper— Radial Thickness.	.2335 .2325	5.931 5.906			
Gasket Cylinder Sleeve—Thickness.	.012	.305			
Sleeve Flange Thickness (Up to Engine No. SA.23082E).	.12575 .12475	3.194 3.169			Slot in bottom of Sleeve.
Sleeve Flange Thickness (Engine No. SA.23083E and future).	.21575 .21475	5.480 5.455			Without slot in bottom of Sleeve.
Depth of recess for Cylinder Inserts in Cylinder Block.	.9072 .9057	23.043 23.005			
Depth of Cylinder Inserts Lower Insert	.2390 .2380	6.071 6.045			Specified Insert depths are over flats. As the mating surfaces are cones, these dimensions cannot be used directly for calculating the 'nip.' Use original Upper Insert only with Sleeve Incorporating Slot; later type only with slotless Sleeve, which has the thicker flange.
Upper Insert (Up to Engine No. SA.23082E).	.5510 .5500	13.995 13.970			
Upper Insert (Engine No. SA.23083E and future).	.461 .460	11.709 11.684			
Stand out of upper insert above block (with new Sleeve gasket).			.0045 .0010	.115 .025	
Stand out of Piston at T.D.C. above top face of Cylinder Block (not insert)			+.010 —.003	+.254 —.076	
Water Pump					
Housing Bore for Bearing	1.5749 1.5744	40.003 39.990			
			+.00061 —.00040	+.015 —.010	
Bearing Case External Dia.	1.57480 1.57429	40.000 39.987			
Spindle Dia.	.6264 .6256	15.905 15.893			Drive to impellor imparted through interference fit of impellor on spindle. Incorporated at Engine No. SA. 14655E.
			—.0022 —.0012	—.056 —.030	
Impellor Bore	.6245 .6240	15.863 15.850			

Component Details	Dimensions New ins.	Dimensions New mms.	Clearance New ins.	Clearance New mms.	Remarks
Thermostat. Up to Engine No. SA.17122E.					
Valve begins to open	167 — 176 F.	(75 — 80 C.)			Stamped No. X43570/11
Valve fully open	203 F.	(95 C.)			
Valve Lift	.312	7.94			
Engine No. SA.17123E and future.					
Valve begins to open	154 — 163 F.	(68 — 73 C.)			Stamped No. X43570/16
Valve fully open	185 F.	(85 C.)			
Valve Lift	.312	7.94			

Oil Pump

Approximate capacity at 50 lb/sq. in. (3.52 kg/sq. cm.) is 3.95 galls. (16.94 litres) per minute at 2000 engine r.p.m. (Oil pump runs at engine speed).

Oil Pressure 40-60 lb/sq. in. (2.8—4.2 kg/sq. cm.).

Component Details	Dimensions New ins.	Dimensions New mms.	Clearance New ins.	Clearance New mms.	Remarks
Bore Inner Rotor	.4987 .4993	12.667 12.683			
			.0012 .0002	.030 .005	
Pump Shaft Dia.	.4985 .4981	12.662 12.651			
			.0014 .0005	.036 .013	
Bush Internal Dia.	.4995 .4990	12.688 12.675			
Outer Rotor Outside Dia.	1.599 1.598	40.615 40.589			
			.006 .004	.152 .102	
Housing Internal Dia.	1.604 1.603	40.742 40.716			
Rotor Depth—Inner and Outer	.9995 .9985	25.388 25.362			
Pump Housing Depth from flange face to bottom of bore	.8410 .8400	21.361 21.336			
Depth of Recess in Front Main Bearing Housing	.157 .156	3.988 3.962			
Gasket Thickness (Uncompressed).	.006	.152			
End Clearance			.0035 .0005	.089 .013	End clearance allowing for .002″ (.051 mm.) compression of gasket. A combined worn clearance of .005″ (.127 mm.) indicates need of facing bearing housing recess and facing.
Inner Rotor Major Dia.	1.172 1.171	29.769 29.743			
Inner Rotor Minor Dia.	.731 .729	18.567 18.517			
Clearance on Rotors			.004 .001	.102 .025	Measured when major dia. of inner rotor and minor dia. of outer rotor are in line; when this clearance exceeds .010″ (.254 mm.) new parts should be fitted.
Camshaft					
Journal Dias.	1.5595 1.5590	39.612 39.599			
			.0045 .0025	.115 .064	Provision made for vernier setting of the valve timing with camshaft chainwheel on centre.
Bore in Block and Front Bush Internal Dia.	1.5635 1.5620	39.713 39.675			
Camshaft End Float					
Front Bearing Length	1.373 1.370	34.874 34.798			
			.0075 .0020	.191 .051	
Front Journal Length	1.3775 1.3750	34.988 34.925			

Component Details	Dimensions New ins.	Dimensions New mms.	Clearance New ins.	Clearance New mms.	Remarks
Tappets and Valves					
Bore in Block.	.5630 .5623	14.300 14.282			
			.0012 .0003	.030 .008	
Tappet Stem Dia.	.5620 .5618	14.275 14.270			
Valve Tip Clearance Inlet & Exhaust (Cold).			.012	.305	
Valve Guide Bore Dia. Inlet & Exhaust.	.3130 .3120	7.950 7.925			Valve Guides not interchangeable; except between Engine No. SA.17677E and SA.29403E when the inlet guide was common.
			.0023 .0008	.058 .020	
Inlet Valve Stem Dia.	.3112 .3107	7.904 7.892			
			.005 .003	.127 .076	
Exhaust Valve Stem Dia.	.309 .308	7.849 7.823			
Valve Head Dia. Inlet	1.252 1.248	31.801 31.699			
Exhaust	1.127 1.123	28.626 28.524			
Valve Lift : Inlet	.3075	7.810			
Exhaust	.342	8.687			
Valve Seating Angle on Valve Head 45°. Valve Seat Angle in New Cylinder Head 89° included.					When seats in Cylinder Head are re-cut for servicing, utilize a 90° (incl.) cutter.

Valve Springs.

Rate : Inner 56.8 lb/in. (1014.3 kg/m)
Outer 106 lb/in. (1892.9 kg/m)

Fitted Length : Inner 1.125" (28.575 mm.) Outer 1.219" (30.963 mm.)

Free Length : Inner 1.51" (38.354 mm.) approx. Outer 1.600" (40.64 mm.) approx.

Fitted Load + 2 lb./—1 lb. (.908—.454 kg.) :
Inner 22 lb. (10 kg.)
Outer 40 lb. (18.1 kg.)

Full Lift Load :	Inlet	Exhaust
Inner	39.5 lb. (17.9 kg.)	41.5 lb. (18.8 kg.)
Outer	72.5 lb. (32.9 kg.)	76.5 lb. (34.7 kg.)

Valve Timing (Crankshaft Degrees).

Exhaust	opens	45° before B.D.C.
	closes	5° after T.D.C.
Inlet	opens	5° before T.D.C.
	closes	25° after B.D.C.

Component Details	Dimensions New ins.	Dimensions New mms.	Clearance New ins.	Clearance New mms.	Remarks
Decompression Cam Clearances.					
Cylinder Nos. 1, 2 and 4			.030	.762	Set with slot in shaft end vertical, located, on all except very early models, by fitting a dowel ($\frac{3}{16}$" dia.) through 3rd pedestal extension.
Cylinder No. 3			.045	1.143	
Flywheel.					Flywheels balanced individually. Held to Crankshaft by 6 set screws locked in pairs. Single dowel locating flywheel on Crankshaft.
Spigot Dia. (for starter gear ring)	13.094 13.091	332.588 332.511			
			—.031 —.023	—.787 —.584	
Gear Ring Inside Dia.	13.068 13.063	331.927 331.800			
Crankshaft Spigot Dia.	4.0002 3.9995	101.605 101.588			
			+.0012 —.0004	+.030 —.010	
Flywheel Dia. for Spigot.	4.0007 3.9998	101.778 101.595			

Run-out of clutch contact face at outer dia. should not exceed .003" (.076 mm.).

Component Details	Dimensions New ins.	Dimensions New mms.	Clearance New ins.	Clearance New mms.	Remarks
Jockey Chainwheel Assembly					
Spigot Dia. Wheel Carrier	.749 .748	19.025 18.999			
			.0025 .0008	.064 .020	
Chainwheel Bush Internal Bore	.7505 .7498	19.063 19.045			
Front Pivot Dia.	.499 .498	12.675 12.649			
			.0025 .0008	.064 .020	
Bore in Timing Cover	.5005 .4998	12.713 12.695			
Rear Pivot Dia.	.4998 .4993	12.695 12.683			
			.0012 .0000	.030 .000	
Bore in Cylinder Block	.5005 .4998	12.713 12.695			
Injector Pump Drive.					
Pump Drive Shaft Minor Dia.	.8748 .8743	22.220 22.207			Drive Bush for chainwheel gives vernier adjustment for pump timing in 1½° stages up to 6°.
			.0012 .0000	.030 .000	
Locating Bush Int. Dia.	.8755 .8748	22.238 22.220			
Locating Bush Ext. Dia.	1.28105 1.28055	32.538 32.526			
			.0014 .0000	.035 .000	
Chainwheel Bore	1.28195 1.28105	32.561 32.538			
Pump Drive Shaft Major Dia.	1.1233 1.1215	28.532 28.486			
			.0042 .0015	.107 .038	
Bearing Housing Internal Dia.	1.1257 1.1248	28.593 28.570			
Drive Shaft End Float.					
Length of Shaft	2.1900 2.1875	55.626 55.563			
			.0075 .0030	.191 .076	
Length of Housing	2.1845 2.1825	55.487 55.436			

Injector Pump and Injectors.

Injection Spill Cut-off 30° (Crankshaft) before T.D.C.

Timing hole in flywheel and Cylinder Block when aligned with ¼" (6.35 mm.) dia. tommy bar locates Nos. 1 and 4 spill cut-off timing.

Slots in Pump Mounting Flange allows for the following movement.
Pumps Pt. Nos. 300342 and 300781—total 10° (Crankshaft).
Pumps Pt. Nos. 300964 and 300972—total 16° (Crankshaft).

Injector Breaking Pressure.	120 ats. (123.5 kg/sq. cm.). (1764 lb/sq. in.).	
Spray Angle.	4°	
Valve Lift.	.0276	.700

Electrical Equipment.

Dynamo :

Runs at 1.72 engine speed.

Component Details	Dimensions New ins.	mms.	Clearance New ins.	mms.	Remarks

Starter Motor.

Number of Teeth in Flywheel Gear Ring and Starter Pinion 113 and 11 respectively.

End Clearance between disengaged starter pinion and Flywheel Gear Ring .090″ (2.29 mm.)—Distance from mounting flange to front face of Flywheel Gear Ring 1.090″ (27.69 mm.).

Starter Pilot Switch should make electrical contact when the leading face of the starter pinion is $1\frac{5}{8}$″ (41.28 mm.) from the starter motor mounting flange face.

Batteries.

Specific Gravity 1.28 — 1.30 at 60°F. (15°C.).

Up to Tractor Serial No. 207705.	120 ampere hour capacity at 10 hour discharge rate 2 — 6 volt 17 plate units connected in series. Recharge rate 13 amps.
Tractor Serial No. 207706 and future.	115 ampere hour capacity at 10 hour discharge rate. 2 — 6 volt 19 plate units connected in series. Recharge rate 12 amps.

Clutch.

Clutch Dia.	10	254
Clutch Springs :	12 green springs each of 105 lb. (47.627 kg.) to 115 lb. (52.199 kg.).	

Fill-up Data.

Fuel Tanks.	Main. 7 Imp. Gallons (31.85 litres). Auxiliary Tank. $\frac{3}{4}$ Imp. Gallon (3.4 litres). Ki-gass Tank. $\frac{3}{4}$ pint (.43 litres).
Engine Sump.	12 pints (6.8 litres).
Air Cleaner Bowl.	$\frac{3}{4}$ pint (.43 litres).
Cooling System.	15 pints (8.5 litres).

Tractor Weight Approx. :

Up to Tractor Serial No. 325000	2700 lb. (1225 kg.)
Tractor Serial No. 325001 and future.	2770 lb. (1256 kg.)

PETROL ENGINE

(Manufactured by the Standard Motor Co.)

ENGINE : 85 m/m bore × 92 m/m. stroke as fitted to Tractors Type TE-A20.

Displacement : 2088 cc. (127.4 cu. ins.) Compression Ratio : 6 : 1. Firing Order : 1, 3, 4, 2.

Maximum Belt Horse Power — 28.2.

Tightening Torques : — Cylinder Head Nuts 60 — 65 lbs. ft. (8.29 — 8.98 kg.m). Main Bearing Nuts 80 — 85 lbs. ft. (11.05 — 11.75 kg.m).

Big End Nuts 50 — 55 lbs. ft. (6.91 — 7.60 kg.m) Flywheel Cap Screws 42 — 46 lbs. ft. (5.8 — 6.4 kg.m).

Component Details	Dimensions New ins.	Dimensions New mm.	Clearance New ins.	Clearance New mm.	Remarks
Main Bearings.					
Housing Bore	2.6255 2.6250	66.688 66.675			For checking housing or bearing bores fit bearing cap and tighten to specified torque.
Radial thickness of Bearings.	.07225 .07200	1.8351 1.8288			
Bearing Bore diameter (fitted).	2.4815 2.4805	63.030 63.005			
			.0025 .0010	.064 .025	Similar tolerances for reground crankshaft to .010", .020", .030", .040" (.254, .508, .762, 1.016 mm) undersize.
Crankshaft.					
Journal diameter.	2.4795 2.4790	62.979 62.967			
Crankshaft End Float.					
Centre Journal length	1.7507 1.7498	44.468 44.445			
			.0117 .0048	.297 .122	
Centre Bearing Cap Width	1.559 1.557	39.599 38.548			
Thrust Washer thickness (2 off)	.093 .091	2.362 2.311			
Big End.					
Crankpin diameter	2.0866 2.0861	53.000 52.987			Similar tolerances for reground crankshaft to .010", .020", .030", .040" (.254, .408, .762, 1.016 mm) undersize.
			.0024 .0006	.061 .015	
Bearing Bore diameter (fitted).	2.0885 2.0872	53.048 52.015			For checking big-end or bearing bores assemble connecting rod and tighten to specified setting.
Connecting Rod Bore diameter	2.2335 2.2327	56.731 56.710			
Radial thickness of Bearings	.07275 .07250	1.8479 1.8415			
Connecting Rod End Float					
Crankpin length	1.1915 1.1865	30.264 30.137			
			.014 .007	.356 .178	
Connecting Rod width	1.1795 1.1775	29.959 29.909			

Component Details	Dimensions New ins.	Dimensions New mm.	Clearance New ins.	Clearance New mm.	Remarks
Small End.					
Bore for Bush	1.0000 .9995	25.400 25.387			
			—.0035 —.0050	—.09 —.13	Heat piston in boiling oil for removal and fitting of gudgeon pin.
Bush, external diameter	1.0045 1.0035	25.514 25.489			
Bush internal diameter	.8752 .8748	22.230 22.220			
			*—.00035 —.00030	+.009 —.008	*Specified clearances using drawing sizes but desired fit of gudgeon pin — hand push fit at 68°F — obtained by selective assembly.
Gudgeon Pin diameter	.87510 .87485	22.228 22.221			
			*—.00045 —.00005	+.011 —.001	
Gudgeon Pin Holes in Piston.	.8753 .87505	22.233 22.226			
Pistons and Sleeves.					
Piston diameter F. Grade (Thrust side top skirt).	3.3430 3.3427	84.912 84.905			
G. ,,	3.3434 3.3430	84.922 84.912			
H. ,,	3.3438 3.3434	84.932 84.922			
			.0037 .0030	.094 .076	
Sleeve Bore F. ,, (Parallel).	3.3463 3.3460	84.996 84.983			
G. ,,	3.3467 3.3464	85.005 84.993			Replacement sleeves available as standard size, and rebored +.020" (.508 mm). Oversize pistons available to suit rebored sleeves. See below.
H. ,,	3.3471 3.3468	85.016 85.009			
Clearance, Bottom of Piston Skirt (Thrust side)			.0022 .0015	.056 .038	Thrust side Piston Skirt tapered .0015" (.038 mm) on diameter.
Top Land diameter.	3.329 3.327	84.557 84.506	.0201 .0170	.510 .432	
Ring Groove width Top and 2nd.	.0807 .0797	2.050 2.024			Piston fitted with three rings above gudgeon pin, one ring below.
			.0030 .0010	.076 .025	
Compression Ring width Top and 2nd.	.0787 .0777	1.999 1.974			
Ring Groove width 3rd.	.1895 .1885	4.813 4.788			
			.0030 .0010	.076 .025	
Slotted Scraper Ring width 3rd.	.1875 .1865	4.763 4.737			Similar tolerances for: oversize rings +.010" (.254 mm), +.020" (.508 mm), +.030" (.762 mm).
Ring Groove width 4th.	.158 .157	4.013 3.989			
			.0030 .0010	.076 .025	
Slotted Scraper Ring width 4th.	.156 .155	3.962 3.937			
Ring Gap (closed)			.015 .010	.381 .254	
Clearance between :— Top Flange of Sleeve and Upper Block— Upper Block diameter	4.140 4.125	105.156 104.775			
			.045 .015	1.143 .381	
Top Flange of Sleeve diameter	4.110 4.095	104.394 104.013			

Component Details	Dimensions New ins.	Dimensions New mm.	Clearance New ins.	Clearance New mm.	Remarks
Clearance between :—					
Sleeve Spigot and Lower Block					
Lower Block diameter	3.6260 3.6245	92.100 92.062			
			.003 .0005	.076 .013	
Sleeve Spigot diameter	3.6240 3.6230	92.049 92.024			
Cylinder Block (Top face to seating face for Sleeve)	4.501 4.499	114.325 114.274			
Gasket thickness (uncompressed)	.019 .016	.483 .406			
Cylinder Sleeve (Top face to seating face).	4.488 4.487	113.995 113.970			
Stand out of Sleeve above Cylinder Block.			.002 .008	.051 .203	
Oversize Sleeves & Pistons					
Piston Diameter +.020" (.508 mm).	3.3632 3.3627	85.425 85.413			
			.0043 .0030	.110 .076	
Sleeve Bore (Parallel) +.020" (.508 mm).	3.36700 3.36625	85.522 85.503			
Water Pump.					
Housing Bore for Bearings	1.5749 1.5744	40.002 39.990			
			+.00061 —.00040	+.015 —.010	
Bearing Case external diameter	1.57480 1.57429	40.000 39.987			
Spindle diameter	.6262 .6257	15.905 15.893			
			—.0032 —.0022	—.081 —.056	Drive to impellor imparted through interference fit of impellor on spindle. Incorporated at Engine No. SC.41539E.
Impellor Bore diameter	.6235 .6230	15.837 15.824			
Thermostat.					
Valve begins to open	133° — 147° F.		56° — 64°C.		
Valve fully open	171°F.		77 C.		
Valve lift	¼" — ⅜"		6.3 — 9.5 mm.		

Oil Pump.

Approximate capacity at 50 lbs. sq. in. (3.52 kg. sq. cm.) is 3.95 gallons (17.95 litres) per minute at 2,000 r.p.m. Oil Pump (Oil Pump runs at half engine speed).

Oil pressure 40 — 60 lbs./sq. in. (2.8 — 4.2 kg. sq. cm.).

Component Details	Dimensions New ins.	Dimensions New mm.	Clearance New ins.	Clearance New mm.	Remarks
Outer Rotor, outside diameter	1.599 1.598	40.615 40.589			
			.006 .004	.152 .101	
Housing Internal diameter	1.604 1.603	40.741 40.716			
Bore, Inner Rotor	.4987 .4993	12.667 12.682			
			.0002 .0013	.005 .033	
Pump Shaft diameter	.4980 .4985	12.649 12.661			
			.003 .001	.076 .025	
Housing Bore internal diameter	.5010 .4995	12.725 12.687			
End Clearance of Rotors.					
Rotor depth — outer and inner	0.9995 0.9985	25.387 25.362			
			.0005 .0025	.013 .064	A combined worn clearance of .005" (.127 mm) indicates need of cover and housing face lapping.
Housing depth	1.001 1.000	25.425 25.400			

Component Details	Dimensions New ins.	Dimensions New mm.	Clearance New ins.	Clearance New mm.	Remarks
Inner rotor, major diameter	1.171 1.172	29.743 29.769			
Inner rotor, minor diameter	.729 .731	18.517 18.567			
Clearance on rotors			.004 .001	.102 .025	Measured when major diameter of inner rotor and minor diameter of outer rotor are in line. Where clearance exceeds .010″ (.254 mm) new parts should be fitted.
Camshaft.					
Front Journal diameter	2.0595 2.0590	52.311 52.299			
			.0045 .0025	.114 .063	Max. wear on camshaft journals .003″ (.076 mm) and .0035″ (.089 mm) in cylinder block.
Bore in Block.	2.0635 2.0620	52.413 52.375			
2nd Journal diameter 3rd ,, ,, Rear ,, ,,	1.71575 1.71525	43.580 43.567			
			.00445 .00245	.113 .062	
Bore in Block	1.7197 1.7182	43.680 43.642			
Camshaft End Float.					
Locating Groove	.1885 .1865	4.788 4.737			
			.0065 .0030	.165 .076	
Locating Plate	.1835 .1820	4.661 4.623			
Tappets and Valves					
Tappet Bore in Block	.9380 .9373	23·825 23·807			
			.0013 .0002	.033 .005	
Tappet diameter	.9371 .9367	23.802 23.792			
Valve Tip clearances (cold) Inlet			.010	.254	
Exhaust			.012	.305	
Inlet valve stem diameter	.311 .310	7.899 7.874			
			.001 .003	.025 .076	
Valve Guide Bore diameter (Inlet and Exhaust)	.313 .312	7.950 7.925			
			.003 .005	.076 .127	
Exhaust Valve Stem diameter	.309 .308	7.849 7.823			
Valve Head diameter : Inlet	1.113 1.109	28.27 28.17			
Exhaust	1.051 1.047	26.695 26.594			
Guide projection above spring seat	.59	15.0			
Valve lift	.2985	7.582			

Valve seating angle on valve head 45°. Valve seat angle in new cylinder head 44½°, but serviced at 45°
Exhaust Valve inserts available for service purposes.

Valve Springs.

Free length 1.787″ (45.390 mm). Fitted load 38 lbs. $^{+\,2\ \text{lbs.}}_{-\,1\ \text{lbs.}}$ (17.237 kg. $^{+.907\ \text{kg.)}}_{-.454\ \text{kg.)}}$

Fitted length 1.321″ (33.553 mm). Full lift load 60 lb. (27 kg.) approx.

Component Details	Dimensions New ins.	Dimensions New mm.	Clearance New ins.	Clearance New mm.	Remarks
Valve Timing (Crankshaft Degrees).					
	Exhaust opens 40° before B.D.C. closes at T.D.C. Inlet opens at T.D.C. closes 40° after B.D.C.				Timing hole in the flywheel and crankcase when aligned with tommy bar locate No. 1 and No. 4 T.D.C.
Flywheel.					
Spigot diameter (for Starter Gear Ring).	13.406 13.403	340.512 340.436			
			—.031 —.023	—.787 —.584	
Starter Gear Ring (inside diameter)	13.380 13.375	339.852 339.725			
Crankshaft Spigot diameter	4.0007 4.0002	101.617 101.605			
			+.0012 —.0004	+.0305 —.0102	
Flywheel diameter for Spigot.	3.9998 3.9995	101.595 101.587			

Run out of Clutch contact face at outer diameter should not exceed .003″ (.076 mm).

Carburetter.

Zenith type 24 T — 2 (fully variable main jet).

Choke tube	17		
Main jet	100		
Slow running jet	60	Inter Con.	1 mm. drilled.
Progression	120 (2 holes)	Air jet	2.0
Needle seating	2.0 mm.	Carburetter bowl stamped "P".	
Petrol level at 4′ 6″ head	15 mm.		

Battery : Tractor Serial No. 200,001 and future — 12 volt 38 amp. hour capacity at 10 hour discharge rate. Specific Gravity 1.28 — 1.30 fully charged at 60°F. (16°C.)

Distributor : Static Setting 1° (Crankshaft) before T.D.C. Contact Breaker Gap .014″ — .016″ (.36 — .41 mm.)

Spark Plug.

	ins.	mm.
Reach	.5	12.7
Thread diameter	14 mm.	
Gap	.032 .030	.81 .76

Starter Motor : No. of Teeth : Flywheel Gear Ring and Starter Pinion, 145 and 10 respectively.

Distance of front mounting flange to rear face of flywheel gear ring. 1.563″ (39.7 mm.)

Dynamo : Runs at 1.9 × engine speed.

Governor : Range 400 — 2000 r.p.m. (Engine).

Governor Lever Spring :

Free Length — inside hook 3.8″ (96.5 mm). End Play .005″ (.127 mm). .010″ (.254 mm) Rate 20 lbs/in. ± 5%.

No. of Coils 24¾. Load at 1″ (25.4 mm) deflection : 20 lbs (9.07 kg.) ± 2 lb. (.907 kg.).

Initial wound-in load : Nil.

Control Rod Compensating Spring :

Free Length : inside hooks 2.187″ (55.55 mm). Rate 64 lbs/in. ± 5%. No. of coils 11½.

Load at ½″ (12.7 mm) deflection : 38 lbs. (17.237 kg.) ± 1½ lbs. (.681 kg.).

Initial wound-in load : 6 lbs. (2.722 kg.).

Fill-up Data :

Fuel Tank	8 Imperial gallons (36 litres), including 1 Imperial gallon (4.5 litres) reserve.
Engine Sump	12 pints (6.8 litres)
Air Cleaner Bowl	¾ pint (0.43 litres)
Transmission	5 Imperial gallons (22.8 litres)
Steering Gear-box	5 pints (2.9 litres)
Front Hubs	⅝ pint (0.35 litres)
P.T.O. Pulley	½ pint (0.28 litres)
Cooling System	15 pints (8.5 litres)

VAPORISING OIL ENGINE

(Manufactured by the Standard Motor Co.)

This information supersedes that originally issued on Pages B.9 to B.12.

Engine : 85 mm bore × 92 mm stroke as fitted to Tractors Type TE-D 20.

Displacement : 2088 CC (127.4 cu. ins.) Firing Order : 1, 3, 4, 2.

There are several types of the V.O. Engine, namely :—

Engine Nos. S120,510E to S170,173E covering versions 1 & 2.
Compression Ratio : 4.8 to 1.
Max. Belt H.P.: 23.9

Engine Nos. S170,174E onwards, covering versions 3 & 4.
Compression Ratio : 5.1 : 1.
Max. Belt H.P. : 25.4

Component Details		Dimensions New		Clearance New		Remarks
		ins.	mm.	ins.	mm.	
Pistons & Sleeves.						
Piston Dia. (Thrust Side Top Skirt)	F. Grade	3.3430 3.3427	84.912 84.905			
	G. ,,	3.3434 3.3430	84.922 84.912			Piston fitted with four rings above gudgeon pin, one ring below. These grades are identical with those of 85 m/m bore petrol engine.
	H. ,,	3.3438 3.3434	84.932 84.922			Oversize pistons available to suit rebored sleeves.
				.0037 .0030	.094 .076	
Sleeve Bore (Parallel)	F. ,,	3.3463 3.3460	84.996 84.988			Sleeves identical with those of 85 mm bore petrol engine.
	G. ,,	3.3467 3.3464	85.006 84.998			Replacement sleeves available as standard size, and rebored + .020″ (.508 mm).
	H. ,,	3.3471 3.3468	85.016 85.009			
Clearance, Bottom of Piston Skirt (Thrust Side).				.0022 .0015	.056 .038	Thrust side Piston Skirt tapered .0015″ (.038 mm) on diameter.
Top Land Diameter		3.329 3.327	84.557 84.506	.0190 .0170	.483 .432	
Ring Groove Width Top, 2nd, and 3rd.		.0807 .0797	2.050 2.024			
				.003 .001	.076 .025	
Compression Ring Width. Top, 2nd, and 3rd.		.0787 .0777	1.999 1.974			
Ring Groove Width 4th		.1895 .1885	4.813 4.788			
				.003 .001	.076 .025	Similar tolerances for oversize rings + .010″ (.245 mm), + .020″ (.508 mm) + .030″ (.762 mm).
Slotted Scraper Ring Width 4th		.1875 .1865	4.763 4.737			
Ring Groove Width 5th		.158 .157	4.013 3.987			
				.003 .001	.076 .025	
Slotted Scraper Ring Width 5th		.156 .155	3.962 3.937			
Ring Gap (closed)				.015 .010	.381 .254	

Component Details	Dimensions New ins.	Dimensions New mm.	Clearance New ins.	Clearance New mm.	Remarks
Oversize Sleeves & Pistons					
Piston Diameter	3.3632	85.425			
+.020″ (.508 mm).	3.3627	85.413			
			.0043	.110	
			.0030	.076	
Sleeve Bore (Parallel)	3.36700	85.522			
+.020″ (.508 mm)	3.36625	85.503			
Valve Head Diameters.					
Version 1. Engine Nos. S120,510E — S121,954E.					
Inlet	1.252	31.800			
	1.248	31.699			
Exhaust	1.252	31.800			
	1.248	31.699			
Version 2. Engine Nos. S121,955E — S170,173E.					
Inlet	1.176	29.870			
	1.172	29.769			
Exhaust	1.051	26.695			
	1.047	26.594			
Version 3. Engine Nos. S170,174E — S225,311E.					
Inlet	1.113	28.270			
	1.109	28.169			
Exhaust	1.051	26.695			
	1.047	26.594			
Version 4. Engine Nos. S225,312E onwards.					
Inlet	1.238	31.445			
	1.234	31.344			
Exhaust	1.051	26.695			
	1.047	26.594			
Thermostat.					
Valve begins to open	167°F—176°F	75°C—80°C.			
Valve fully open	203°F.	95°C.			
Valve lift	.312	7.94			

Carburettor.

Zenith Type 24 T-2 (fully variable main jet).

Choke Tube	17
Main Jet	105
Slow Running Jet	60
Progression	120 (2 holes)
Needle Seating	2.0 mm.
Fuel level at 4′ 6″ head	15 mm.
Inter-con	1 mm drilled.
Air Jet	2.0 mm.
Carburettor Bowl Stamped	"V.O."

Distributor. Static Setting 4 (crankshaft), before T.D.C. (Versions 1 & 2 and early editions of version 3, 6° (Crankshaft).

Spark Plug

	ins.	mm.
Reach	.75	19.05
Thread diameter	14 mm.	
Gap	.035	.89
	.030	.76

Fill-up Data.

Fuel Tank. Vaporising Oil : 7 Imperial Gallons (31.5 litres) Petrol : 1 Imperial Gallon (4.5 litres).

For other details and data — refer to 85 mm. bore petrol engine, Pages B21 to B25

LAMP OIL ENGINE

(Manufactured by the Standard Motor Co.)

ENGINE : 85 mm bore × 92 mm stroke as fitted to Tractors Type TE-H 20.

Displacement : 2088 CC (127.4 cu. ins.)

Compression Ratio : 4.5 : 1.

Firing Order : 1, 3, 4, 2.

Maximum Belt H.P. : 22.9

Component Details		Dimensions New		Clearance New		Remarks
		ins.	mm.	ins.	mm.	
Pistons and Sleeves.						
Piston Diameter. (Thrust Side Top Skirt)	F. Grade	3.3435 3.3432	84.925 84.917			Piston fitted with four rings above gudgeon pin, one ring below.
	G. ,,	3.3439 3.3436	84.935 84.917			Oversize pistons available to suit rebored sleeves.
	H. ,,	3.3443 3.3440	84.945 84.938			
				.0031 .0025	.079 .064	
Sleeve Bore (Parallel)	F. ,,	3.3463 3.3460	84.996 84.988			Sleeves identical with those of 85 m/m bore petrol engine.
	G. ,,	3.3467 3.3464	85.006 84.998			Replacement sleeves available as standard size, and rebored — .020" (.508 mm).
	H. ,,	3.3471 3.3468	85.016 85.009			
Clearance, Bottom of Piston Skirt (Thrust side)				.0016 .0010	.041 .025	Thrust side Piston Skirt tapered .0015" (.038 mm) on diameter.
Top Land Dia.		3.328 3.325	84.531 84.455	.0221 .0180	.561 .457	
Ring Groove Width Top, 2nd and 3rd		.0817 .0807	2.075 2.050			
				.004 .002	.102 .051	Similar tolerances for oversize rings — .010" (.245 mm) — .020" (.508 mm) — .030" (.762 mm).
Compression Ring Width Top, 2nd and 3rd		.0787 .0777	1.999 1.974			
Ring Groove Width 4th and 5th		.1905 .1895	4.839 4.813			
				.0040 .0020	.102 .051	
Slotted Scraper Ring Width 4th and 5th		.1875 .1865	4.763 4.737			
Ring Gap—closed				.015 .010	.381 .254	
Oversize Sleeves & Pistons						
Piston Diameter + .020" (.508 mm).		3.3637 3.3632	85.438 85.425			
				.0038 .0025	.096 .064	
Sleeve Bore (Parallel) + .020" (.508 mm).		3.36700 3.36625	85.522 85.503			
Spark Plug						
Reach		.75	19.05			
Thread diameter		14 mm.				
Gap		.032 .028	.81 .71			

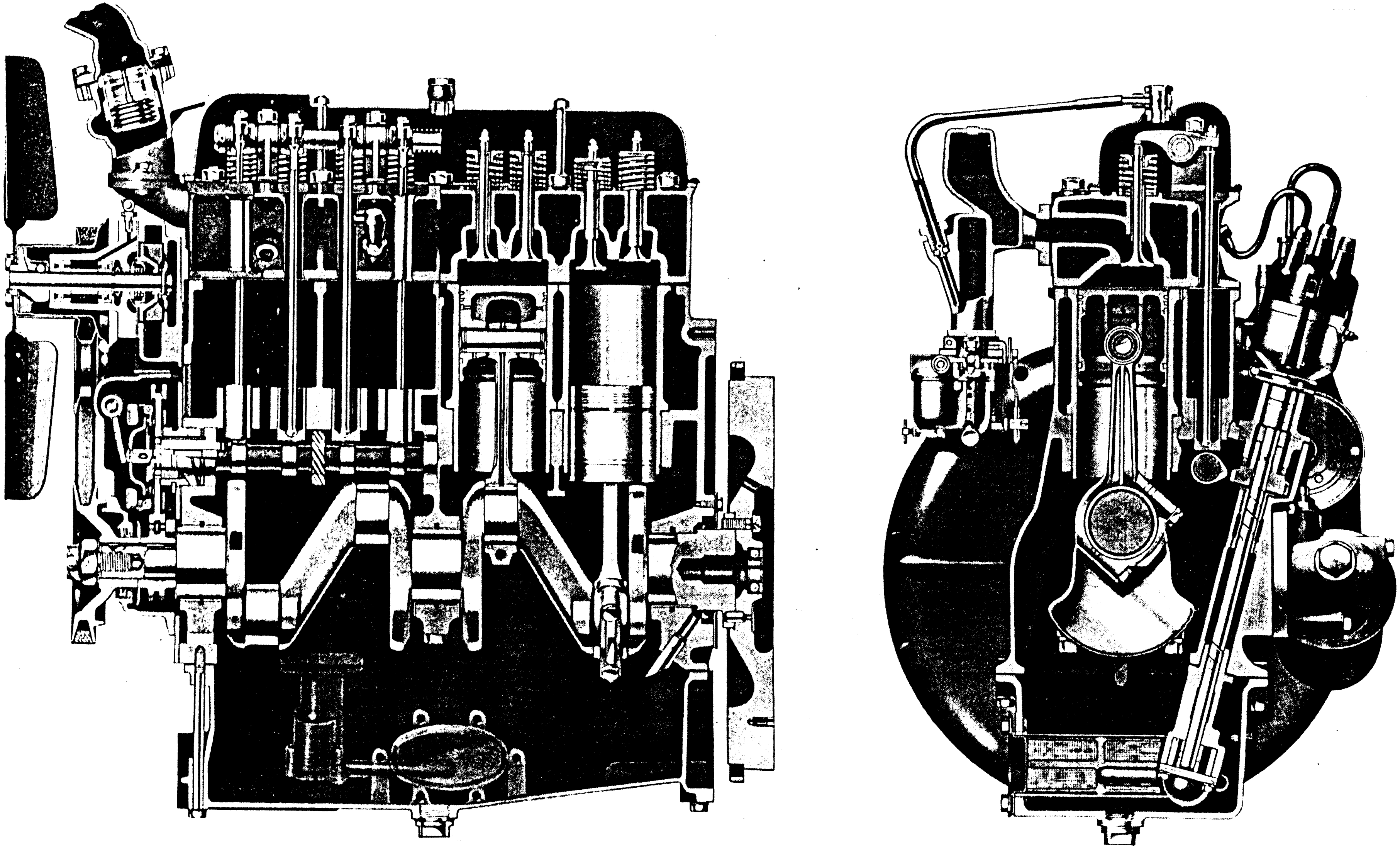
The Thermostat and Carburettor are identical to the vaporising oil engine. See page B28.

Fill-up Data.

Fuel Tank. Lamp Oil. 7 Imperial Gallons (31.5 litres). Petrol 1 Imperial Gallon (4.5 litres).

Cooling System : 17 pints (9.6 litres.)

For other details and data — Refer to 85 mm bore petrol engine. Pages B21 to B25.



SECTIONAL VIEWS OF PETROL ENGINE

ENGINE SECTION

The following instructions assume the use of the specially designed dismantling stand and range of tools and equipment listed in Section U of this Manual.

Separate dismantling and assembly instructions have been prepared for the removal and replacement of all main components, but those covering replacement of the crankshaft assume a complete engine overhaul.

The comprehensive dimensional specification, presented in Section B, should be referred to when inspecting components for wear. Screw threads should always be lubricated before tightening.

PETROL ENGINE AS FITTED TO TRACTORS TYPE TE-A20 AND TE-C20

Lubrication System

It is proposed under this heading to describe the passage of oil through the engine, and to explain the function and dismantling procedure for the various components connected with oil distribution (i.e. oil filter and oil pump).

Oil Distribution (Fig. 1).

Oil is pumped from a wire mesh screen through an annular space around the pump drive shaft to the filter, from which it passes to the oil gallery for distribution as indicated in the table overleaf. Oil leakage between shaft and upper bush is prevented by a reverse spiral groove on the upper portion of the shaft.

Front, centre and rear journals of both crankshaft and camshaft are connected by drillings directly to the oil gallery, whilst oil arrested by rear crankshaft seal drains through rear main bearing cap to sump. Lubrication of connecting rod big-end bearings is provided through drillings in crankshaft connecting front journal and No. 1 crankpin, centre journal and Nos. 2 and 3 crankpins and rear journal and No. 4 crankpin. The clearance between connecting rod bearing and crankpin provides sufficient flow of oil under pressure to pass along a central drilling in connecting rod to gudgeon pin, with a further surge when the connecting rod drilling aligns the supply drilling at the crankpin. Cylinder walls are lubricated by intermittent splash feed through a bleed hole drilled in the connecting rod.

A spiral oil groove connects two flats which are machined on the camshaft rear journal in such positions that as the shaft revolves, one approaches the oil inlet drilling from the gallery, while the other approaches a second drilling through the cylinder block and head to the rear rocker shaft pedestal. Momentarily, during each revolution of the camshaft, both holes are uncovered by the flats and oil under gallery pressure passes along the spiral groove and up to the hollow rocker shaft where it is distributed through drillings to internally grooved rocker bushes. Oil is directed through relief holes from rockers on to adjusters and push rods, returning by gravity through tappet chambers to sump. This drip feed also helps to lubricate the intermediate camshaft journal, while excess oil from rocker gear is drained from cylinder head through crankcase to sump.

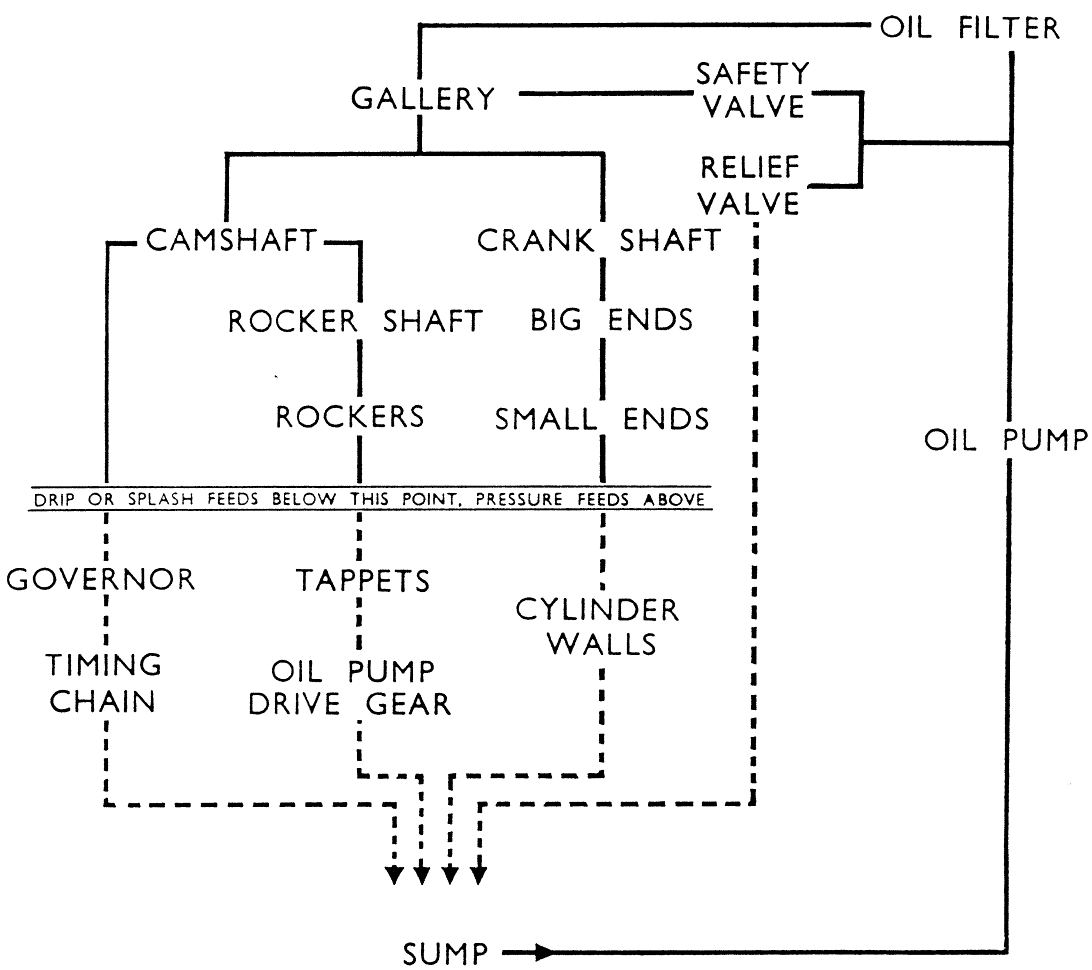


FIG. 1

NOTE : Valve guide tops stand proud of cylinder head to avoid possibility of oil drainage to combustion chambers.

Lubrication of timing chain and governor mechanism is provided through a drilling from the circular groove in the front camshaft journal to a slot on the timing sprocket mounting face, from which oil is dispersed by centrifugal force, to drain to sump through a recess on forward face of front main bearing cap.

The Oil Pump (Fig. 2)

After detachment, the oil pump can be dismantled by removal of 4 set screws securing cover assembly to pump body, revealing the spindle and inner rotor as-

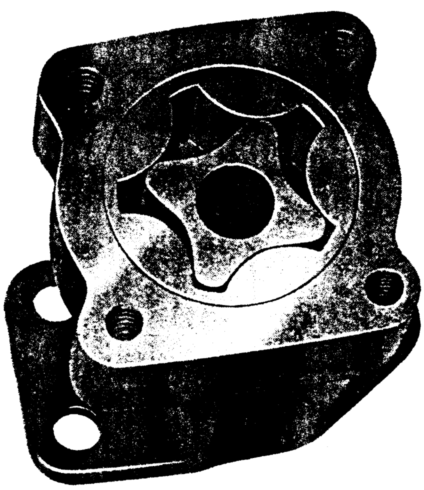


FIG. 2.

sembly which drives the outer rotor. It will be seen from Fig. 2 that the outer rotor has 5 lobes while the eccentrically mounted inner rotor has four. Thus, as the spindle turns, oil from the vacant space over the inlet port is transferred to the outer port, from which it is expelled as the lobes engage. The pump requires no attention other than washing in paraffin during a major engine overhaul.

The Oil Filter: (Fig. 3)

Vertical type X—fitted to tractors type TE-A20 before Serial No. 56340 :

Inclined type Y—fitted to tractors type TE-A20 after Serial No. 56339 :

Although the above oil filters are different in appearance, they have the same principle of operation and both house a pressure relief and safety valve. Oil is pumped from the sump through port A to the outside of the filter element. Particles of dirt are removed as the oil passes through to the inside of the element and escapes to the gallery through diagonal port B. If tightness of bearings or low viscocity of oil causes the pressure in the system to rise above 40—60 lbs. sq. inch (2.8—4.2 kg. per sq. cm.), unfiltered oil passes back to the sump as pressure relief valve C opens. Should the element become clogged and the passage of oil severely restricted, oil in the diagonal port B and gallery will be at lower pressure

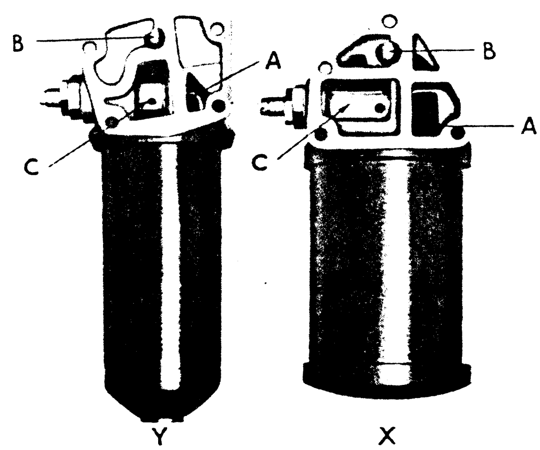


FIG. 3.

than that on the outside of the element, opening a safety valve at the lower end of port B and allowing unfiltered oil to pass into gallery.

To Dismantle Vertical Type (see Fig. 4)

1. Remove long bolt 12 which screws into boss filter base.
2. Tap head assembly 3 free from barrel 2, withdraw element 21 and remove 'C' spring 20 from boss.
3. Remove top pressure plate 19, felt washer 18, plain washer 17, and element locating spring 16.
7. Tap base assembly off barrel 2.
8. From base assembly remove 'C' spring 22. Detach pressure plate 23 and felt washer 24 from boss and rubber jointing 25 from its groove.
9. Wash all parts in paraffin and rebuild base assembly.

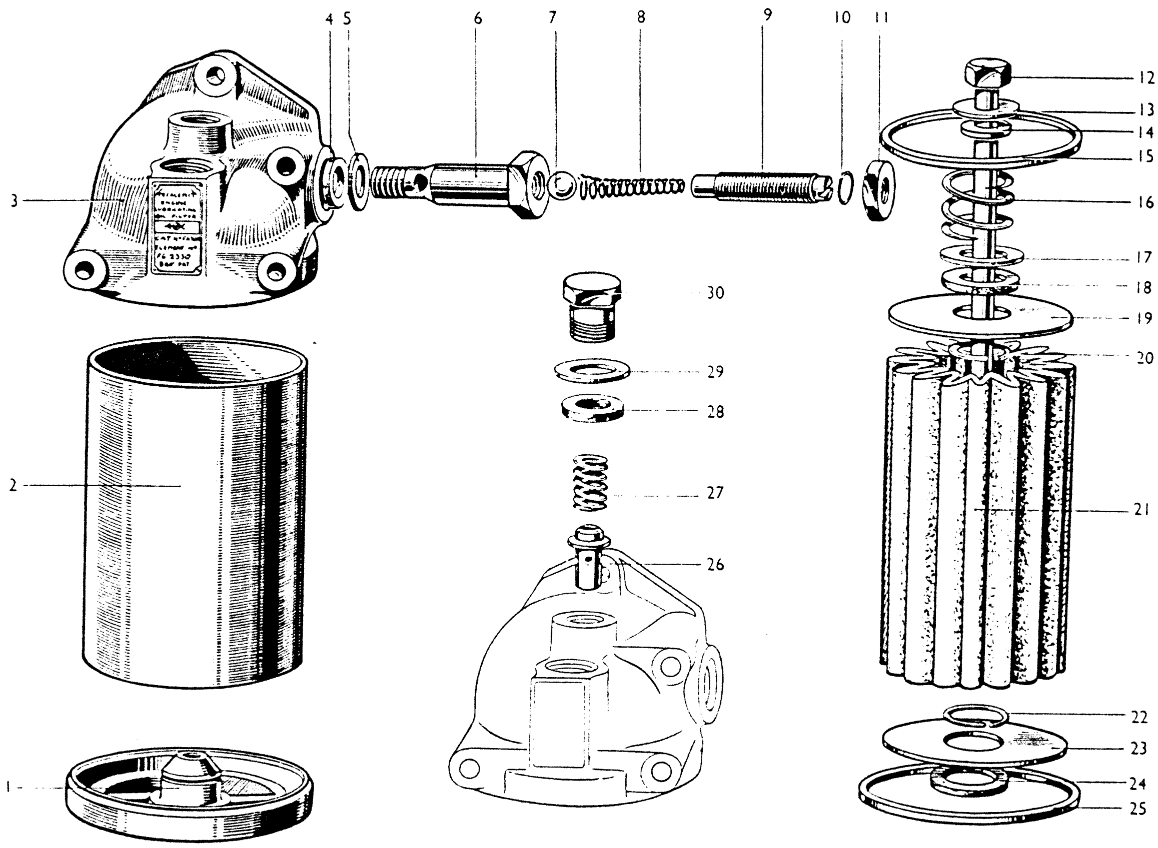


FIG. 4

4. Unscrew and remove safety valve plug 30, spring 27, and valve 26. Remove plug washer 29, and rubber sealing washer 28 from recess in plug boss.
5. Withdraw pressure relief valve assembly with washer 5 and seal 4 after unscrewing the larger hexagon on body 6.
6. Dismantle pressure relief valve assembly by unscrewing locknut 11 and plug 9 and withdrawing spring 8 and ball 7.

Re-Assembly of vertical type

Before re-assembly, carefully scrape all paint and dirt from machined faces and bosses, wash all parts in paraffin and blow out with compressed air. Re-new any defective part, paying particular attention to rubber and felt sealing washers.

1. Insert ball 7 in pressure relief valve body 6 and locate spring 8 with its

wide end on ball. Screw adjustment plug 9 into body and place over its slotted end a new lead packing ring 10 before screwing down locknut 11. As a preliminary setting, the plug should be screwed in so that about 6 — 7 threads are exposed above lock nut.

2. Place rubber sealing washer 4 into recess and screw down the valve assembly on to washer 5.

3. Place safety valve 26 in its bore and locate spring 27 on valve shoulder.

4. Locate rubber sealing washer 28 in its recess and tighten plug 30 on to its washer.

5. Place spring 16, steel washer 17, felt sealing washer 18, and pressure plate 19 over central boss inside filter head, and secure by fitting 'C' spring 20 in groove.

6. Replace joint ring 25 in groove of base, and secure felt washer 24 and pressure plate 23 by 'C' spring 22.

7. Assemble base, head and barrel with new filter element 21 and secure by screwing down long bolt 12 on to washer 13, having inserted rubber seal 14.

Inclined Type—General (Fig. 5)

This filter can be mounted in place of the vertical type without the necessity of drilling and tapping further bolt holes in the engine crank case. The filter further differs in that the barrel and base are cast in one unit to form the container. The safety valve also is of different design. Although instructions are given for removal and replacement of bottom pressure plate 21, the operations are awkward, and not usually necessary.

To Dismantle inclined type.

1. Remove long bolt 11 which screws into a boss in the base of container 1. Tap off head 2 and remove sealing washer 13, plain washer 12, and ring 14.

2. From filter head remove "C" spring 18, clamping plate 17, felt washer 16, and steel dished washer 15.

3. The safety valve assembly 25 can now be unscrewed and removed for cleaning, but not further dismantled.

4. Instructions relative to pressure relief valve are identical with those for vertical type filters as these valves are interchangeable.

5. From screwed boss in the base of container, remove "C" spring 20 to release pressure plate 21, felt washer 22, steel washer 23, and pressure plate spring 24.

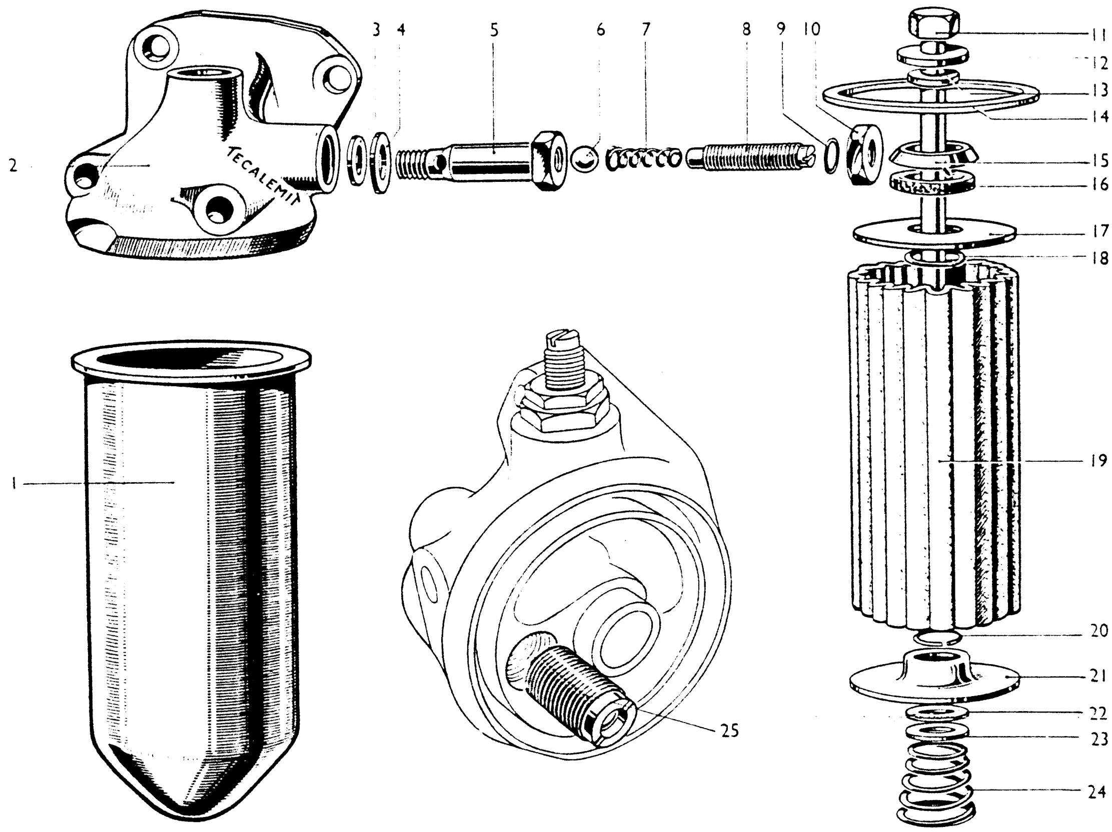


FIG. 5.

Re-Assembly of inclined type.

Clean all parts as recommended for vertical type filters, then proceed as follows :—

1. Insert ball 6 in pressure relief valve body 5 and locate spring 7 with its wide end on ball. Screw adjustment plug 8 into body and place over its slotted end a new lead packing ring 9 before screwing down lock nut 10. As a preliminary setting, the plug should be screwed in so that about 6—7 threads are exposed above lock nut. Place rubber sealing washer 3 into its recess and screw down the valve assembly on to washer 4.

2. Replace safety valve assembly 25.

3. On filter head 2, replace steel dished washer 15, felt washer 16 and clamping plate 17. Secure by fitting " C " spring 18 in its groove.

4. In base of container, replace pressure plate spring 24, steel washer 23, felt washer 22, and pressure plate 21. Secure by fitting " C " spring in its groove.

5. Replace joint ring 14 in its recess in head, locate head on container and replace sealing washer 13. Secure by tightening long bolt 11 on to its washer 12.

OVERHAUL OF CYLINDER HEAD ASSEMBLY

Necessity for Decarbonisation and Valve Grinding.

The combustion of the fuel-air mixture supplied to an engine cylinder should spread rapidly and evenly from the spark plug points through the charge. The heat of combustion should rapidly expand the gases produced by the combustion, and exert a steady sustained pressure on the piston.

The gradual build up of carbon deposits from the burnt gases inside the combustion chamber eventually adversely affects combustion because the deposits become incandescent from the heat of combustion, and prematurely ignite the incoming gas charge. Also, they cause areas of irregular combustion, giving sharp, violent increases of pressure on the piston.

The actual increase in compression ratio and poor heat dissipation due to layers of carbon can be sufficient to cause the very high pressure and temperature necessary for spontaneous combustion of fuel well before the piston has reached the top of its stroke.

This inefficient combustion is usually made evident by a characteristic metallic knocking or 'pinking,' or by a tendency for the engine to 'run on' after the ignition is switched off.

Loss of Compression.

Starting difficulty, loss of power, or increased fuel consumption will often indicate that cylinder compression is being impaired by carbon deposits in the valve guides which prevent valves from closing properly, or valve seating faces having become pitted or burnt and which need regrinding, re-cutting or even replacing.

Testing Cylinder Head Compression.

Cylinder compression can be tested by either of the following methods :—

(*a*) By turning crankshaft two complete turns with starting handle, a comparison can be made of the compression resistance of the four cylinders and thus the condition of the four pairs of valves.

(*b*) By connecting a pressure gauge with suitable adaptor to each of the spark plug holes in turn and operating the starter with ignition switched off. It is important for this test that the battery is fully charged. At cranking speed the cylinder-head pressure of an engine in good condition should be 90 to 100 lbs. per square inch. (6.33—7.03 kg. per sq. cm.)

The important point to note during both these tests is any deficiency in compression for one particular cylinder compared with the average for the other three.

Visual Indication of Need for Decarbonisation.

Decarbonisation is usually necessary after about 300 hours work. An indication of the condition of combustion chamber can be obtained from that of the spark plugs. If, on removal for examination, the plugs have acquired a considerable amount of carbon around the base of the electrodes, a similar state can be assumed to exist in the combustion chambers.

The following instructions are necessary for the complete reconditioning of the cylinder head. It is unlikely that the complete overhaul will be necessary until the engine has done many hundreds of hours work, but removal of carbon deposits and lapping of valves should be carried out at regular intervals.

Preparations for Lifting Cylinder Head (Fig. 6).

1. Remove radiator filler cap and drain water from radiator and cylinder block by opening the two drain taps, one of which is located at the base of the radiator, and the other on cylinder block behind dynamo.

2. Detach hood. This entails removal of two support attachment bolts from forward end of fuel tank, and two shoulder screws from radiator support bracket.

3. Remove hood.

4. Turn off fuel, disconnect fuel pipe at sediment bowl, and remove tank, which is secured by four bolts.

5. Remove crankcase breather pipe by unscrewing the banjo connection at rocker cover and screwed adaptor at manifold.

6. Remove cotter pin from governor spring link lever 1 at forward end of throttle rod 2. Pull off link and allow to remain suspended on spring 3.

7. Disconnect radiator stay and hose 4 at water outlet elbow 5.

8. Disconnect by-pass hose 6 at thermostat body 7 or water pump 8 and remove the two set screws securing thermostat body to flange at forward end of cylinder head.

9. Swing clear the assembly comprising thermostat body and water outlet elbow, pivoting on throttle rod, as shown in Fig. 6.

10. Disconnect exhaust pipe clip at engine mounting flange.

11. Using service wrench FTB2, remove manifold nuts. Pull manifold off its studs and leave suspended clear of cylinder head as shown in Fig. 6. Remove gaskets.

12. Remove rocker cover with gasket.

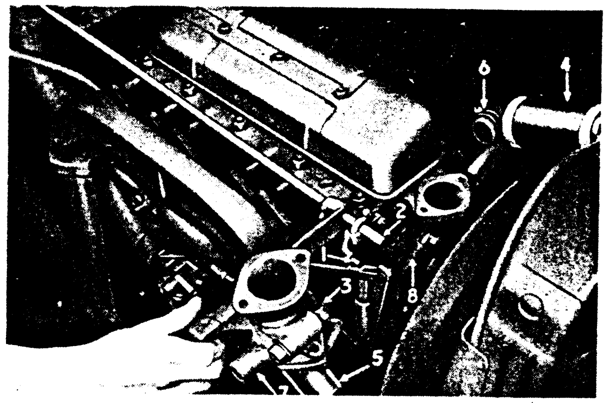


FIG. 6

13. Lift rocker shaft assembly after removing the four pedestal securing nuts from their studs.

14. Lift out push rods ensuring that tappets are not disturbed.

15. Remove spark plugs and immerse in petrol.

To Remove and Dismantle Cylinder Head Assembly.

1. Remove the ten cylinder head securing nuts from their studs.

2. Pulling at thermostat flange at forward end, and rocker cover flange at rear, remove cylinder head and gasket.

Note :-

Do not break the seal between head and block by turning engine. This may disturb sleeves.

3. On to the second and fourth cylinder head studs on manifold side, screw sleeve retainers—FT.3, Fig. 7.

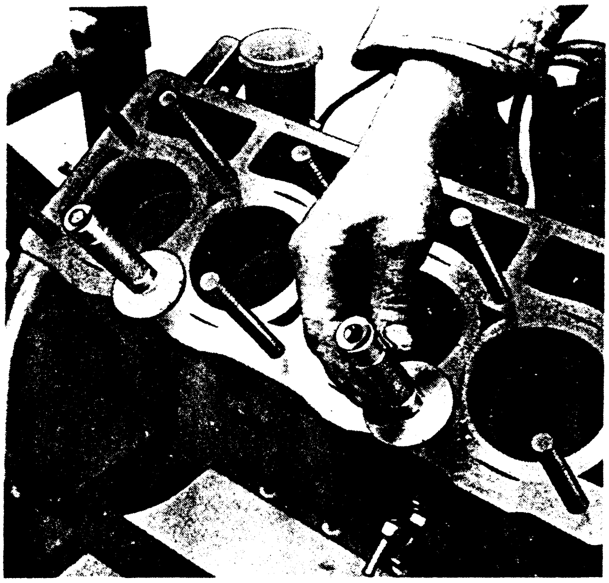


FIG. 7

4. Mount cylinder head assembly on service fixture FTB9, with pegs located in end stud holes. Adjust the position of the strut to obtain a vertical pull on collar. Compress valve springs and remove split cones. Valves and springs should be placed in order of removal on stand as shown in Fig. 8.

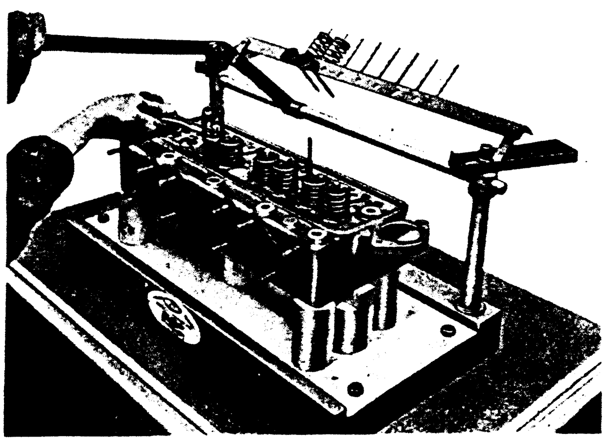


FIG. 8

Note :-

If oil retaining cups and seals are fitted above valve guides, they should be discarded.

Replacement of Push Rod Tubes :-

Damaged push rod tubes can easily be replaced using service tool FT.53, Fig. 9.

To Remove Tube.

1. Cut through the tube with a hack-saw. Fig. 10 inset.
2. Knock out each half of the tube from its location in cylinder head.

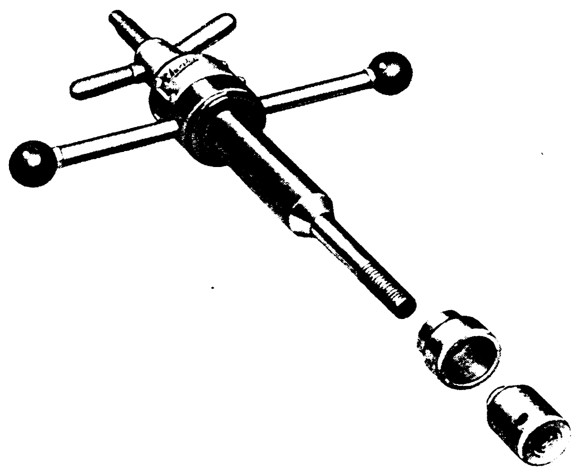


FIG. 9

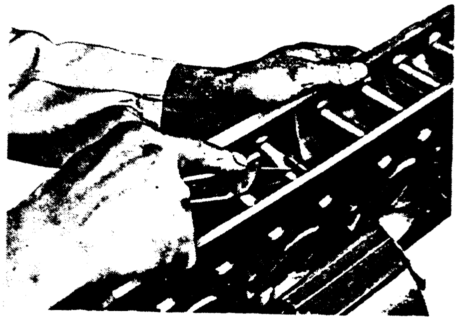
To Fit New Tube.

Place collar A on tool shank as shown in Fig. 10.

2. Locate new tube in cylinder head flange.
3. Insert tool shank through tube and tighten tapered collar B.
4. Turn handle C to pull tube into position.

5. Unscrew and remove tool.

6. Replace tool without collar A, secure tapered collar B. and tighten by turning handle C. to locate taper of tool body in tube.



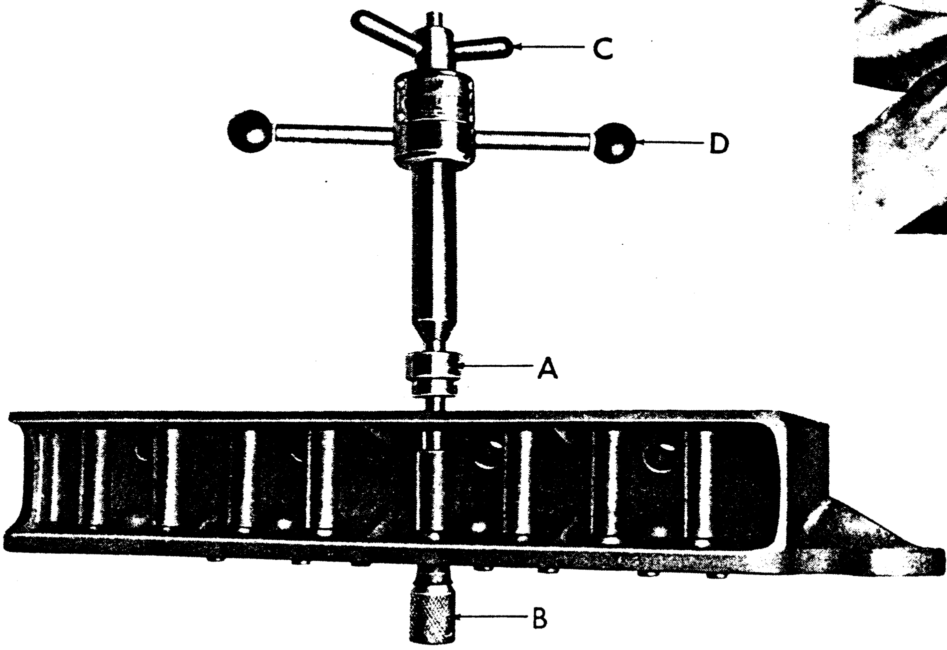


FIG. 10

7. Turn handle lever D to spin out edge of tube.

8. Continue tightening and spinning until edge of tube is spread into recess to give firm location.

Rocker Assembly (Fig. 11)

Pedestals 1, rockers 2 and 3, and springs 4 can be slid off the rocker shaft 5 after removal of one of the end collars 6 and the shaft locating plug 7 from No. 4 pedestal. Prior to tapping off the end collar, it is necessary to tap out its locating pin 8.

Should any of the rocker bushes 9 have worn, the assembly comprising rocker and bush must be renewed. However, adjusting pins and locknuts 10 are available as spare parts.

After blowing out all oil drillings with compressed air, re-assemble as follows :—

1. Assemble rockers and springs on shaft as shown in Fig. 11 with pairs of rockers converging towards valve pad ends and with the rear pedestal, which has the oil feed drilling, located at the radially drilled and tapped shaft end.

2. Tap on end collar, insert pin and peen over.

3. Position shaft in the drilled pedestal so that locating plug can be inserted and tightened over its shake-proof washer.

Tappets and Pushrods.

Examine each tappet in turn. Face markings illustrated in Fig. 12A., indicate that the tappet has not been turning in its bore, while those illustrated in Fig. 12B indicate satisfactory turning, thus ensuring even wear and satisfactory rocker adjustment. Tappets which have not been turned should either be replaced or relocated in another bore where satisfactory rotation has taken place. If a push rod is bent or has worn seating, it should be replaced.

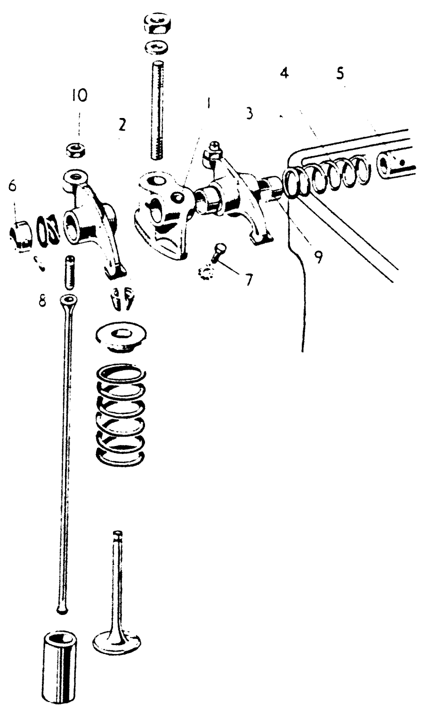


FIG. 11

Removal of Carbon Deposits.

An examination of carbon deposits on the cylinder head, combustion chambers and piston crowns will indicate the general mechanical conditions of the engine. A hard dry deposit shows that the piston rings etc., are not unduly worn. The reverse is indicated if the carbon is soft and oily.

Pistons and Sleeves.

1. Turn crankshaft until two pistons are about $\frac{1}{4}''$ (6.35 mm) before the top of their stroke and insert an old piston ring in the bore on top of one of them.
2. Place sufficient clean rag in remaining cylinders to ensure that carbon scrapings do not enter the bores.
3. Using a suitable scraper, carefully remove from the piston crowns all carbon inside the old piston ring, leaving a ridge around the piston edge and at the top of the sleeve bore. This helps to retain compression.

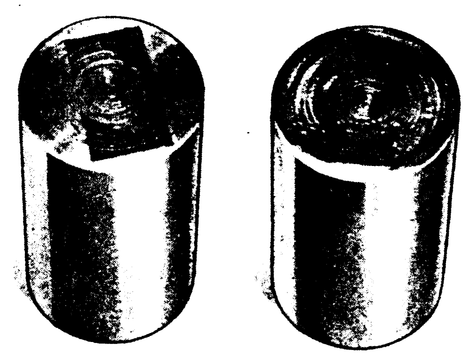


FIG. 12

4. Repeat this procedure for the remaining three pistons, taking care that no scrapings or chips drop between the sleeves into the cylinder block water jacket. Wipe off piston crowns with petrol-moistened rag.
5. Scrape any particles of dirt or grit from the upper machined surface of cylinder block and wipe off with a petrol-moistened rag.

Note :-

To ensure that no loose carbon particles remain around piston edges, thin oil can be squirted on to the edges of piston crowns, and the crankshaft rotated. Any loose particles will be left on the bores, and can easily be wiped away.

Cylinder Head.

1. Examine water jacket. Immerse head in caustic soda solution if necessary to clear scale. Dismantle and clean thermostat assembly—see Section D.

2. Remove all carbon deposits from combustion chambers, valve ports and guide shrouds by means of suitable scrapers, or pneumatic hand tool, as shown in Fig. 13.

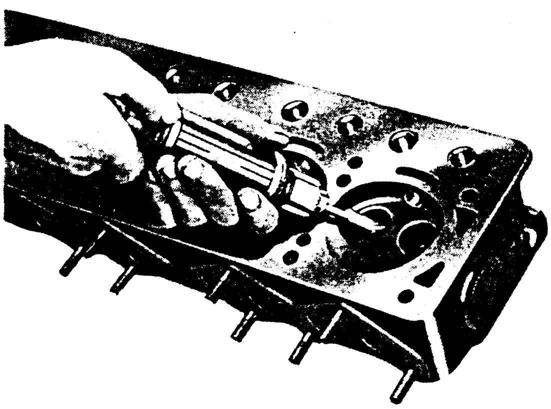


FIG. 13

3. Thoroughly clean all machined faces and wash in petrol or paraffin.

Valves, Seats and Guides.

1. Thoroughly scrape all carbon from each valve head, wash valve in petrol, afterwards polishing head and stem, preferably using a rotating wire buffer similar to that illustrated in Fig. 14.

   Be careful to replace each valve in its correct position on the Service Fixture so that it can be subsequently fitted in its correct guide.

2. When each valve is thoroughly cleaned, examine the fit in its guide bore.

   The clearance between stem and guide should be :—

   Exhaust
   0.003″ — 0.005″ (.0762 — .1270 mm)

   Inlet
   0.003″ — 0.001″ (.0762 — .0254 mm)

3. If the clearance appears excessive, the valve stem diameter should be measured. The diameter of unworn stems should be :—

   Exhaust
   0.309″ — 0.308″ (7.8486 — 7.8232 mm)

   Inlet
   0.311″ — 0.310″ (7.8994 — 7.8740 mm)

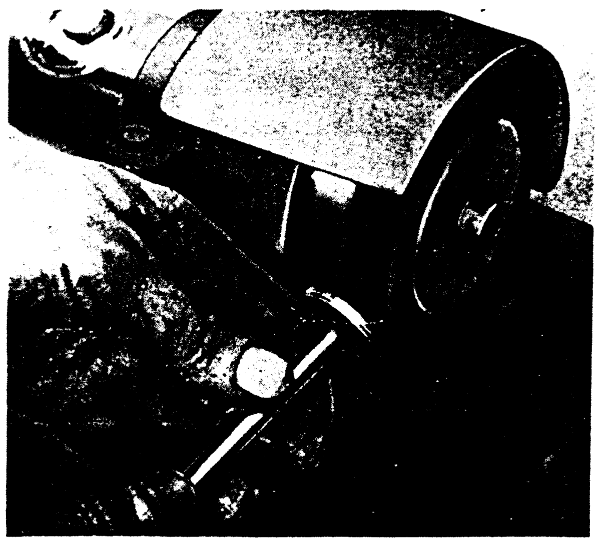


FIG. 14

After this examination, and before further treatment, it should be decided whether wear on valve stems and guides warrants replacement.

Spark Plugs.

After plugs have been washed in petrol and allowed to dry, the insulators and electrodes should be cleaned with a wire brush, or, preferably, with one of the proprietary spark plug service units. Remove all traces of grit or carbon from screw threads. Examine the insulators for cracks and the electrodes for signs of excessive burning ; if damage of this nature is suspected, plugs should be renewed. If it is decided that a plug is worthy of further use, the centre and side electrodes should be dressed with a small smooth file, and the gap set to 0.028/0.082 ins. (.701/.813 mm) by bending the side electrode.

Valve Grinding and Cutting.

The operations detailed below are necessary for the purpose of ensuring a gas-tight seal between valve and seat in cylinder head.

Grinding-in is necessary whenever a new, refaced, or very slightly pitted valve is to be used in a cylinder head where the valve seat is in a similar condition. Valves and seats which have become more extensively worn should be replaced or re-cut before regrinding. The necessary cutting treatment depends entirely on the condition and previous treatment of the valve or seat, which should be examined and compared with the examples shown in Fig. 17.

Grinding-In.

It is most important that each valve is ground into its correct seat in the cylinder head, and for this reason it has been emphasised that care should be taken, after removal, to assemble valves in their correct order on the cylinder head Service Fixture. The valve grinding tool used can be either of the hand type or the pneumatic type as shown in Fig. 15, and the treatment for each valve is as follows :—

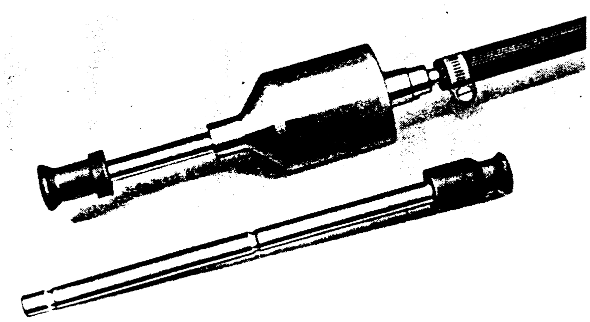


FIG. 15

1. Mount the cylinder head on the the service stand with combustion chambers uppermost.

2. Coat the bevelled face of the valve with grinding paste. If the seats are in fairly good condition, it will only be necessary to use fine paste, but if this is not sufficient to produce a clean surface, a little coarse paste must be used, finishing off with fine grade.

3. Exerting an even pressure on the grinding tool, rotate the valve backwards and forwards as shown in Fig. 16. After a few oscillations, lift the valve and press down in another position. This ensures even grinding.

4. Examine the valve as the work proceeds until a smooth dull ring is formed round its seating face cor-

FIG. 16

responding with the seat cut in the cylinder head.

5. Test if seat is true. Carefully clean all grinding paste from both valve and seat, mark seat in at least 4 positions with a soft lead pencil, then rotate the dry valve as if continuing grinding process. The correctly ground-in valve will then make a bright ring concentric with the smooth matt band first observed. If this ring is unbroken and all pencil marks broken, the valve will be gas-tight on assembly.

Cutting Valves and Seats.

Typical conditions of valves and seats which require re-cutting are illustrated in Fig. 17.

Fig. 17A. shows a new, correctly seated valve providing a centrally located seating area of approximately half that of the inclined face. In Fig. 17B grinding has been carried out to such an extent that the valve head has sunk into the cylinder head, giving such a large seating area that its efficiency has been impaired.

Fig. 17C shows an extreme condition in which the valve is shrouded by a step formed on the seat due to excessive grinding. Engine performance will suffer because of the consequent later opening and early closing of the valve, and the loss of seating efficiency described above. In Fig. 17D the step illustrated in detail C has been removed, using the $44\frac{1}{2}°$ cutter but the seating face still remains too large. Fig. 17E illustrates the use of the 70° narrowing cutter to reduce the seating area to the correct size. It will be seen that the lower part of the $44\frac{1}{2}$ seat has been cut away, leaving the correct valve contact area of approximately half of the inclined face.

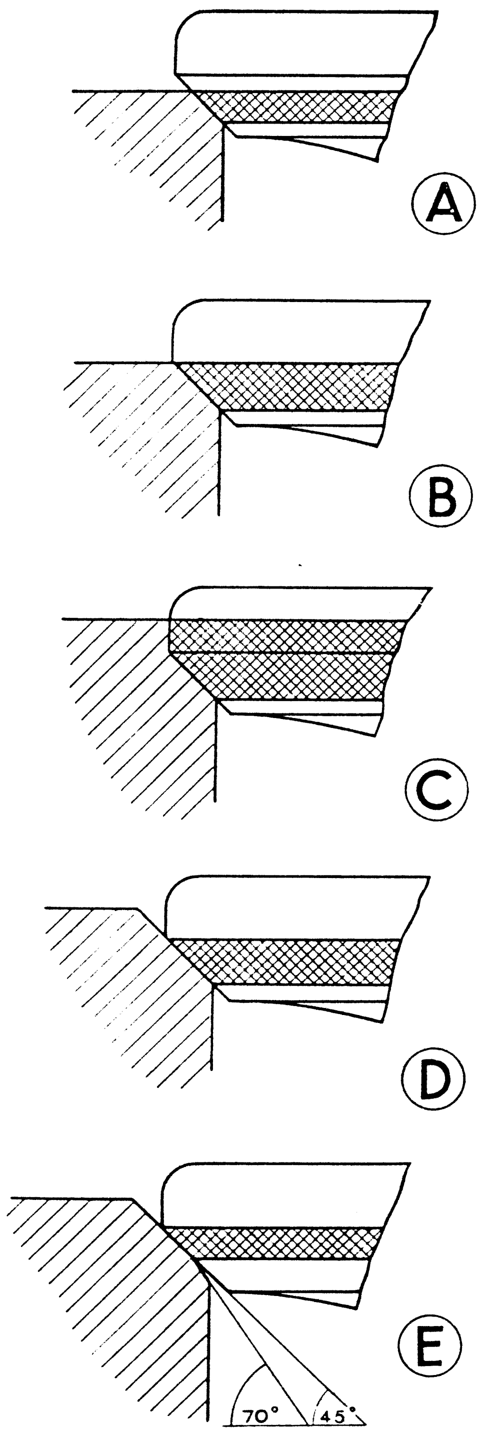


FIG. 17

Refacing Valves.

Valve head seating angle is 90° included.

Valves are manufactured from a much harder steel than that of their seats in the cylinder head. Consequently, if a valve is badly burnt or pitted, the grinding operation previously described would remove an excessive amount of material from cylinder head seats before restoration of the sealing face of the valve heads. Therefore, badly pitted valves should always have their sealing faces re-ground at the correct angle before lapping-in. It is strongly recommended that grinding is carried out using the specialised machine illustrated in Fig. 18. The least possible amount of steel should be ground away, consistent with

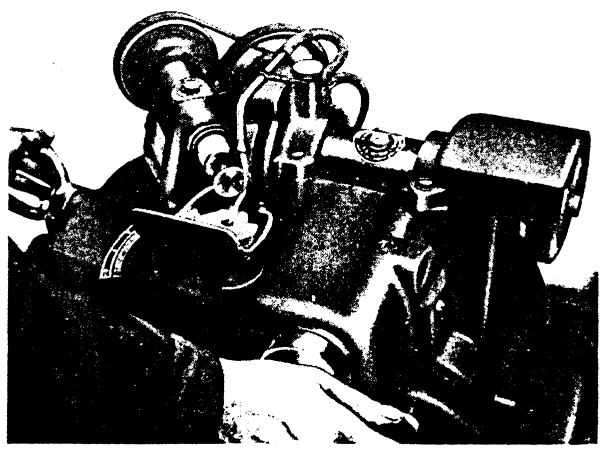


FIG. 18

the removal of the pittings. A valve should be discarded if re-facing treatment reduces its head thickness above the seating edge below $\frac{1}{32}$" (1 mm). If the head is too thin the edges are apt to curl up when the valve becomes hot.

Re-cutting Valve Seats.

Valve seat angle is 89° included.

It will not usually be necessary to recut seats with the $44\frac{1}{2}$ cutter unless they are badly pitted, or if a step has formed as shown in Fig. 17C use the cutter to remove the absolute minimum of metal necessary to form the profile shown in Fig. 17D. The narrowing cutter should be used as necessary to provide the correct sealing area shown in Fig. 17E.

FIG. 19

The use of the valve seat cutter and pilot, service tool FT.316, is illustrated in Fig. 19. The cutter is a push fit over the tapered shank of the tool, while the pilot is a sliding fit in the valve guide bore. After locating the pilot with the cutter teeth bearing lightly on the seat requiring treatment, a few revolutions of the tool will suffice to clean up the seating face. This procedure applies to either cutter.

Note—Valves and seats **must** be lapped-in after refacing. Valves should be mounted on the cylinder head service fixture in their correct order for assembly.

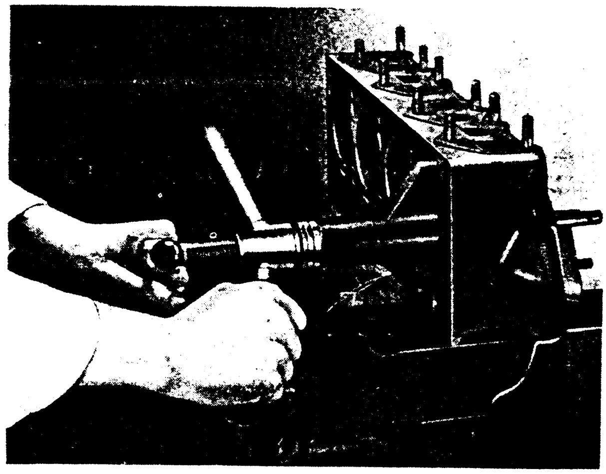


FIG. 20

Precautions before Re-Assembly.

Before re-assembling the eight ground-in valves, all traces of paste should be removed from valve head, stems, and seats in the cylinder head. Ensure that no paste remains in the valve guide bores by dipping valve stems in petrol and passing up and down in guides. Ensure that all valve guides protrude $\frac{9}{16}$" (14.3 mm) above valve spring seats in cylinder head. If the protrusion is less than $\frac{9}{16}$" (14.3 mm) the guide will have to be removed, cleaned, and re-located, using service tool FT.60—Fig. 20 and 21. Examine all valve springs. If a spring compresses to a length less than $1\frac{1}{4}$" (31.75 mm) under a load of 38 lbs. (17.237 kg.) it should be renewed.

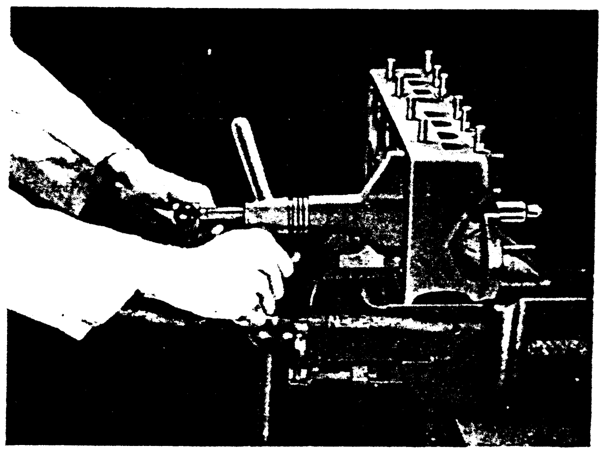


FIG. 21

Assembly of Valves and Springs.

Locate each valve in its correct guide and mount the cylinder head on the service stand with valve spring seats uppermost. Oil retaining cups and seals are not to be fitted.

Assemble each valve spring as follows :—

1. Place spring over the valve stem with close wound coils to spring seat shown in Fig. 23 inset.
2. Mount collar and compress spring.
3. Insert split cones, and allow the spring to expand.

To replace Cylinder Head Assembly.

1. Remove all rag from cylinder bores.
2. Ensure that none of the tappets has become displaced in its bore.
3. Remove cylinder sleeve retainers.
4. Carefully place a new cylinder head gasket over studs on to face of block.

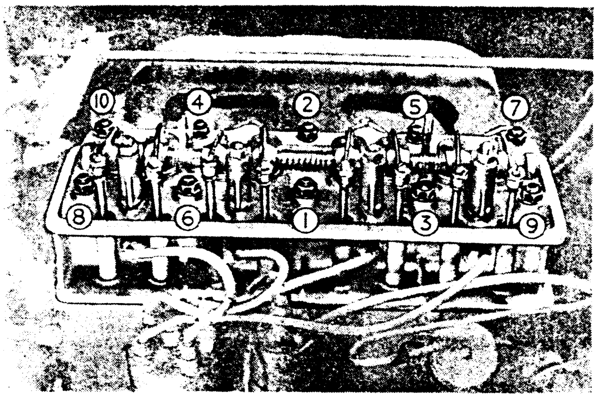


FIG. 22

5. Mount cylinder head over studs and tighten nuts over washers gradually in order shown in Fig. 22 to a torque wrench reading of 60—65 ft. lbs. (8.25—8.95 m.kg.)
6. Insert push rods in their tubes.

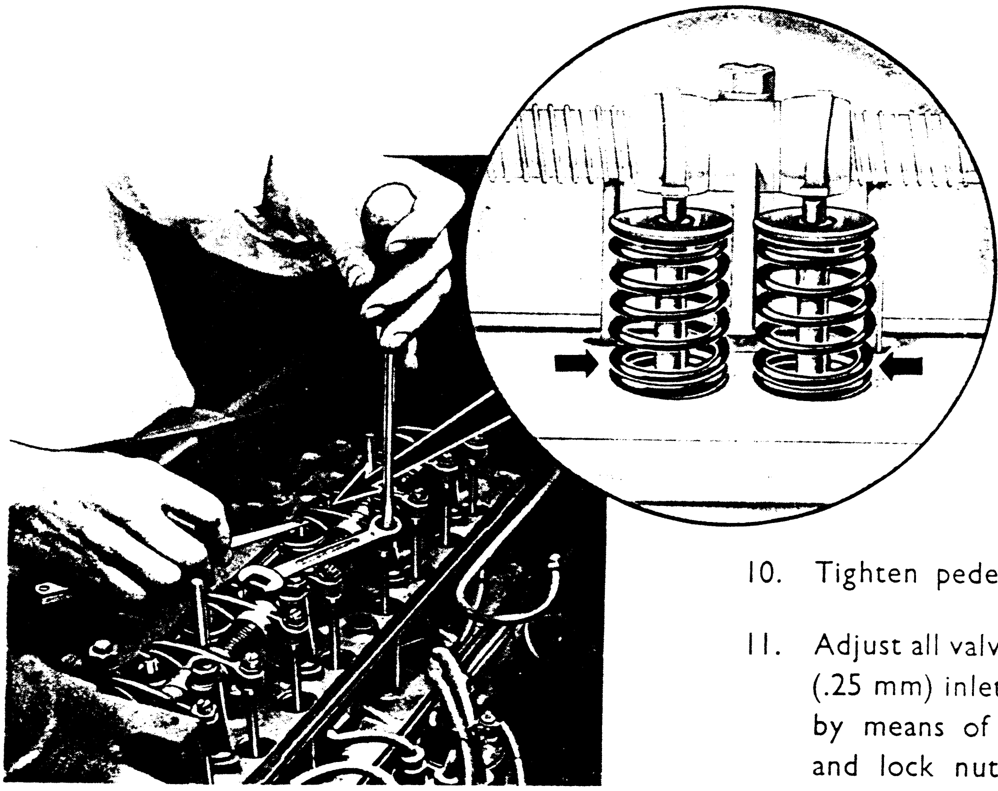


FIG. 23

7. Slacken off all rocker adjusters.
8. Mount rocker shaft assembly, locating pedestals over the four long studs on left side of head.
9. Locate rocker ends over valve tips, and adjusters in push rod cups.
10. Tighten pedestal securing nuts.
11. Adjust all valve tip clearances to 0.010" (.25 mm) inlet, 0.012 (.3 mm) exhaust by means of rocker adjuster screws and lock nuts as shown in Fig. 23.

12. Replace rocker cover with gasket.

13. Replace spark plugs and leads.

To Complete Re-Assembly.

1. Renew manifold gasket if showing signs of " blowing."

2. Mount manifold on studs over gaskets, and secure by tightening nuts on to lock washers. Tighten gradually in the order shown in Fig. 24.

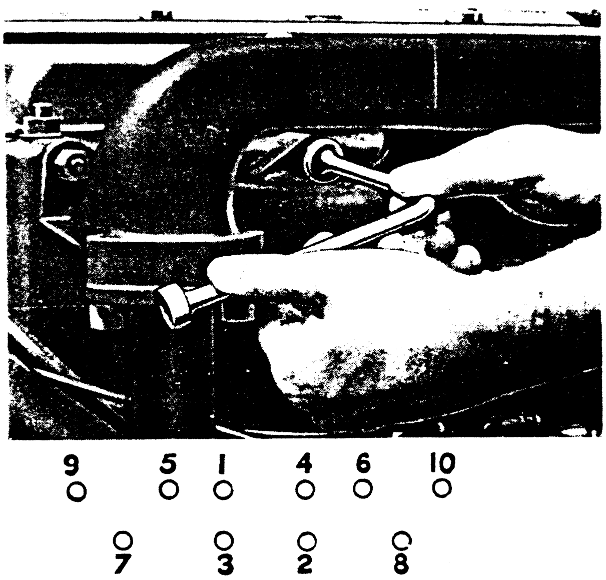


FIG. 24

3. Attach exhaust pipe clip to engine mounting flange by tightening set screws.

4. Secure thermostat body to flange at forward end of cylinder head by tightening two set screws on to lock washers.

5. Re-connect thermostat by-pass hose at thermostat body and radiator hose and stay at water outlet elbow.

6. Replace governor spring link and secure with cotter pin.

7. Replace crankcase breather pipe with fibre washers at screwed adaptor in manifold and banjo connection on rocker cover.

8. Replace fuel tank and re-connect fuel pipe at sediment bowl.

9. Replace hood.

10. Replace battery.

11. Re-fill radiator.

12. Turn on petrol.

After the engine has been run for a few hours, re-adjustment of valve tip clearances may be necessary, due to bedding-in of valves.

CAMSHAFT AND TIMING MECHANISM

Removal of Timing Cover.

1. Support engine forward of sump plug and remove hood together with front axle and radiator assembly.

2. Remove fan belt and fan which is secured to pulley by 4 set screws with lock washers.

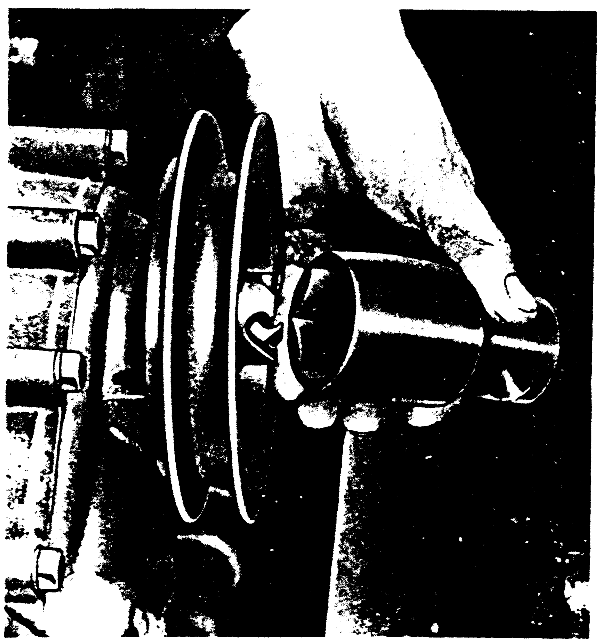


FIG. 25

3. Remove starting handle jaw, using service tool FTB.16, Fig. 25, with long lever. Bend back tabs of starting handle jaw lock washer, then select 4th gear and apply parking brake before striking lever to unscrew jaw.
4. Remove pulley from crankshaft key.
5. Disconnect throttle tie rod from governor lever by removal of clevis·
6. Disconnect governor lever rod from ball connection on lever at forward end of throttle rod.
7. Pull timing cover with gasket free from the two locating dowels, after removal of 3 bolts, 8 set screws, and one nut from stud.

Removal of Camshaft.

1. Withdraw governor cup and shaft assembly from its hole in the camshaft Then remove governor plate for examination. See Section F.
2. Bend back corners of locking plate and remove the two set screws securing camshaft timing sprocket.
3. Remove crankshaft sprocket oil thrower, and lever crankshaft sprocket about $\frac{1}{8}''$ forward.
4. Remove camshaft sprocket with chain.
5. Remove camshaft locating plate which is secured to engine plate by 3 set screws on lock washers.
6. Remove rocker assembly, cylinder head, pushrod and tappets. (See page C7—11).
7. Withdraw camshaft.

Re-assembly—Valve Timing.

1. Replace camshaft, tappets, cylinder head, push rods and rocker mechanism. (See page C17), for cylinder head replacement carry out instruction 1—10 only.
2. Locate crankshaft sprocket.
3. Replace camshaft sprocket. (See " Valve Timing ").
4. Before adjusting valve timing, check sprocket alignment by placing a straight-edge across front faces of sprockets and shim as necessary behind crankshaft sprocket. This check should always be made if it is suspected that the engine has had treatment which has affected crankshaft or camshaft end float.
5. Replace crankshaft sprocket oil thrower with dished edge forward and timing cover with new gasket.
6. Replace pulley and fan, locating any balancer weights with the stamped " BALANCER " to front and with drilled holes in line. Note that fan blades should be to rear of central mounting plate. Should stud have screwed out when removing timing cover, it should be replaced directly below water pump.

Valve Timing.

The following procedure assumes that adjacent teeth of camshaft and crankshaft timing sprockets have been scribe marked when No. 1 inlet and exhaust valves are fully closed with No. 4 inlet valve just opening and exhaust valve just closing.

1. Set No. 1 piston at T.D.C. See Section G Pages 17-19.
2. Locate camshaft sprocket by set screws through any two convenient holes.
3. Turn sprocket and camshaft until scribe marks are adjacent.
4. Lightly press No. 4 cylinder rocker adjusting screw into push rod cups, and rock camshaft sprocket gently backwards and forwards as shown in Fig. 26 to check whether the introductory condition applies.

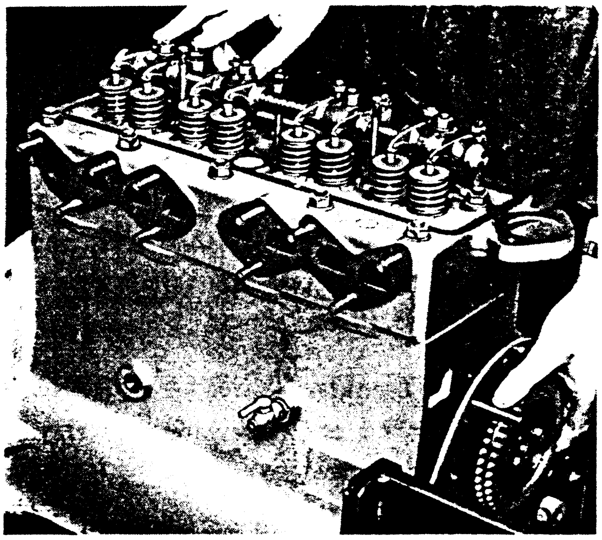


FIG. 26

5. If instruction (4) gives a positive result, mount chain and secure camshaft sprocket in position chosen.
6. If instruction (4) gives a negative result, repeat instructions (2) to (5) having located camshaft sprocket 90° clockwise from previous position. There are four alternative positions.
7. Adjust all rocker clearances to—
   0.010" (.254 mm) inlet.
   0.012" (.305 mm) exhaust.
   replace cover with new gasket before continuing re-assembly.

The following procedure assumes that no components are marked, in which case it is necessary to remove starter for access to flywheel. The operations can, of course, be more conveniently carried out if engine is removed and flywheel completely exposed.

1. Mount and locate camshaft sprocket and chain by inserting set screws through any two convenient holes.
2. Turn flywheel by means of a suitable lever through starter hole in crankshaft flange, until No. 4 inlet and exhaust valves are closed, then adjust their rocker clearances to :
   0.020" (.508 mm) inlet.
   0.022" (.559 mm) exhaust.
3. Insert a 0.010" (.254 mm) feeler gauge between rocker and No. 4 inlet valve tip and turn flywheel in direction of normal rotation, until feeler is just beginning to be gripped (i.e. valve beginning to open).
4. Chalk mark flywheel and adjacent spot on crankcase.
5. Insert 0.010" (.254 mm) feeler gauge between rocker and No. 4 exhaust valve tip and turn flywheel in same direction until grip on feeler is just beginning to relax (i.e. valve just closing).
6. Chalk mark flywheel adjacent to previous mark on crankcase.
7. Return flywheel to original position and, approaching in direction of normal rotation, position it so that its two chalk marks are equidistant from the one on the crankcase. This positions the camshaft so that No. 4 inlet valve

has just begun to open and No. 4 exhaust valve is just about to close, with No. 1 inlet and exhaust valves fully closed.

8. Without altering position of camshaft, remove sprocket and chain and turn flywheel until No. 1 piston is at T.D.C. (See Section G. Pages 17-19)

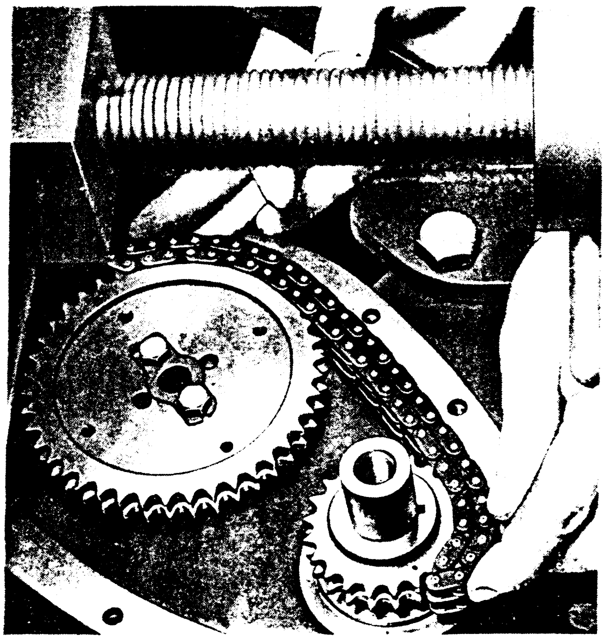


FIG. 27

9. Still without altering position of camshaft, mount sprocket with set screws finger tight and apply chain as shown in Fig. 27. The chain, located on crankshaft sprocket, should engage at least 4 teeth on camshaft sprocket with no slackness. Reversal of sprocket provides four alternative positions on camshaft, giving a location variable by $\frac{1}{4}$ tooth. The drillings in camshaft sprocket are located so that 90° movement will give $\frac{1}{2}$ tooth adjustment, while reversal of sprocket will give a further $\frac{1}{4}$ tooth adjustment in either direction.

10. Having found the correct position for camshaft sprocket, mount chain, adjust all rocker clearances to :—

    0.010″ (.254 mm) inlet.

    0.012″ (.305 mm) exhaust.

    replace cover with new gasket before continuing re-assembly.

USE OF DISMANTLING STAND

For all subsequent dismantling and assembly operations described in this section, the engine should be removed from the tractor. The use of the Tractor Dismantling Stand FT. 27 is strongly recommended and will be assumed.

ENGINE REMOVAL AND REPLACEMENT

To Mount Front Engine Stands.

1. Drain radiator and cylinder block by opening drain taps after having removed radiator filler cap.

2. Detach hood. This entails removal of two support attachment bolts from forward end of fuel tank and two shoulder screws from radiator support bracket.

3. Link together the three rail sections of the dismantling stand and position centrally beneath tractor.

4. Roll trolley jack along rails, position below sump drain and adjust so that the load is just relieved from front axle.

5. Disconnect steering drag links at rear. The steering drop arm taper pins can be released by tapping the arms with a hide-faced hammer, after removal of nuts and plain washer. Until drag links are re-connected on assembly, care should be taken that the positions of drop arms and steering wheel are not disturbed.

6. Disconnect radius rods at rear by removal of footrests.

7. Disconnect radiator hoses and stay to water outlet elbow, remove battery, fuel tank and fan.

8. Remove the four large and two smaller bolts securing front axle support respectively to crankcase and sump.

9. Draw clear assembly comprising front axle, radiator, radius rods and track rods.

9a. Remove dynamo, dynamo bracket and fan.

10. Secure engine to front section of dismantling stand by means of four suitable bolts and nuts, as shown in Fig. 28. Ensure that all four bolts are located before any of the nuts are tightened.

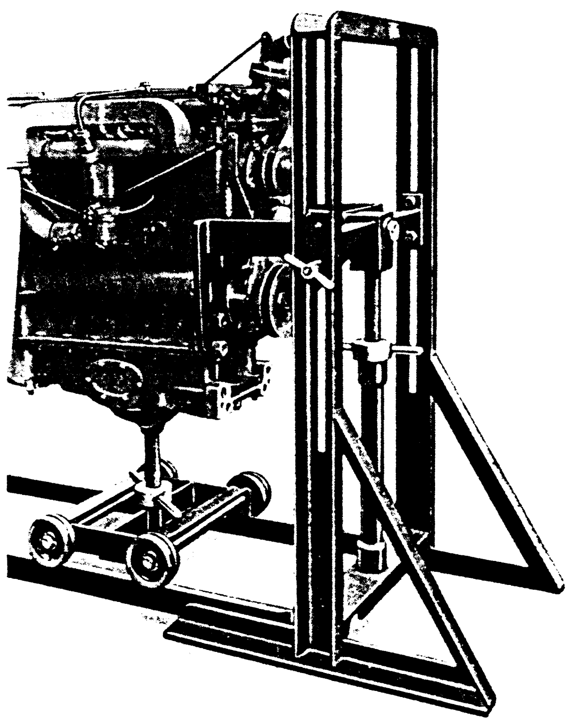


FIG. 28

To Mount Rear Engine Stand.

1. Support weight of transmission assembly by second trolley jack placed under drain plug.

2. Disengage electrical leads from mounting clips and disconnect at starter, and coil.

3. Disconnect.
   (a) air cleaner pipes at carburetter hose and crankcase banjo connection.

   (b) assembly comprising exhaust pipe, manifold and carburetter.

   (c) oil gauge pipe, probably entailing removal of tool box.

   (d) Loosen U bolt nuts at forward end of throttle rod, eleven set screws and nuts from one stud and one bolt securing engine to transmission case.

5. Roll tractor to rear to free clutch housing flange from dowels in engine flange and drive shaft from clutch splines.

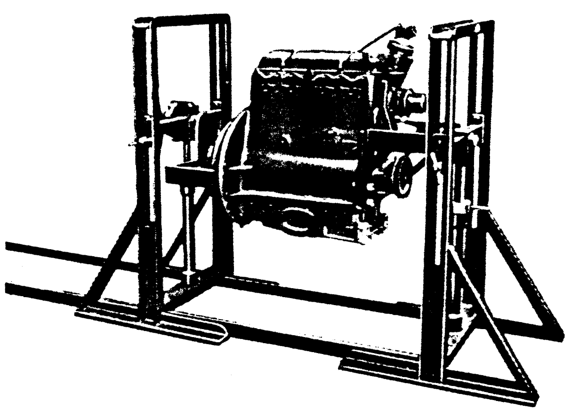


FIG. 29

6. Locate dowels in centre holes of rear mounting stand and secure engine by four bolts and nuts. Ensure that both front and rear mounting stands are positioned with slots in base plates located over rails, as shown in Fig. 29.

Engine Replacement.

Procedure for engine mounting is a reversal of that given for removal. Before dismounting rear stand ensure that engine is supported by jack, behind sump drain plug. When securing engine to transmission housing, note that :—

(a) the transmission case of all tractors except those of early manufacture is, an Electron casting and the gasket, set screws, stud and bolt should, therefore, be scraped clean and coated with "Titanine" before before mounting the engine.

(b) the stud is positioned centrally at top of engine flange.

(c) the bolt is positioned above starter motor.

(d) the two large set screws are from bottom of sump.

When replacing Front Axle Support, the heads of the four large bolts should be to front, while those of the two small bolts should be to rear.

SLEEVES, PISTONS & CONNECTING RODS

Advantage should be taken of the makers reboring service, embracing an exchange scheme for sleeves which can be rebored 0.020″ (.508 mm) oversize.

Withdrawal of Pistons and Connecting Rods.

1. Drain Sump.
2. Remove
   (a) engine and mount on dismantling stand.

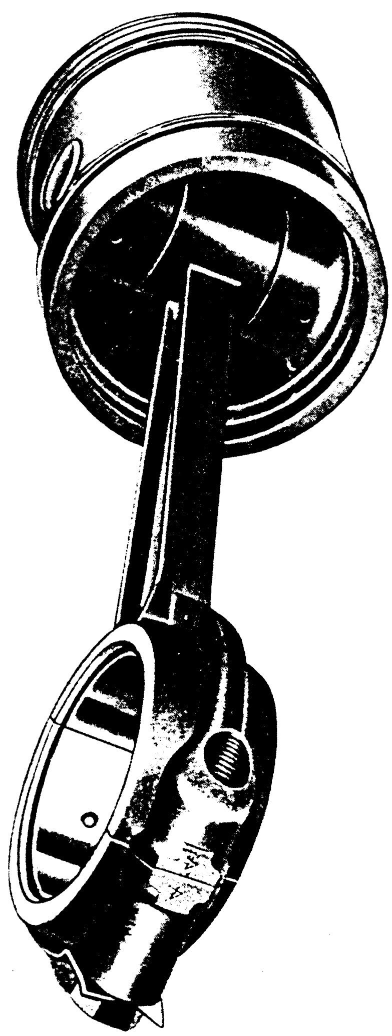


FIG. 30

   (b) rocker shaft assembly and push rods.

   (c) cylinder head and tappets, as previously instructed.

3. Invert engine in stand and remove oil strainer with gasket—six set screws.
4. Remove sump with gasket—seven long and twelve short set screws.

Note.

Before proceeding to remove pistons and connecting rods, notice whether the small adjacent faces on rods and caps are appropriately marked, as shown in Fig. 30. If not, mark them with a centre punch, No. 1 to front. Mark piston crowns similarly.

Big ends will pass through sleeve bores but pistons will not clear crankshaft.

For each connecting rod, proceed as follows :—

5. Remove big end caps—two set screws with lock plate.
6. Slide piston and connecting rod out of sleeve bore and remove bearings.
7. Replace bearing cap with distinguishing marks adjacent as shown in Fig. 30.

Replacement of Pistons and Connecting Rods.

For each assembly proceed to carry out instructions 1—5.

1. Remove bearing cap.

2. Compress piston rings using tool shown in Fig. 31.

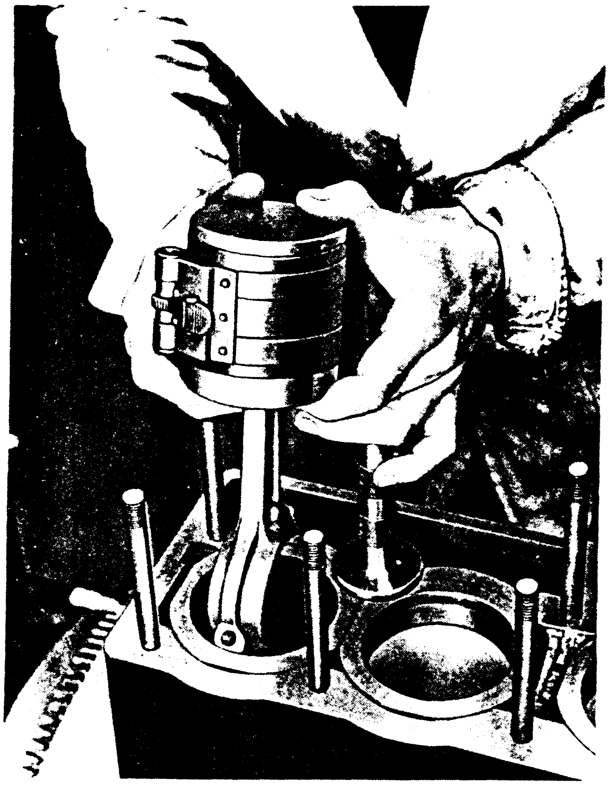


FIG. 31

3. With engine in normal position, lower connecting rods into bores so that split in piston skirt is away from thrust side (i.e. towards camshaft) and the rod as shown in Fig. 31.

4. Press piston into its appropriate sleeve and align connecting rod squarely with crank pin.

5. Mount bearings in cap and rod, locating on notches. Upper and lower halves are similar.

6. Turn crankshaft so that Nos. 1 and 4 crankpins are uppermost. Smear crankpins and bearings with oil, and fit caps locating on dowels and tightening screws over lock plates to a torque wrench reading of 42—46 ft. lbs. (5.8—6.36 Kg.m.). Repeat for connecting rods No. 1, 2 and 3. Bend back corners of all lock plates over screw heads.

7. Replace sump, cylinder head etc., and mount engine (See pages 22 and 23).

Withdrawal of Sleeves.

1. Remove pistons and connecting rods, as previously instructed.

2. Remove sleeve retainers.

3. With engine in normal position, scribe mark each sleeve and adjacent block so that it can subsequently be replaced in its original position.

4. Insert claw of service tool FT.1, Fig.32, with heavier side uppermost, and withdraw each sleeve.

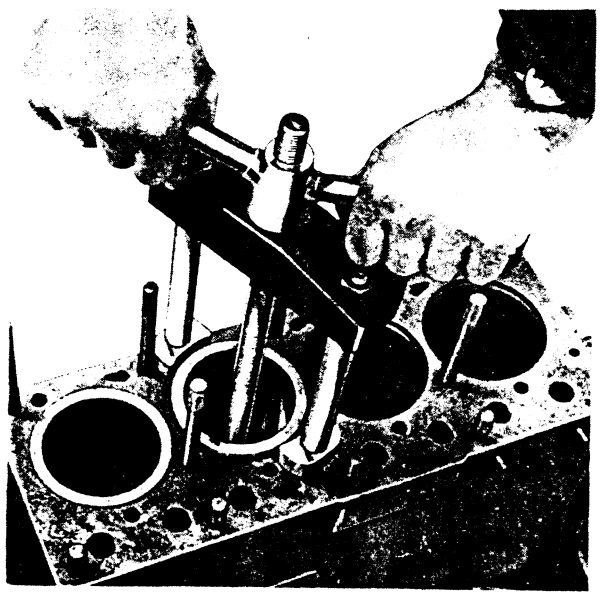


FIG. 32

5. Remove sleeve bottom gaskets.

Replacement of Sleeves.

1. Place sleeve bottom gaskets on location ledges for sleeve bottom flanges.

Note :-

It is most important that these ledges are absolutely clean and free from grit or scale before bottom gaskets are fitted.

2. Replace each sleeve in its original position in cylinder block, aligning scribe marks made during sleeve removal. Tap down each sleeve lightly with a hide faced hammer to ensure good seating on bottom gasket. The sleeves should all stand equally proud of cylinder block.

3. Replace sleeve retainers.

4. Replace pistons and connecting rods, sump, cylinder head etc., and mount engine. (See pages 22 and 28).

To Dismantle Piston and Connecting Rod Assembly.

The piston has been designed so that at working temperature the gudgeon pin is fully floating in the connecting rod bush and the piston. Consequently, at normal room temperature the fit of the gudgeon pin in the piston will be very tight indeed. In order to remove or fit the piston without damage to the gudgeon pin bearing surfaces, an approximation to normal engine temperature has to be brought about so that the split skirted piston can expand and enlarge the gudgeon pin holes sufficiently for insertion of the pin.

Accuracy of piston fit in cylinder sleeve is ensured by grading these components in increments of 0.0004″ on their diameters. There are 3 Grades, each being distinguished by the letter F, G or H, which is stamped on piston crown and pen etched on sleeve upper flange. A piston should on no account be fitted in a sleeve of different grade, although it is of course, permissable to use paired pistons and sleeves or different grades in the same engine. However to ensure satisfactory balance, it is recommended that the maximum variation in weight of pistons or connecting rods in an engine should not exceed 4 drams (7 gms.).

After removal of assembly, proceed as follows :—

1. Remove piston rings.

2. Scrape off all carbon and wash in paraffin. Pay particular attention to ring grooves. An old broken piston ring, suitably filed is of assistance when cleaning ring grooves.

3. Remove circlips from each end of gudgeon pin, using thin-nosed pliers as shown in Fig. 33.

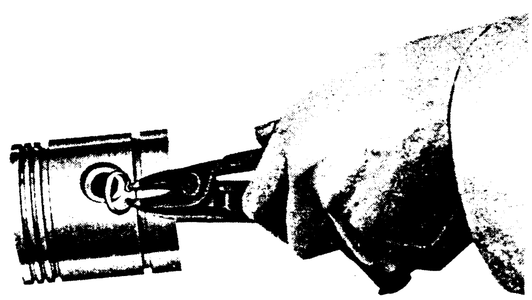


FIG. 33

4. Immerse piston in boiling water or oil for approximately 10 minutes.

Note.

The gudgeon pin may be replaced without removal of piston rings if the piston is immersed in boiling water or oil.

5. Dry piston and mount service tool FTB.19 shown, with pliers, in Fig. 34, screwing the two sections together and tightening on gudgeon pin ends.

6. Tap out gudgeon pin and place inside its piston. Ensure that each connecting rod and piston is suitably marked so that it can be correctly replaced.

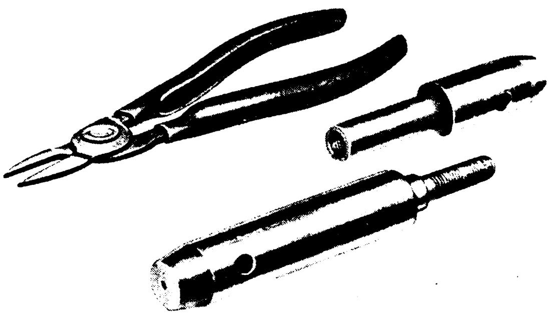


FIG. 34

To Fit Piston to Connecting Rod.

1. Place the four gudgeon pins on bench in correct order.
2. Immerse the four clean pistons in boiling water, or preferably boiling oil, for approximately 10 minutes.
3. Mount gudgeon pin on service tool F.T.B. 19 Fig. 34.
4. Remove each piston in turn, and, holding connecting rod in position, insert appropriate gudgeon pin so that the split in the piston skirt is on the same side of the rod as the bearing cap, as shown in Fig. 35. If a new connecting rod is used, it must be marked to indicate its intended position.
5. Using thin nose pliers, insert circlips.
6. Fit piston rings.

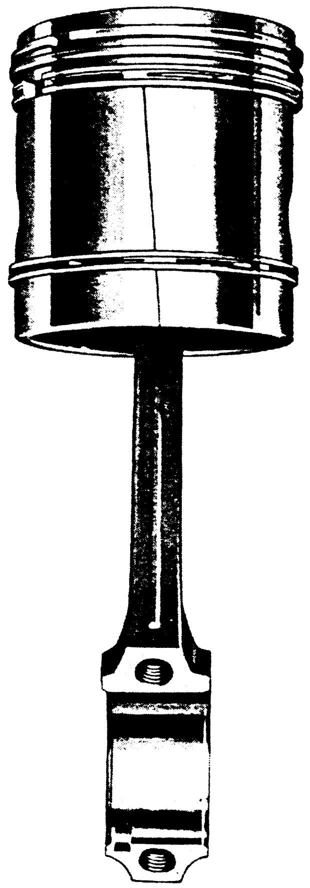


FIG. 35

Note.

If sleeve bore wear has begun to make itself evident by increased oil consumption, an improvement will be effected if piston rings are renewed. Should the worn clearance between piston top skirt and sleeve bore exceed 0.007″ (.178 mm) sleeve boring or replacement becomes necessary. Piston ring gap should be checked with the ring in approximately the same position in its sleeve as the bottom of normal ring travel. Squareness of location will be ensured if the ring is pushed in position with the piston crown.

To Align Connecting Rods.

A connecting rod should always be checked for straightness and alignment using old gudgeon pin before removal of gudgeon pin bush. A bent or distorted rod cannot be correctly mounted in the jig for the reaming operation described later.

1. Remove big end bearing liners, wash connecting rod in paraffin and mount on aligning jig FT.335 as shown in Fig. 36. Bolt up tight.

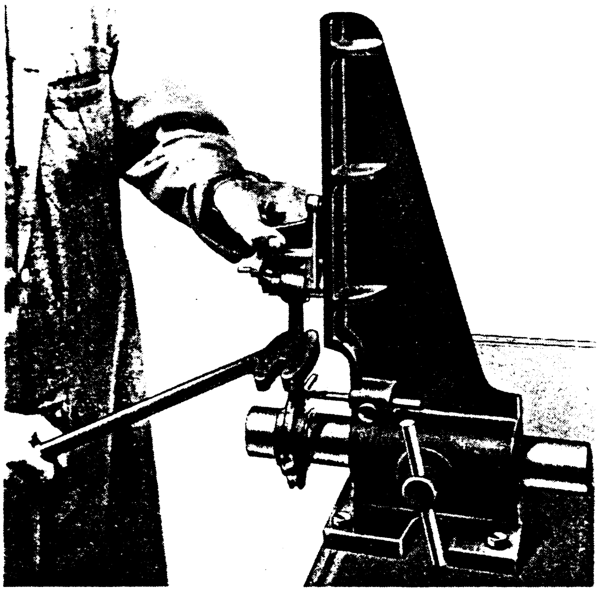


FIG. 36

2. Insert gudgeon pin and mount indicator. Reversal of position of indicator will show any mis-alignment in lateral or transverse plane. For correct alignment both indicator pins should be in contact with the ground face of the fixture.

3. To correct any mis-alignment, locate the arbor jaws approximately centrally on connecting rod, and bend or twist rod as necessary.

To Remove Gudgeon Pin Bush.

Locate spigot of service tool (20S-FT-6200) in the bush bore, as shown in Fig. 37. Tap out bush.

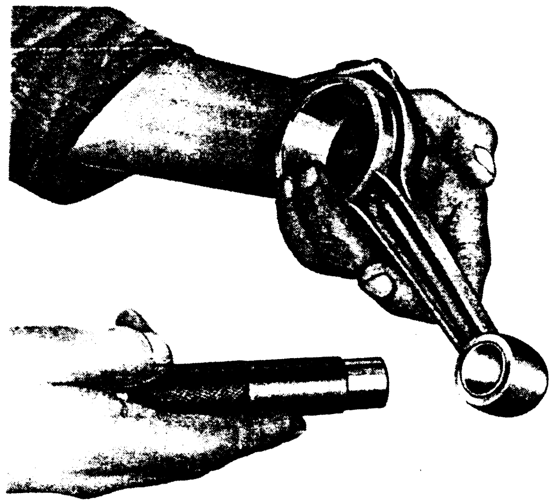


FIG. 37

To Fit Gudgeon Pin Bush.

1. Thoroughly clean new bush in paraffin, afterwards smearing outside with oil. Similarly treat bush housing in connecting rod.

2. Insert spigot of service tool in bush, and tap into position ensuring that the oil hole is in line with the drilling in the connecting rod.

The internal diameter of a gudgeon pin bush supplied as a service part is undersize and must be reamed out before the new gudgeon pin is fitted. However, when the bushes are supplied as an assembly, they are already reamed for correct gudgeon pin fit.

To Ream Gudgeon Pin Bush.

The specially designed kit, 20S-FT-6200—comprising aligning jig with high and low reamers is illustrated in Fig. 38, and its use is strongly recommended when reaming out gudgeon pin bushes prior to fitting new gudgeon pins.

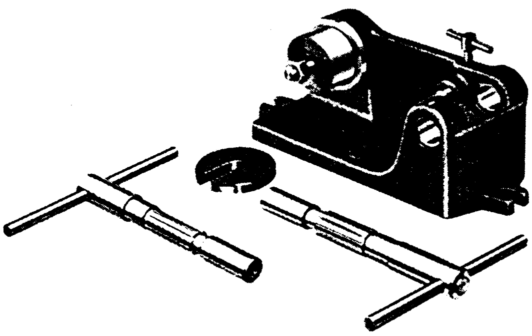


FIG. 38

1. Mount connecting rod, with big end shells removed, on large spigot on jig.
2. Insert reamer marked " LOW " until forward shank is just entering rear locating hole in jig.
3. Mount split collar and tighten nut.
4. Tighten big end cap screws.
5. Push in support plunger until in contact with rod, then tighten screw.
6. Rotate reamer by means of torque bar, as shown in Fig. 39, applying light forward motion so that teeth begin to cut into bush.
7. Continue this process, taking care not to take too deep a cut. It should at all times be possible to turn the tool **easily :** if difficulty is encountered, too deep a cut is being attempted or the tool needs dressing.
8. Without removing connecting rod, wipe clear all swarf from bush and insert gudgeon pin. If the pin cannot be inserted, repeat the reaming procedure using reamer marked "HIGH."
9. If the pin can be inserted, dismount rod, remove big end cap, clear swarf by blowing out oil drilling and bush bore with compressed air.
10. Replace big end cap.

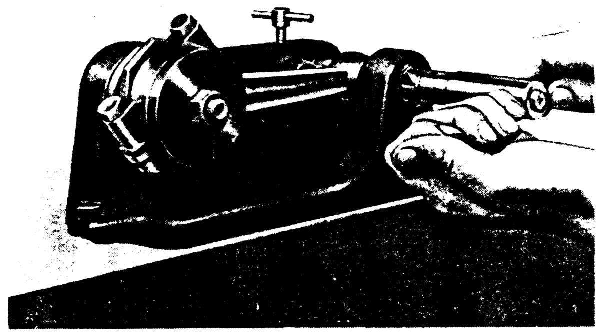


FIG. 39

To Dress Reamer Cutting Teeth.

After a lengthy period of usage, bronze removed from bushes will affect the cutting efficiency of tool teeth. With teeth in this condition, the rotary action of the tool will tend to polish rather than cut and operation will become very stiff. To restore cutting quality, tool teeth should be scraped.

Crankshaft and Bearings.

Whenever crankshaft or main bearings are to be removed, the engine should be completely dismantled for renewal of oil seals and cleaning of all components connected with oil and water distribution.

Note :—
Advantage should be taken of the crankshaft exchange service operated by the Makers-Journal and crankpin bearings are available 0.020″ (.508 mm) 0.030″ (.762 mm) and 0.040″ (1.016 mm.) undersize.

Preliminary Dismantling.

Remove :—

Engine and mount on dismantling stand. See page C.22.
Clutch—6 set screws on lock washers. See section I.
Starter and distributor, water pump. See sections D and G.
Cylinder head. See page C.8.
Connecting rods, pistons and sleeves See page C.24.
Timing cover, camshaft and sprocket. See page C.18.
Oil filter assembly. Vertical type, fitted before tractor

Serial No. 5640—2 bolts $4\frac{3}{8}''$ long
1 bolt $3\frac{1}{8}''$ long.
1 nut from stud.

Inclined type, fitted after tractor
Serial No. 56339—1 bolt 4″ long.
1 bolt $2\frac{1}{16}''$ long.
2 bolts $1\frac{15}{16}''$ long.

Oil pump with drive shaft and gasket— 3 studs on lock washers.

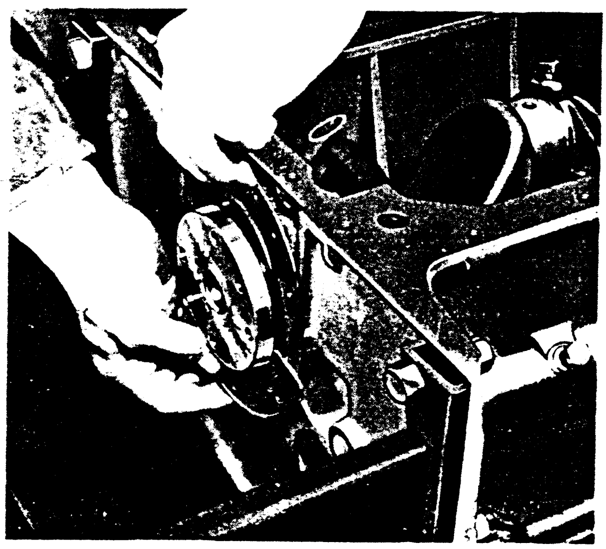


FIG. 40

Flywheel—4 set screws locked in pairs by plates ; tap off dowel in crankshaft end flange.

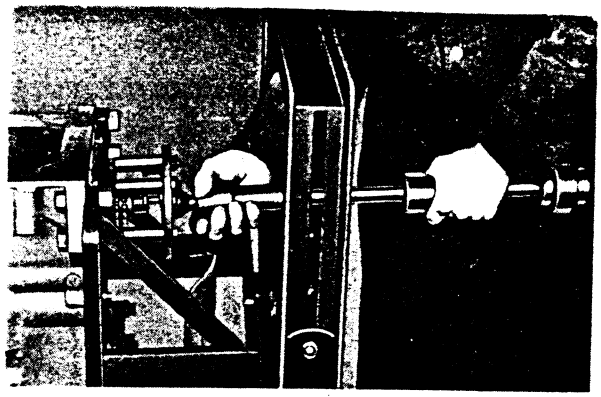


FIG. 41

Removal of Crankshaft and Main Bearings.

With engine upturned in stand, proceed as follows :—

1. Remove the two rear oil seal retainers Fig. 40, which are each secured by 4 set screws on lock washers.

2. Remove crankshaft timing sprocket and front engine plate with gasket. Removal of sprocket is facilitated by the use of service tool FTB7C as shown in Fig. 41.

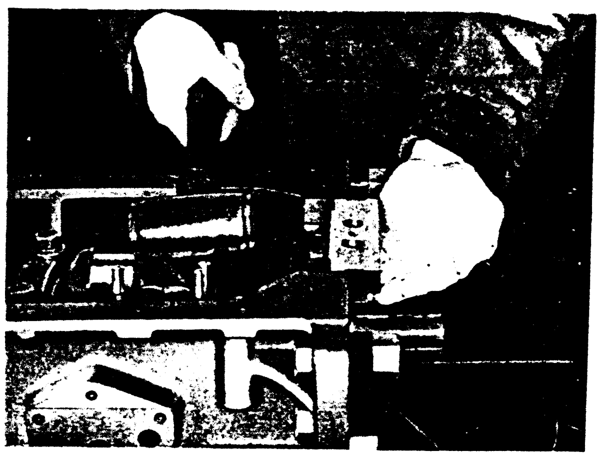


FIG. 42

3. Remove the two cheese headed screws securing front main bearing sealing block.

4. Tap off sealing block, using hide faced hammer, as shown in Fig. 42.

5. Remove front main bearing cap with liner—2 set screws on lock washers.

6. Remove centre main bearing cap with liner and two thrust washers shown in Fig. 43—2 set screws on lock washers.

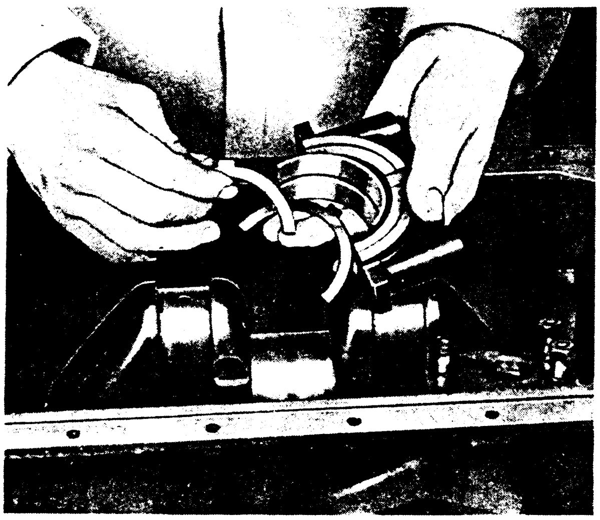


FIG. 43

7. Remove rear main bearing cap with liner—2 set screws with lock washers. Withdrawal of cap is facilitated if 2 sump set screws are positioned in cap, as shown in Fig. 44, so that they can be pulled whilst tapping cap with hide faced hammer. Do not strike oil seal drain pipe.

8. Lift out crankshaft with rear oil seal, then remove bearing liner.

Replacement of Crankshaft and Main Bearings.

Before re-assembly of engine, closely examine all machined faces of crankcase and cylinder block and remove all traces of dirt, carbon, sealing compound or old gasket material. After thoroughly washing in paraffin, blow out all oil galleries and passages with compressed air. (See Lubrication System). Remove plugs from main oil gallery before blowing out.

Re-assembly should not commence until you are absolutely certain that cylinder block and crankcase is absolutely clean.

Before fitting new bearing liners and thrust washers they should be washed in paraffin and smeared with engine oil.

With crankcase upturned in engine stand, proceed as follows :—

1. Place upper main bearing liners in position in crankcase, locating their notches in the grooves in bearing housing.

2. Place top thrust washers, oil grooves outwards, in recesses on either side of centre bearing housing. Note that top thrust washers have no location tags.

3. Place rear oil seal, lip inwards, over its locating shoulder on crankshaft and lower shaft on to its three bearings

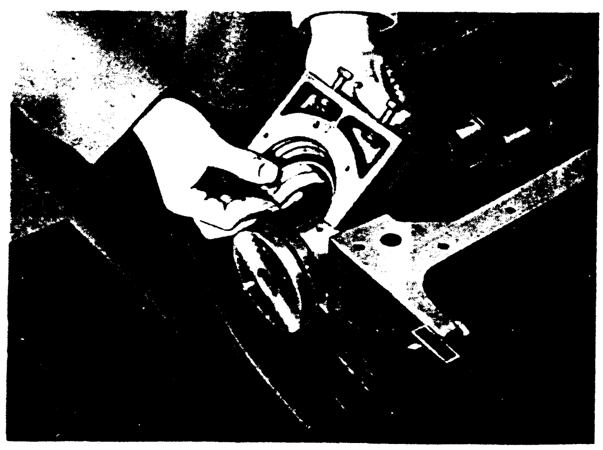


FIG. 44

pushing seal into its recess in crankcase.

4. Locate bearing liner in centre cap and the two lower thrust washers on either side, with oil grooves outwards. Smear crankshaft journal with engine oil and mount cap so that locating notches for upper and lower bearing liners are on same side—see Fig. 45 illustrating similar mounting for front bearing.

Note :-

Main bearing caps are not interchangeable — identification numbers are stamped on main bearing caps and adjacent face of crankcase.

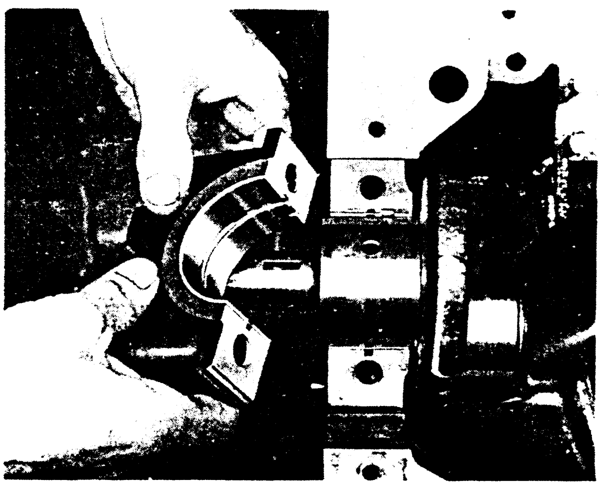


FIG. 45

5. Before fully tightening cap screws on their lock washers, rotate crankshaft a few times to spread the oil and to ensure that there are no tight spots, due to faulty location.

6. Locate bearing liner and mount front cap so that upper and lower locating notches are on same side, as shown in Fig. 45. Check for "tight spots."

7. Similarly, mount rear cap, pressing oil seal firmly home in its recess. Before tightening cap screws ensure that rear

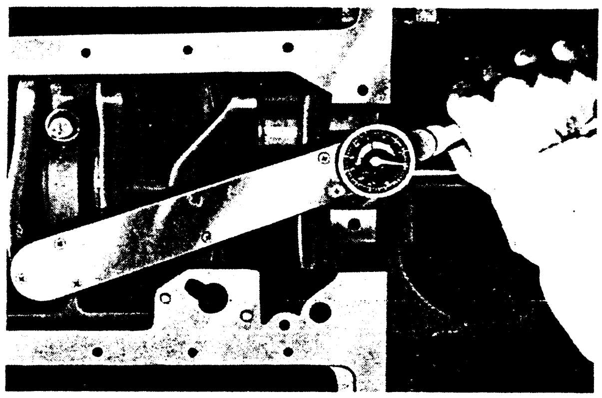


FIG. 46

machined cap face is flush with that of crankcase. Line up by tapping with hide faced hammer. Check for "tight spots."

8. Tighten all main bearing cap screws to a torque wrench reading of 90—100 ft. lbs. (12.4—13.8 kg. metres) as shown in Fig. 46.

9. Soak rear bearing cap felt seals in shellac and insert in their grooves, using a suitable rod as shown in Fig. 47.

Press down tight, using extra felt if necessary to ensure that groove is completely filled.

10. Scrape clean front bearing sealing block, wash in paraffin and dry. Coat the two "T" shaped sealing pads with shellac and compress into their recesses. Lightly smear top of block with shellac and tap into position ensuring that the two tapped holes face the timing plate over front main

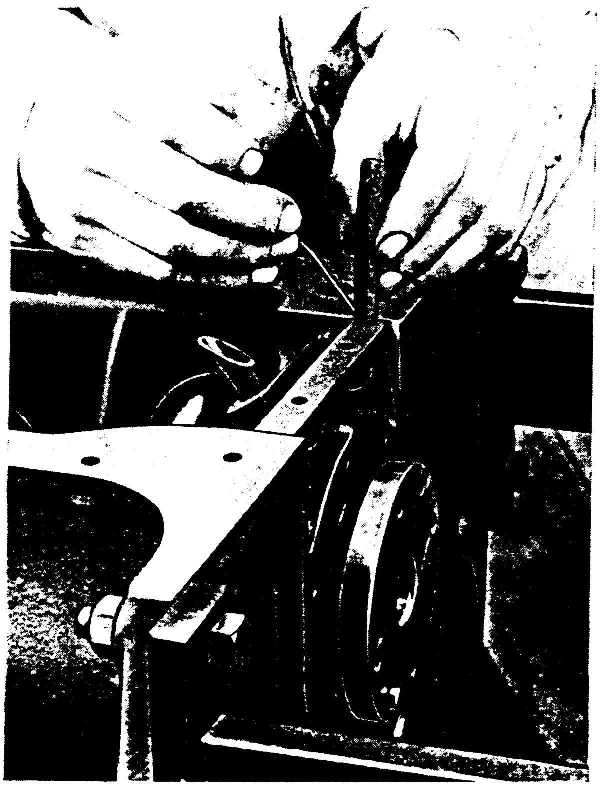


FIG. 47

bearing, as shown in Fig. 48 afterwards screwing down the two cheese headed security screws.

11. Secure the two rear oil seal retainers in position on crankcase—each with 4 set screws on lock washers.

12. Replace flywheel. Dowel holes in flywheel are 90° apart, while those in flange are 180° apart. Thus re-location of dowel provides four alternative mounting positions for flywheel.

13. Re-fit front engine plate using new gasket, then fit crankshaft timing sprocket, noting that the chamfer gives lead on shaft. Shims of alternative thickness are available for fitting behind sprocket for subsequent alignment with camshaft sprocket.

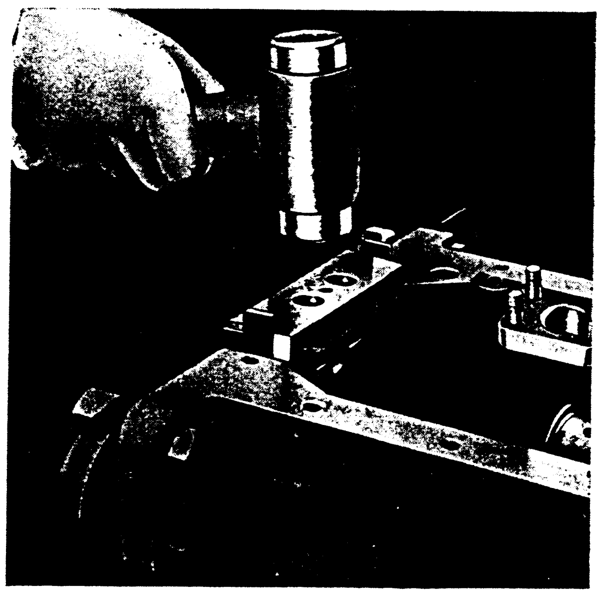


FIG. 48

Completion of Engine Re-assembly.

This procedure is a reverse of that given for "Preliminary Dismantling." It will of course, be necessary to adjust valve and distribution timing as instructed on pages C. 19—21 and section G. pages 17—19.

SECTION C

ENGINE SECTION—DIESEL ENGINE

INDEX

DIESEL ENGINE
AS FITTED TO TRACTORS TYPE TE-F20

INTRODUCTION.

For the benefit of engineers who have not had previous experience with this type of engine we give a short explanation of the Diesel principle.

A charge of air only is drawn into the cylinder of a Diesel engine and compressed to about one seventeenth of its original volume when the piston reaches the top of its compression stroke. At a critical moment before the T.D.C. position is reached a finely atomised and accurately metred spray is injected into the pre-combustion chamber. The temperature reached by the air due to the large pressure increase is sufficient to ignite the injected fuel without external aid such as provision of a high tension spark.

The higher compression ratio and greater fluctuations in pressure transmitted to the bearings, crankshaft, etc., necessitate stronger materials and a more robust engine. To this end the crankshaft is barrel mounted so that each of its three bearing housings form stiffening webs for the crankcase, while special consideration has been given to the design of crankshaft and connecting rods.

The following instructions assume the use of the specially designed Dismantling Stand and the full range of Service Tools and Equipment.

Where fuller instruction on the application of certain Service Tools is considered desirable, the tool manufacturers supply the necessary information with the tool kit. These instructions, therefore, are not repeated in detail.

Note : When working with Diesel equipment, mechanics are advised always to protect their hands with a barrier cream.

LUBRICATION SYSTEM

OIL DISTRIBUTION.

Oil is sucked from the wire mesh screen in the oil sump, up the suction pipe, through the oil pump via inlet and outlet ports in the front bearing housing—on which the pump is mounted—to the filter and thence to the oil gallery for distribution as indicated in Fig. 101.

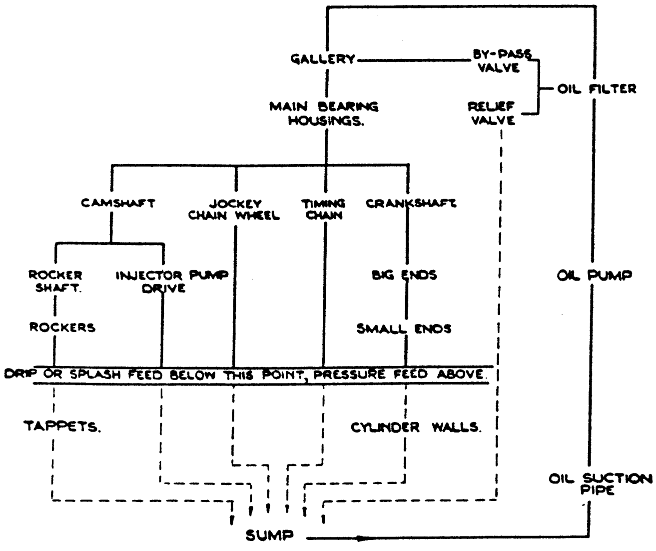


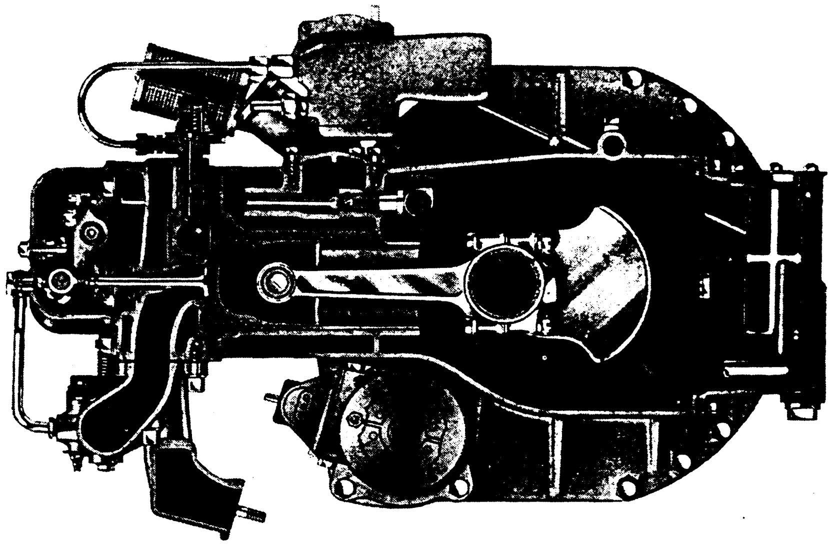
FIG. 101.
OIL DISTRIBUTION DIAGRAM.

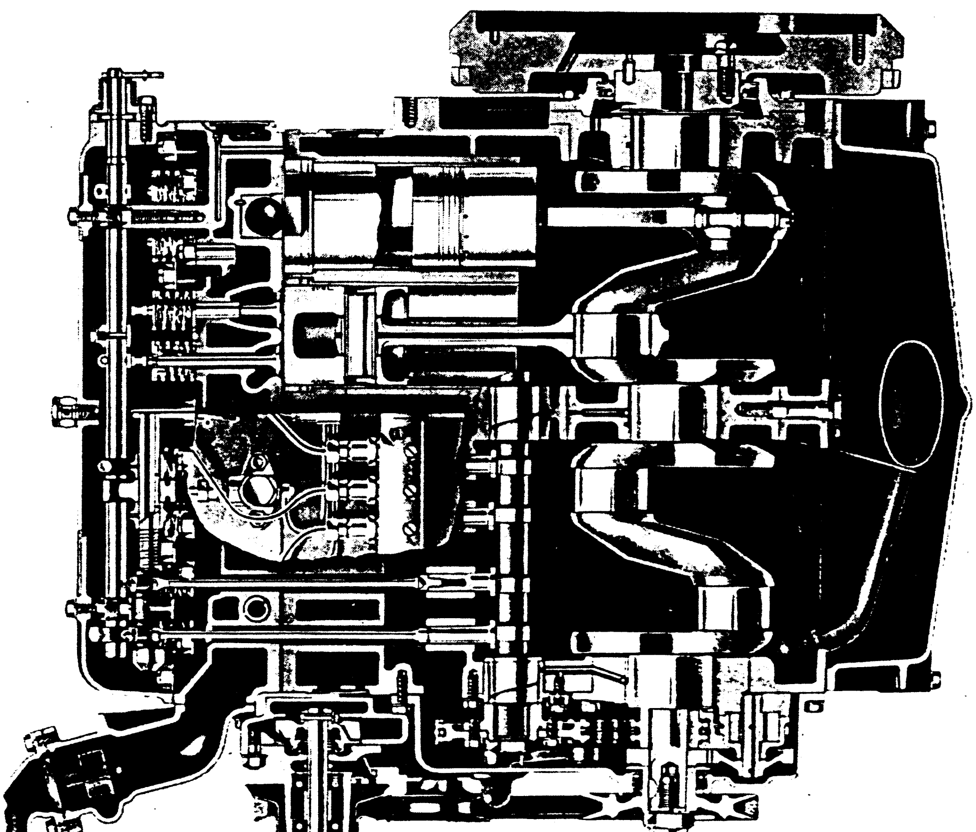
Front, centre and rear journals of the crankshaft are connected by drillings directly to the oil gallery, while oil arrested by the crankshaft rear oil seal drains through the rear bearing housing to sump.

Lubrication of connecting rod big-end bearings is provided through drillings in crankshaft, connecting front journal and No. 1 crankpin ; centre journal and Nos. 2 and 3 crankpins ; rear journal and No. 4 crankpin. The clearance between connecting rod bearing and crankpin provides sufficient flow of oil under pressure to pass along a central drilling in connecting rod to gudgeon pin, with a further surge when the connecting rod drilling aligns with the supply drilling at the crankpin. In the Diesel engine, there is no bleed hole drilled in the connecting rod to allow intermittent splash feed to the cylinder liner walls.

An annular groove in the bore of each main bearing housing connects by drillings through the housing and cylinder block, to the camshaft journals.

The bore of the camshaft front bearing incorporates an annular groove with inlet and outlet ports, through which a constant oil feed is passed to the injector pump drive.





SECTIONAL VIEWS OF DIESEL ENGINE

A groove encircles the camshaft rear journal and connects two flats machined on the journal in such positions that, as the shaft revolves, one approaches the oil drilling from the rear main bearing housing, while the other approaches a second drilling through the cylinder block and head to the rocker shaft rear pedestal. Momentarily, during each revolution of the camshaft, both holes are uncovered by the flats and oil under pressure passes along the spiral groove and up to the hollow rocker shaft where it is distributed through drillings to the annular groove between the twin rocker bushes. Oil is directed through relief holes from rockers onto the push rods, returning by gravity through tappet chambers to sump.

Oil build up behind the camshaft rear journal is prevented by a drilling through the centre of the journal by which oil can drain back to the sump.

Lubrication of the timing chain is provided through two small pipes, one of which taps the internal oil way supplying the camshaft front journal ; the other connects through separate drillings with the annular groove in the bore of the front bearing housing.

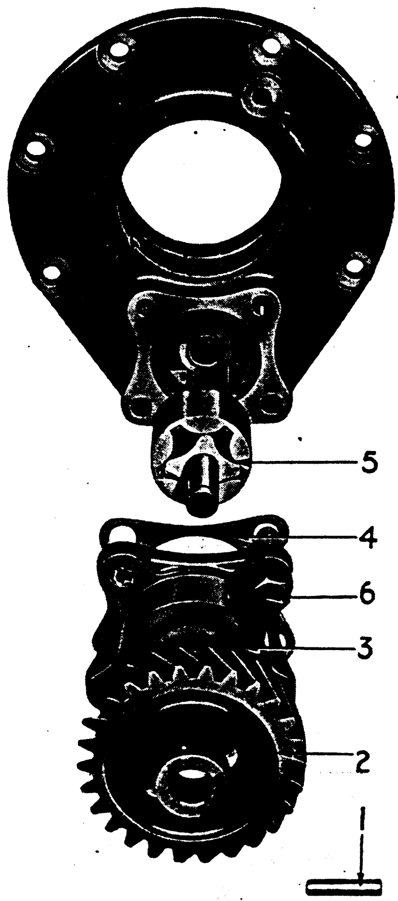


FIG. 102.
OIL PUMP AND FRONT MAIN BEARING HOUSING.

DISMANTLING AND RE-ASSEMBLY OF LUBRICATING OIL PUMP.

The Oil Pump, illustrated Fig. 102, is spigoted and flange bolted to the front main bearing housing and driven by a helical spur gear from the crankshaft.

The pump and drive gear can be removed and dismantled when timing cover has been removed.

It will be seen from Fig. 102, that the outer rotor has five lobes while the eccentrically mounted inner rotor has four. Thus, as the shaft turns, oil from the vacant space over the inlet port is transferred to the outer port, from which it is expelled as the lobes engage.

To Dismantle.

1. Tap out the pin (1) retaining the drive gear (2) and pull the driving member off the shaft.
2. Remove the four bolts from the pump body (3) and pull off, together with gasket (4) and rotors (5) which run directly in the pump body.

Oil Pump Spindle Bush Removing and Replacing.

The Oil Pump Spindle Bush situated in the pump body and that in the main bearing housing can be removed, when necessary, with the aid of Service Tool FT.129. See Fig. 103.

Fit a new bush, with long taper leading in both the bearing housing and pump body with the aid of Service Tool FT.130. A shoulder is provided on the spigot of this tool to ensure the bush does not protrude and foul the inner rotor, fit the bush in the pump body, therefore, from the inside. See also Note under " Front Bearing Housing " Page 132.

Reaming Oil Pump Spindle Bushes.

Before re-assembling the pump, new spindle bushes must be reamed through using Reaming Equipment FT147 as follows :—

Front Bearing Housing : Fit the short spigot of the jig into the oil pump recess with the dowel inserted into the top right-hand screw hole, i.e., that used to locate the pump body—see **Re-Assembly** para. 2. below.

FIG. 103.
REMOVING OIL PUMP SPINDLE BUSH.
SERVICE TOOL FT. 129.

Secure Jig in position with screw and bolt using a flat washer between the bearing housing and nut lockwasher.

With the Jig firmly located, ream through the spindle bush carefully until the reamer end bottoms on the bearing housing.

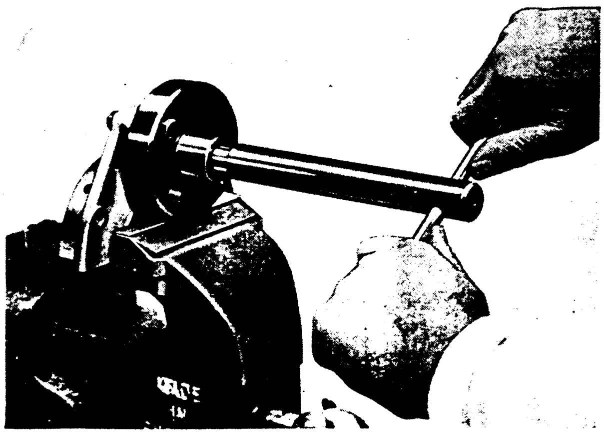


FIG. 104.
REAMING OIL PUMP SPINDLE BUSH.
SERVICE TOOL FT. 147.

Remove Jig and blow out swarf.

Oil Pump Body : for this bush the opposite side of the Jig is used. This has the longer spigot and is also recessed to accommodate the mounting spigot of the pump body. The dowel fits into the hole for the locating screw, shown (6) Fig. 102. Secure in position with nuts and bolts through diagonally opposite fixing holes.

With Jig firmly located, ream through the bush carefully and blow out swarf after completion.

Re-Assembly.

1. When assembling the rotors ensure that the chamfered edge of the outer rotor is facing inwards towards the front bearing housing.
2. Replace pump body assembly, using new gasket, with spigot of body in the recess of the front bearing housing. The body is located by the top right-hand fixing screw (6), which has a fitting shank of larger diameter. Screw in all screws evenly on lockwashers finger tight, commencing with the locating screw, before tightening down by diagonal selection to a torque reading of 16 to 18 lb ft. (2.2 to 2.5 kgm.)
3. Replace driving gear on shaft and refit securing pin.

LUBRICATING OIL FILTER.

General. FIG. 105.

Oil is pumped from the sump through port A to the outside of the filter element. Particles are removed as the oil passes through to the inside of the element and escapes to the gallery through diagonal port B. If tightness of bearings or high viscosity of oil causes the pressure in the system to rise above 40-60 lbs. sq. in.

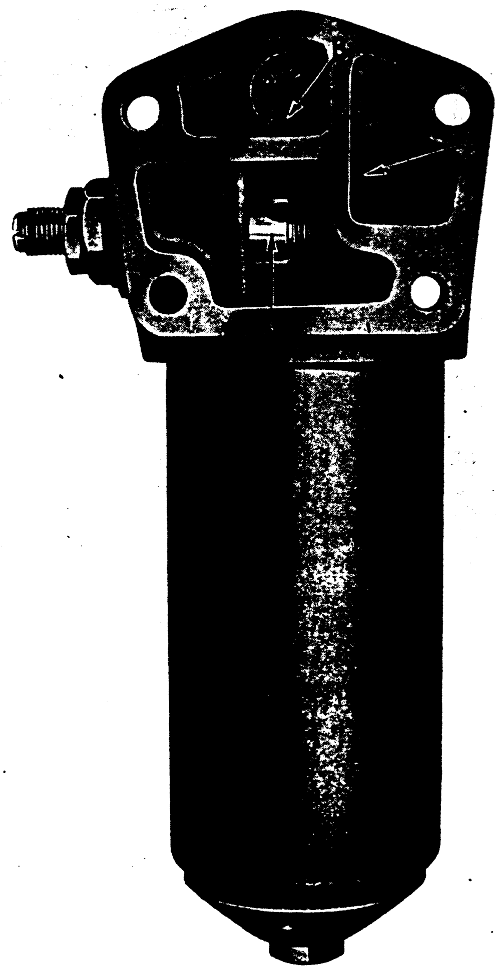


FIG. 105.
LUBRICATING OIL FILTER.

(2.8 — 4.2 kg. sq. cm.), unfiltered oil passes back to the sump as pressure relief valve C opens. Should the element become clogged and the passage of oil severely restricted, oil in the diagonal port B and gallery will be at a lower pressure than that in the outside of the element, opening a by-pass at the lower end of port B and allowing unfiltered oil to pass into the gallery.

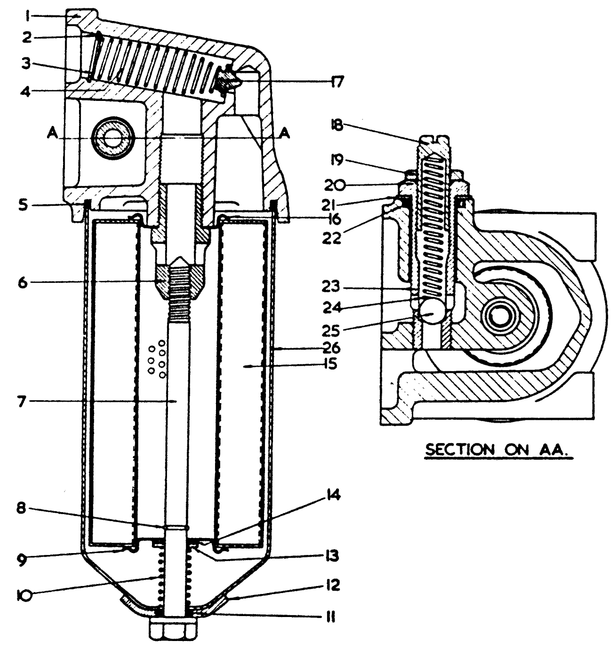


FIG. 106.
SECTIONAL VIEW OF LUBRICATING OIL FILTER.

Description. FIG. 106.

The filter consists of a sump (26) positioned by a centre bolt (7) to a filter head (1). The bolt screws into a centre tube (6) which retains the element guide (16). The sump beds on a seal (5) carried in a groove in the head. The lower end of the centre bolt is fitted with a spring (10), washer (13), seal (14) and an element guide (9) retained by a circlip (8). The base of the sump has a reinforcing washer (12) bored to accommodate a seal (11).

The filter head is formed with inlet and outlet passages, the latter containing the by-pass valve (17) loaded by a spring (4) retained by a washer (3) and circlip (2). The engine relief valve is assembled in a bore in the filter head and consists of a body (23) screwed into the head against a washer (21) which beds on a seal (22). The bore of the body is fitted with a ball (25) and spring (24) retained by an adjusting screw (18) secured by a locknut (19) which beds on a lead washer (20).

Dismantling.

1. Unscrew the centre bolt (7) from the centre tube (6), withdraw the sump (26), extract the seal (5) from the filter head (1) and remove the element (15).
2. Remove the circlip (8), slide the lower element guide (9), seal (14), washer (13) and spring (10) off the centre bolt and withdraw the sump ; collect the reinforcing washer (12) and seal (11).
3. Extract the circlip (2) and collect the washer (3), spring (4) and by-pass valve (17).
4. Unscrew the locknut (19) and the adjuster (18) and collect the spring (24) and ball (25). Unscrew the relief valve body (23) and collect the washer (21) and seal (22).

Re-assembly.

1. Place the washer (21) and seal (22) on the engine relief valve body (23) and screw the latter firmly into the filter head (1) ensuring that the seal is correctly assembled in its recess.
2. Position the ball (25) in the body, place the spring (24) in the adjuster (18) and screw the latter into the relief valve body to an approximate setting, i.e., about 8-10 threads exposed above the locknut. Fit a new lead seal (20) over the adjuster and secure by means of the locknut (19).
3. Fit the by-pass valve (17) in the smaller end of the spring (4) and position the assembly in the filter head ; place the washer (3) on the spring and fit the circlip (2).
4. Pass the seal (11) and reinforcing plate (12) over the centre bolt (7) followed by the sump (26). Slide the spring (10), washer (13), seal (14) and lower element guide (9), recess foremost, over the centre bolt and fit the circlip (8).
5. Place the filter element in the sump so that it rests on the lower element guide, fit the seal (5) in its groove in the filter head and offer up the sump to the head.
6. Screw the centre bolt into the centre tube firmly enough to ensure that there will be no leakage past the seals (5, 11).

OVERHAUL OF CYLINDER HEAD ASSEMBLY

DECARBONISATION AND VALVE GRINDING.

By dissolving the carbon deposits, detergent additive engine oils, as recommended for this engine, considerably reduce the otherwise heavy residuals left by the combustion of diesel fuel. The carbon dissolved is held in suspension in the lubricating oil, causing early discolouration and the impression that the oil requires changing, this is normal and indicates that the detergent additives are working.

Any loss of compression, resulting from carbon accumulation, affecting the seating of the valves or causing valves to stick in their guides will obviously have a distinctly adverse affect on the performance of this type of engine.

Decarbonisation and valve grinding normally becomes necessary after the first 300 hours and subsequently every 1,000 working hours, dependent upon the type of work undertaken. Under light load conditions these periods may have to be reduced.

The general condition of the engine can be deduced by examination of the structure of the carbon. A heavy formation of hard coke tends to indicate that the engine is burning excessive lubricating oil. The fuel injection equipment should be checked if a heavy soft sooty accumulation is found.

Cleanliness.

Before starting to dismantle the engine, suitable caps or masking tape should be available for blanking off all open fuel connections as soon as a union has been removed. Scrupulous cleanliness must always be observed when handling fuel connections.

KEY TO ANNOTATION

1. Radiator Filler Cap.
2. Injector Pipes.
3. Main Fuel Tank.
4. Fuel Return Pipe.
5. Injector—No. 3.
6. Breather Filter Assembly.
7. Tap—Main Fuel Tank.
8. Auxiliary Tank.
9. Balance Pipe.
10. Drain Plug—Auxiliary Tank.
11. Tap—Auxiliary Tank
12. Rear Fuel Filter.
13. Front Fuel Filter.
14. Engine Oil Filler Cap.
15. Engine Oil Dipstick.
16. Oil Filter.
17. Radius Rod.
18. Engine Oil Pressure Relief Valve.
19. Injector Pump.
20. Air Vent Governor.
21. Bypass Pipe.
22. Hood Stays.

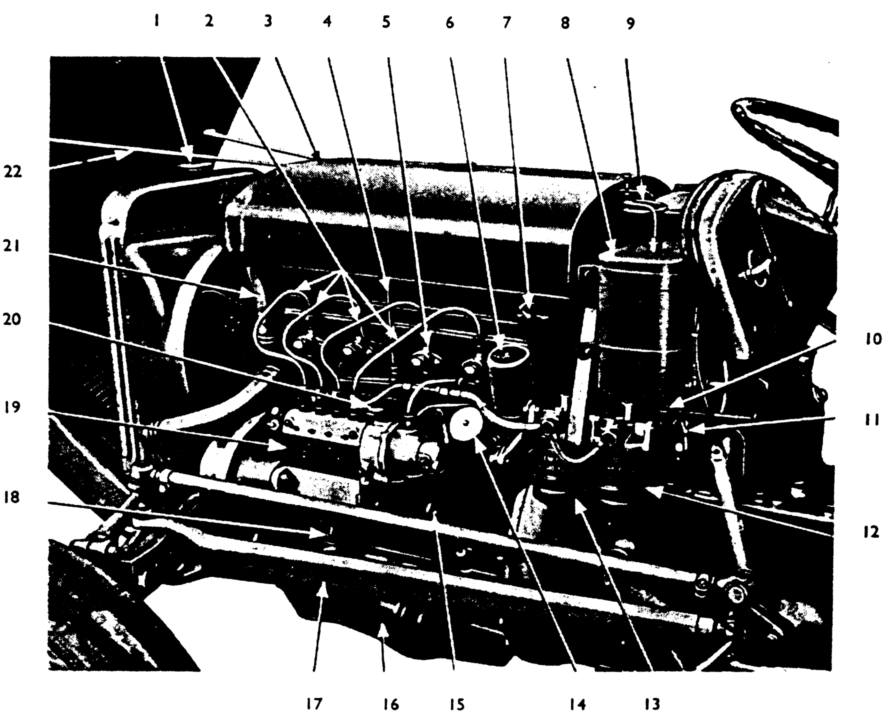


FIG. 107.
LEFT HAND VIEW OF ENGINE.

At cranking speed the compression pressure in each cylinder should be in the region of 600 lb/sq. in. (42. kg/sq. cm.) ; the explosion pressure in the order of 720 lb/sq. in. (50.4 kg/sq. cm.).

Before investigating any pressure loss, make sure the decompression shaft is not operating and that decompression cam and valve tip clearances are set accurately. See page C.109.

Preparations for Lifting the Cylinder Head. FIGS. 107 & 108.

1. Open both drain taps and remove filler cap (1) to drain radiator and cylinder block.

2. Disconnect hood stays (22) at forward end of fuel tank and tip hood forwards.
3. Remove right-hand battery cover and disconnect positive lead.
4. Turn off fuel taps (7) and (11), open drain plug (10) and drain auxiliary tank.
5. Disconnect from main fuel tank (3) :—
   (*a*) Kigass Tank (24).
   (*b*) Fuel Return pipe (4).
   (*c*) Main fuel delivery pipe at tap (7).
   (*d*) Auxiliary tank balance pipe (9) and remove pipe.
   (*e*) Four fuel tank securing bolts. Lift off tank, rubber pads and packing plates.

12. Disconnect radiator tie-rod (33) from water outlet elbow (32) and loosen top hose rear clip.
13. Remove set screws and pull outlet elbow free from top hose.
14. Remove taper set screws from sleeve (31) coupling front and rear of decompression operating shaft and slide sleeve to rear to clear break.
15. Disconnect decompression operating shaft bracket (25) and clip securing governor pipe to rear of cylinder head.
16. Thoroughly clean all unions and remove injector pump delivery pipes (2) and fuel return pipe (4).

KEY TO ANNOTATION.

23. Kigass Filter.
24. Kigass Tank.
25. Bracket—Decompression Operating Shaft.
26. Decompression Link Rod.
27. Kigass Atomiser.
28. Rocker Cover.
29. Breather Pipe & Valve.
30. Inlet Manifold.
31. Decompression Shaft Sleeve Coupling.
32. Water Outlet Elbow.
33. Radiator Tie-Rod.
34. Front Decompression Handle.
35. Water Pump.
36. Exhaust Manifold.
37. Dynamo.
38. Cylinder Block Drain Tap.
39. Exhaust Pipe.
40. Starter Motor.
41. Air Pre-Cleaner.
42. Exhaust Pipe Clip.
43. Radius Rod.
44. Steering Drag Link.
45. Air Cleaner Bowl.
46. Heater Plug.
47. Rear Decompression Handle
48. Venturi Assembly.

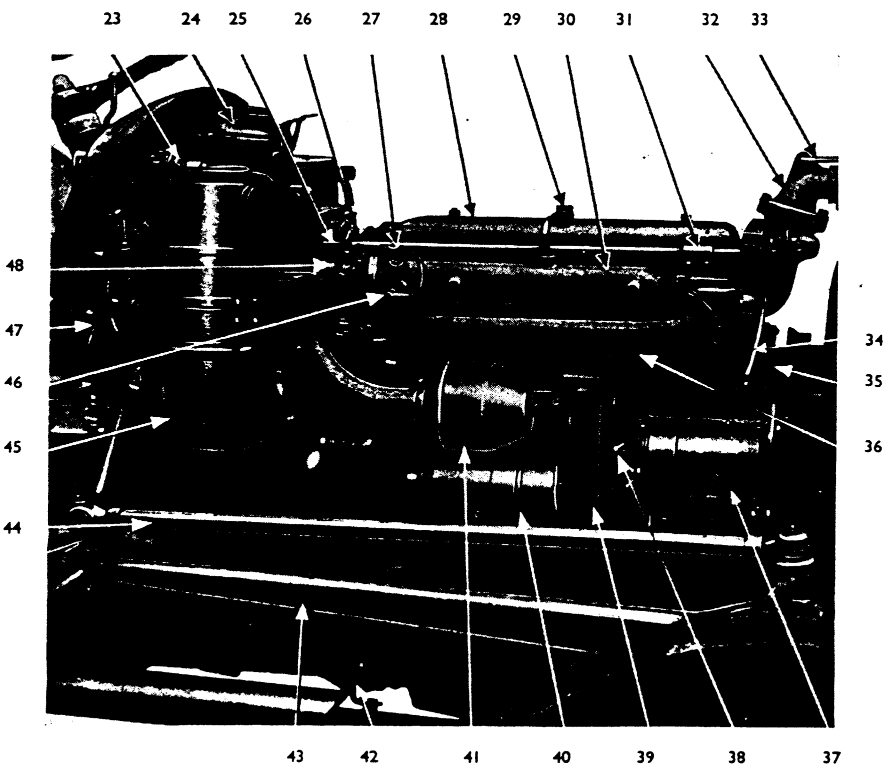


FIG. 108.
RIGHT HAND VIEW OF ENGINE
(Main Fuel Tank Removed).

6. Remove air pre-cleaner (41), air inlet pipe and hose elbow complete.
7. Disconnect exhaust pipe clip (42) and exhaust pipe (39) from manifold (36).
8. Disconnect inlet manifold breather pipe (29) from rocker cover and inlet manifold and clean restrictor valve.
9. Slacken and remove all manifold nuts, take off exhaust manifold and remove long inlet manifold studs.
10. Disconnect link rod (26) from decompression operating lever at rear of rocker cover.
11. Remove by-pass pipe (21) from water pump and thermostat body.

Removing and Dismantling Cylinder Head.

1. Remove rocker cover (28) and gasket. Remove nuts and spring washers from pedestals and lift off rocker and decompression shaft assembly. Lift out push rods and carefully place them in order of removal for replacement in their original positions.
2. Remove all injectors and copper washers.
3. Unscrew nuts evenly in reverse order to that recommended in Fig. 110 and

remove cylinder head and gasket complete with thermostat housing and front decompression handle assembly.

4. Without disturbing setting of front decompression handle, remove thermostat housing assembly with gasket from front of cylinder head.

5. With cylinder head mounted in Service Fixture FTB.9 (shown Fig. 8, page C9), using seating plate marked TEF, compress valve springs and remove split cones and collars. On removing valves and springs carefully place them in their correct positions on the Service Fixture.

   Cup shaped valve guide collars fitted on engines prior to No. SA.7595E must be replaced by the later flat face type or alternatively modified by removing the vertical lip flush with the seating face.

REMOVING CARBON.

Pistons and Sleeves.

1. Position crankshaft with two pistons at top dead centre, and blank off with rags remaining cylinders and ports to prevent entry of carbon particles.

2. Carefully remove carbon from piston crown and combustion space, leaving a ridge around piston edge and at top of cylinder inserts.

3. Repeat for remaining pistons. Scrape off dirt, grit or sealing compound from top of cylinder block and wipe piston crowns with petrol moistened rag.

Cylinder Head and Exhaust Manifold.

1. Examine cylinder head for signs of porosity and fur deposits.

2. Remove all carbon from combustion head, pre-combustion chambers, valve ports, seats and guides by means of suitable scrapers or pneumatic hand tool. Carefully clean out all displaced carbon.

N.B. Never clean pre-combustion chambers with the injectors still fitted.

3. Remove old manifold gaskets and clean off dirt or grit from head faces.

Injectors.

All injectors should be dismantled, cleaned and, after examination, reassembled and adjusted in accordance with separate instructions.

Valves.

Remove all carbon from each valve head and stem. Examine seating faces ; if badly pitted or burnt they will require machine facing.

Compare the strength of new valve springs against those removed from the cylinder head and renew any showing signs of fatigue. Refer to Section B page B18.

Valve Grinding.

It is not proposed herein to give detailed instructions for "grinding-in" valves or cutting valve seats, the procedures for which are fully covered in the Petrol Engine Section, pages C.13 to 16.

It is, however, particularly important with the compression ignition engine to ensure that there is no compression loss through badly seating valves. For this reason it is strongly recommended that both valve seats and the cylinder head seatings are always faced with the appropriate cutters—removing only sufficient metal to confirm that there is an even seat without any distortion—before proceeding to "grind-in" the valves with a fine paste.

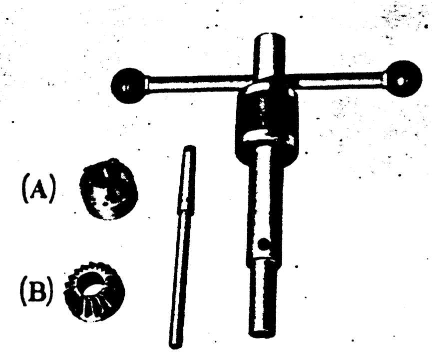


FIG. 109.
VALVE SEAT SERVICE KIT. HANDLE—316X AND PILOT—316-10, WITH GLAZE BREAKER (A) — 317G-22 AND 45° CUTTER (B) — 317-22.

To facilitate cutting cylinder head seats, it is advisable first *lightly* to skim the top face, using Glaze Breaker No. 317/G-22, Fig. 109, to remove the hard surface produced by the hammering of the valves.

Re-Assembly.

All parts must be completely clean before commencement.

1. Insert valves in correct guides and mount cylinder head with valve stems uppermost on Service Fixture FTB.9, seating plate TEF.
2. Assemble each valve by placing springs and collars over stem, compress springs, refit split cones and allow springs to expand.
3. Remount thermostat housing and front decompression handle assembly on front of cylinder head using new gasket.

Replacement of Cylinder Head Assembly.

1. Remove all rags.
2. Carefully place new cylinder head gasket over cylinder block studs with " TOP " mark upwards and fit new manifold gaskets to cylinder head.
3. Remount cylinder head and tighten nuts on flat washers evenly, in order recommended in Fig. 110, torque loading 75—80 lb. ft. (10.4—11 kg.m.).

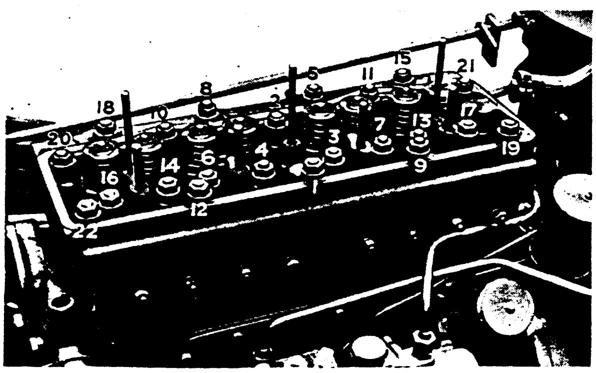


FIG. 110.
ORDER OF TIGHTENING CYLINDER HEAD NUTS.

4. Insert push rods into their original bores.
5. Slacken off all rocker adjusters and mount rocker and decompression shaft assembly.
6. Locate rocker ends on valve stems and ends of adjusting screws in push rod cups ensuring decompression cams are not in contact with exhaust rocker ends. Replace nuts and washers on pedestals and tighten down firmly.
7. Adjust inlet and exhaust valve clearances to .012″ (.305 mm.) by means of rocker adjuster screws and locknuts, as shown in Fig. 111.

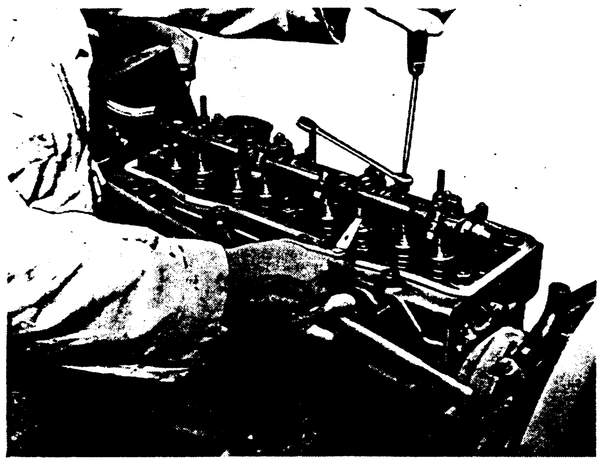


FIG. 111.
ADJUSTING VALVE TIP CLEARANCES.

8. After adjusting valve clearances, reset decompression cam clearances (see Fig. 112) as follows :—

   (*a*) Locate the decompression shaft so that the slot at the rear end is vertical. This is facilitated by a hole in No. 2 pedestal extension, through which a dowel (3/16″ dia.) can be inserted to engage a corresponding hole in the decompression shaft.

   (*b*) With the shaft firmly located, loosen the clamp bolt of each cam and, with the valve fully closed, adjust clearance between cam and rocker arm to .030″ (.76 mm.) for Nos. 1, 2 and 4 cams and .045″ (1.14 mm.) at No. 3.

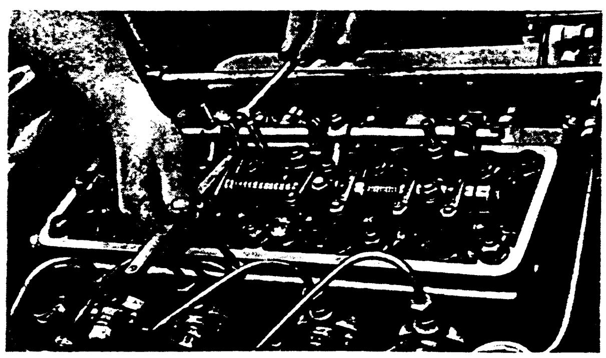


FIG. 112.
SETTING DECOMPRESSION CAM CLEARANCES.

   (*c*) Retighten clamp bolt after setting each cam. Remove dowel.

9. Replace rocker cover and gasket, locating the slot at the rear of decompression shaft over flats of operating lever inside rocker cover.

To Complete Assembly. See FIGS. 107 & 108.

1. After checking that thermostat is still in position, refit water outlet elbow (32) with new gasket, securing top hose with clip. Tighten set screws and reconnect tie-rod (33). Replace by-pass pipe (21).
2. Replace inlet manifold studs and refit exhaust manifold (36). Tighten nuts in order suggested in Fig. 113.

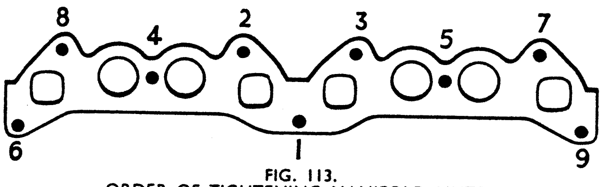


FIG. 113.
ORDER OF TIGHTENING MANIFOLD NUTS.

3. Reconnect decompression operating shaft bracket (25), decompression link rod (26) and clip securing governor pipe to rear of cylinder head.
4. Reconnect breather pipe (29) to rocker cover (28) and inlet manifold.
5. Reconnect exhaust pipe (39) with new gasket and exhaust pipe clip (42), refitting air pre-cleaner (41), inlet pipe and hose elbow.
6. Recouple decompression operating shaft, securing sleeve (31), with taper set screws.
7. Carefully replace all injectors using new copper washers, **tighten both nuts down evenly** to a final torque wrench reading of 12 to 14 lb. ft. (1.6—1.9 kgm.). Attach fuel return pipe (4). Reconnect high pressure pipes (2) to injector pump only.
8. Replace rubber pads and packing plates and remount main fuel tank. Reconnect fuel return pipe, auxiliary tank balance pipe (9), main fuel delivery pipe and kigass tank brackets, before tightening down four tank securing bolts and tab washers.
9. Replace hood stays (22) and battery lead.
10. Refill radiator, close auxiliary tank drain plug (10) and turn on fuel taps (7) and (11).
11. De-aerate the fuel system in accordance with published instructions. Turn over engine and check injector pump delivery before finally connecting delivery pipes to injectors.
12. Start up engine and check for leaks, etc.

After the engine has been run for a few hours, retightening of cylinder head nuts and further adjustment to valve tip and decompression cam clearances will be necessary.

N.B. It is essential for **all** cylinder head nuts to be retightened in the correct sequence to the recommended torque. This is facilitated by the use of Service Tool FTB.30, which enables the otherwise inaccessible cylinder head nuts under the rocker and decompression shafts to be tightened with both shafts in position. See Fig. 114.

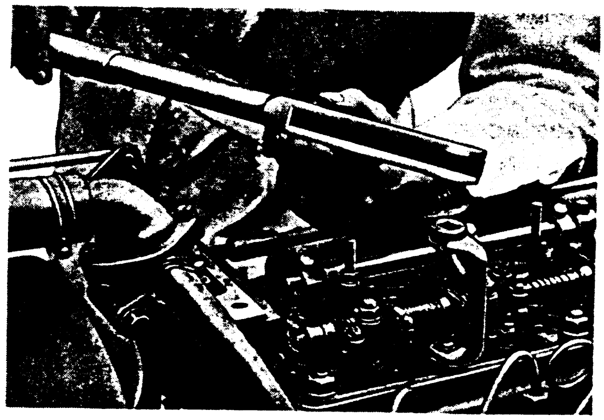


FIG. 114.
TIGHTENING CYLINDER HEAD NUTS WITH ROCKER SHAFT ASSEMBLY IN SITU. SERVICE TOOL FTB.30 WITH TORQUE WRENCH.

TO REMOVE VALVE SPRINGS AND COLLARS WITH CYLINDER HEAD FITTED.

By using the piston head at T.D.C. to support the valve, valve springs and collars can, if necessary, be removed while the head is in position, by means of Service Tool FTB.34, mounted as shown in Fig. 115.

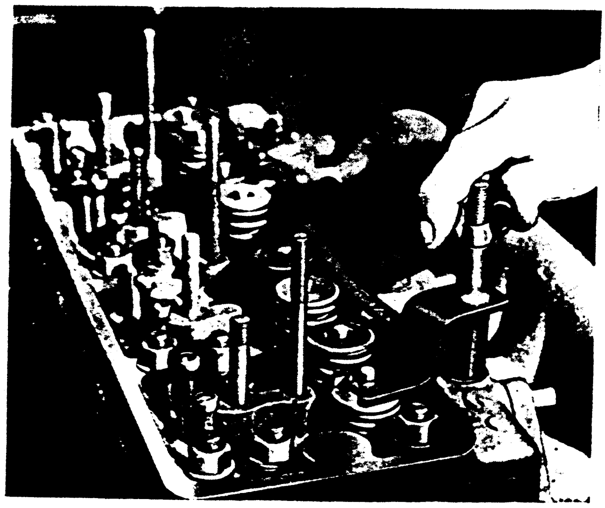


FIG. 115.
REMOVING VALVE SPRINGS AND COLLARS WITH CYLINDER HEAD IN SITU. SERVICE TOOL FTB. 34.

TO DISMANTLE AND RE-ASSEMBLE ROCKER AND DECOMPRESSION SHAFT ASSEMBLY.

To Remove Decompression Shaft.

1. Remove all cam clamping bolts and locknuts and the shaft locating screw with spring washer from No. 3 pedestal extension.

2. Slide out the shaft.

To Replace Decompression Shaft.

This is the reversal of the removal procedure.

The slot is to the rear of the shaft, which is located endways by the grub screw fitted through the 3rd pedestal extension into the square groove. The plain hole in the shaft, which is used when setting decompression cam clearances, must be situated beneath the drilled No. 2 pedestal extension.

Cams are interchangeable, but take care to assemble each cam over its locating groove, with the longer flat face towards the rocker shaft. Clamping bolts must be inserted from the rocker shaft side. Bolts should be left loose until cam clearances are set.

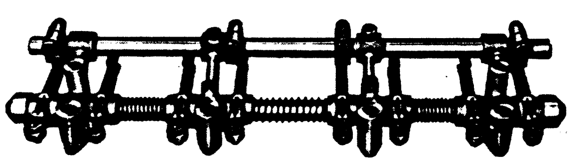


FIG. 116.
ROCKER AND DECOMPRESSION SHAFT ASSEMBLY.

To Dismantle Rocker Shaft.

1. Remove decompression shaft as instructed.

2. After extracting pin securing end collars and removing the shaft locating screw from No. 3 pedestal : pedestals, rockers, springs and end collars with double coil spring washer can be slid off the shaft.

3. Examine rocker bushes for wear and renew if necessary. See below.

To Re-Assemble Rocker Shaft.

After cleaning all components, blow through oil ways with compressed air and re-assemble, as shown in Fig. 116, in the reverse order to dismantling. Note that front and rear pedestals are interchangeable, with an oil feed drilled through from the base, the rear pedestal thereby connects the oil way from the camshaft rear journal with the rocker shaft.

The two outer springs are identical, the longer spring is fitted between Nos. 4 and 5 rockers.

Position the shaft with the tapped hole beneath the 3rd pedestal, i.e., that drilled for the locating screw.

RENEWING VALVE ROCKER BUSHES.

1. Tap out the old bushes, which are a comparatively easy fit in the rocker, with the aid of a chiselled end punch.

2. Mount new bushes centrally into the rocker and press carefully fully home with the aid of a soft jawed vice, leaving an annular space between the two bushes for oil distribution.

To Ream Rocker Bushes.

New rocker bushes must be reamed through in situ, using Reamer and Adaptor FT.125 mounted in Fixture 6100—Fig. 117.

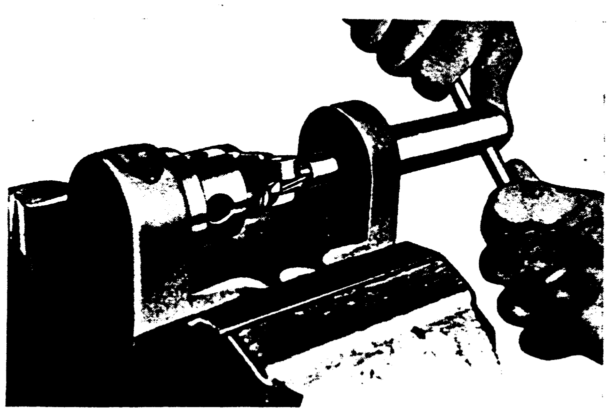


FIG. 117.
REAMING ROCKER BUSHES. REAMER AND ADAPTOR FT. 125, FIXTURE NO. 6100.

RENEWAL OF PRE-COMBUSTION CHAMBER LOWER HALF.

Examine the orifice in the lower half of all pre-combustion chambers, those showing signs of erosion or burning, as shown A in inset Fig. 118, must be renewed.

Equipment Required :-
Service Tool FT.136, comprising Remover, Replacer and Finisher. Service Tool FT. 6056, Hand Machining Equipment.

To Remove Pre-Combustion Chamber.

1. Fit spigot of Drill Jig FT.136/1, so that holes lie on the vertical and horizontal centre lines of the orifice.
2. With Jig held firmly in position drill through the holes into the pre-combustion chamber, using 3/16" (4.77 mm.) diameter drill, locating Jig by inserting two of the replacement pegs FT.136/2, into the first two drillings, see Fig. 118, otherwise difficulty will be experienced in fitting the Remover.

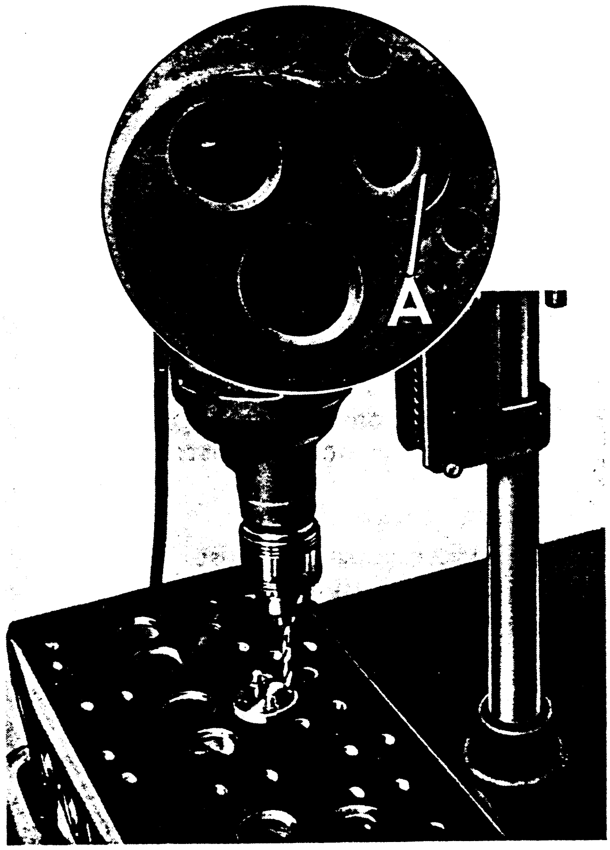


FIG. 118.
DRILLING LOWER PRE-COMBUSTION CHAMBER FOR REMOVAL DRILL JIG. FT.136/1 AND PEGS FT.136/2.

3. Remove Jig and pegs and fit Remover FT.136/3 into the drilled holes. Secure Remover in position by mounting head in vice, tightened just sufficiently to prevent the tool slipping out of its location, see Fig. 119. Strike handle of Remover in an anti-clockwise direction to loosen the pre-combustion chamber and then proceed to unscrew and remove it from the head.
4. Before fitting a new lower pre-combustion chamber, ensure that the threads in cylinder head and the joint face of upper chamber are clean and free of carbon.

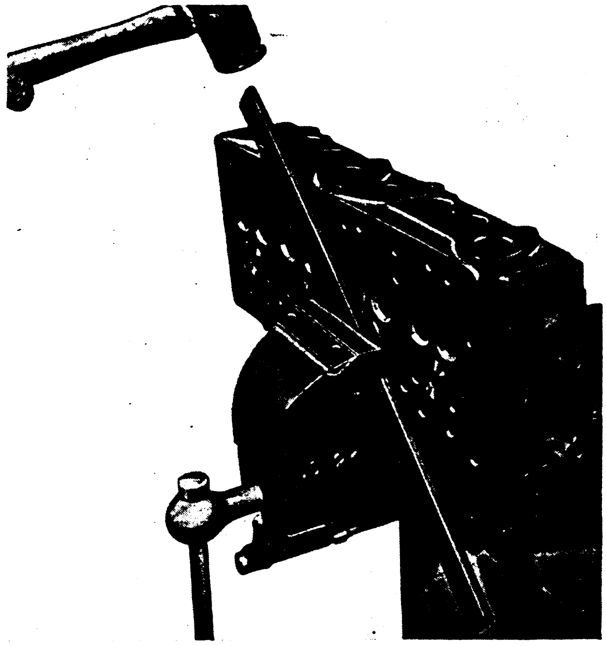


FIG. 119.
UNSCREWING LOWER PRE-COMBUSTION CHAMBER SERVICE TOOL FT. 136/3.

To fit new Pre-Combustion Chamber

1. With handle of FT.136/3 placed edgeways between the lugs, screw down lower chamber so that it is held fast in position.

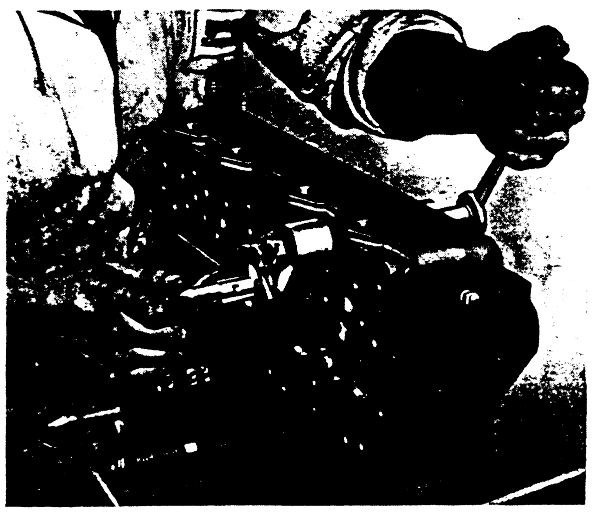


FIG. 120.
CENTRALISING GUIDE FT.136/4 WITH NEW PRE-COMBUSTION CHAMBER ORIFICE USING PILOT FT. 136/5.

2. Mount cylinder head in soft jawed vice and fit guide FT.136/4 loosely over the new pre-combustion chamber. Using pilot FT.136/5, register the bore of the guide concentrically with the chamber orifice and then secure firmly in position, Fig. 120.

3. Remove pilot and mount FT.6056 with cutter FT.136/6 on cylinder head ; after centralising the cutter in the guide bore, tighten all securing nuts finishing with the platform.

4. Insert an air pressure pipe through the injector port so that a constant stream of air plays onto the cutter. This will prevent swarf accumulating around the cutter and scoring the face of the pre-combustion chamber as the semi-circular lugs are removed.

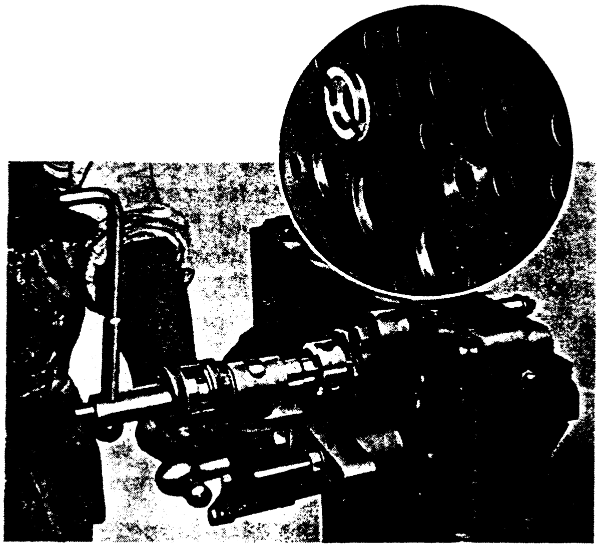


FIG. 121.
REMOVING FITTING LUGS—SEE INSET—OFF NEW PRE-COMBUSTION CHAMBER USING SERVICE TOOL FT. 6056 WITH CUTTER FT. 136/6 AND GUIDE FT. 136/4.

5. Proceed to skim off the lugs by rotating the cutting handle, as shown in Fig. 121, using the knurled screw feed, until the bottom face of the chamber is just below the cylinder head face. The actual depth of recess is controlled by the stop on the guide.

6. Remove machining equipment and carefully blow out all swarf.

REMOVING AND REPLACING VALVE GUIDES.

Check the fit of all valves in their respective guides. If the clearance exceeds .006″ (.152 mm.) on the inlet or .008″ (.203 mm.) on the exhaust, renew as necessary. Refer to Section B Page B18 for the individual sizes.

It is recommended that the exhaust valve guides of engines prior to SA.30865E are removed, and the exhaust ports enlarged, in accordance with details given in Fig. 122, using Service Tool FT.6056 with Cutter FT.137, shown inset. The depth of the cut is controlled by the stop on the stem of the Cutter. Exhaust valve guides Part No. 108047 only must now be fitted.

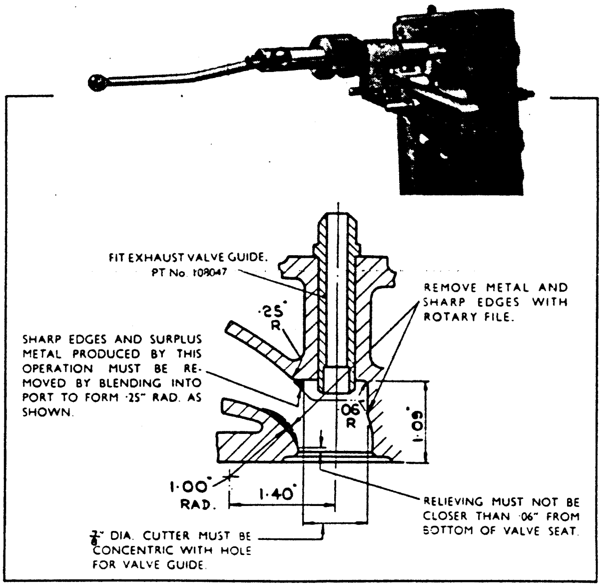


FIG. 122.
EXHAUST PORT MODIFICATION
(Engines Prior to No. SA.30865E)
SERVICE TOOL FT. 6056 WITH CUTTER FT. 137 (INSET).

All guides can be extracted using Service Tool FT.60 and similarly replaced in conjunction with the modified Adaptor No. FT.60/6A. The application of FT.60 is shown in Figs. 20 and 21, Page C.16.

Important

After renewing the guides, the valve seats in the cylinder head **must** always be recut to ensure concentricity with the new guide bore and the valves themselves must then be " ground-in " to suit.

VALVE SEATS.

Fig. 123 illustrates the various forms of valve seatings which will be found in the cylinder head.

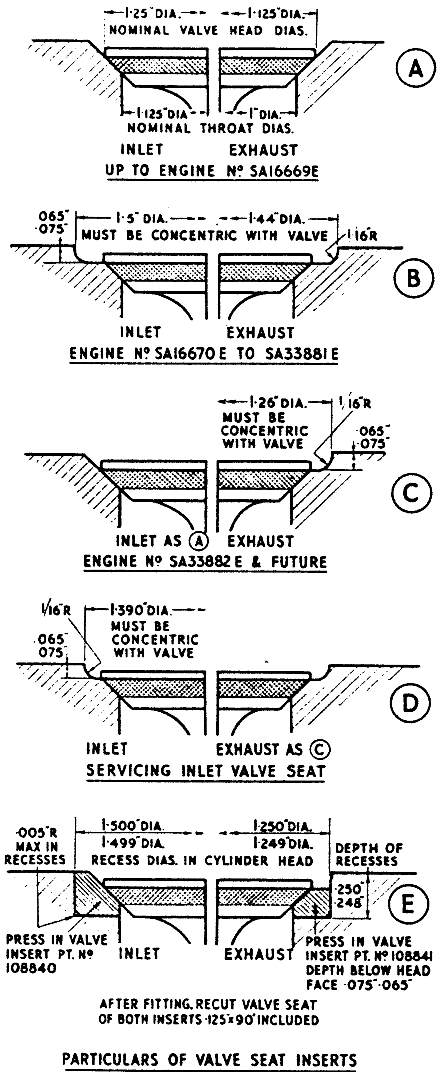


FIG. 123.
VALVE SEATS

Fig. 123A shows the original form of both inlet and exhaust seats which were modified at Engine No. SA.16670E to those shown in Fig. 23B and subsequently changed at Engine No. SA.33882E to the forms shown Fig. 23C. It is recommended that engines prior to SA.16670E are modified similarly, if required, by means of the Hand Machining Equipment FT.6056, set to recess to the specified depth, with cutter FT.138 adjusted to the required diameter. See Fig. 124.

Over a period of time a step will be produced by the hammering of the valve on its seat. Moreover, it must be appreciated that a step can be made if valves are subjected to an unnecessarily lengthy 'grinding-in' process with coarse paste. Seatings will then have to be recut using the Service Kit shown in Fig. 109 and the inlet seats may be recessed to the diameter shown in Fig. 123D.

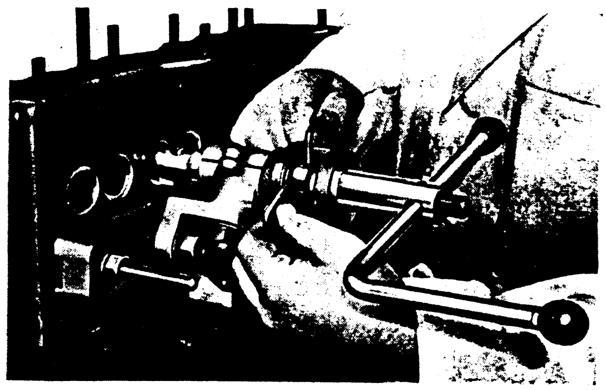


FIG. 124.
RECESSING VALVE SEATS. SETTING DEPTH STOP. SERVICE TOOL FT. 6056 WITH CUTTER FT. 138.

In extreme cases of wear the valve seating will have to be remade by fitting inserts as shown in Fig. 123E—Part Nos. 108840 and 108841, inlet and exhaust respectively—with the aid of Service Tool FT. 6056, using the standard Cutter provided with the kit, and Insert Replacer FT. 6057. The service procedure may then be repeated.

TAPPETS AND PUSH RODS.

The mushroom shaped tappets can only be extracted through the crankcase when the sump and camshaft have been removed.

After removal, examine each tappet in turn. Face markings illustrated B Fig. 125, indicate that the tappet has not been turning in its bore, while those illustrated A indicate satisfactory turning, thus ensuring even wear and satisfactory rocker adjustment. Tappets which have not been turning should either be renewed or relocated in another bore where satisfactory rotation has taken place. If a push rod is bent or has a worn seating, it should be replaced.

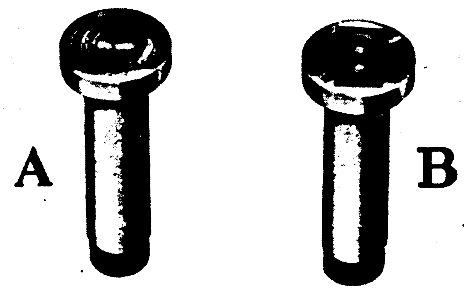


FIG. 125.
ILLUSTRATING GOOD "A" AND BAD "B" TAPPET MARKINGS

CAMSHAFT AND TIMING MECHANISM

TO REMOVE AND REPLACE CAMSHAFT.

Removal of Timing Cover.

1. Support engine at rear-end of sump, using Trolley Jack with cradle Pt.63 located either side on the sump flange, the position is shown in Fig. 149. Remove hood together with front axle and radiator assembly — Page C128.
2. Remove fan belt and fan which is secured to pulley by 4 set screws with lockwashers.
3. Remove starting handle jaw, using Service Tool FTB.16, Fig. 126, with long

FIG. 126.
REMOVING STARTER JAW. SERVICE TOOL FTB. 16.

lever. Bend back tabs of starting handle jaw lockwasher then select 4th gear and apply parking brake before striking lever to unscrew jaw.

4. Remove pulley from crankshaft key.
5. Pull timing cover with gasket free from the two locating dowels after removal of set screws and lockwashers.

Removal and Replacement of Crankshaft Front Oil Seal.

1. The crankshaft front oil seal situated in the timing cover can now be removed with the aid of Service Tool FT.44B and Universal Handle No. 550. See Fig. 127.

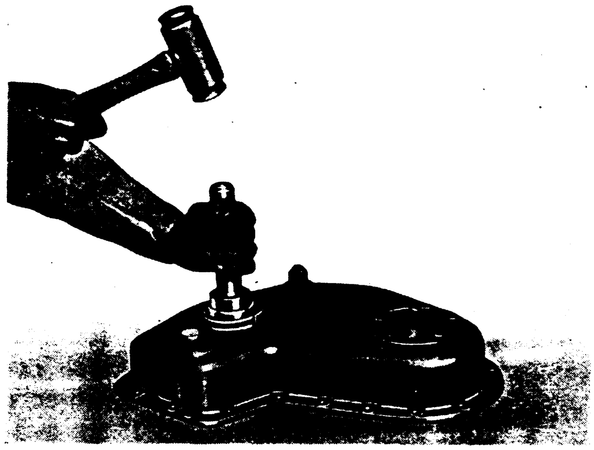


FIG. 127.
REMOVING CRANKSHAFT FRONT OIL SEAL USING SERVICE TOOL FT. 44B WITH HANDLE NO. 550.

2. Fit new oil seal, lip inwards, using replacer adaptor FT.103A. Do not use undue force otherwise the seal will be damaged and the bore in which it seats distorted.

Removal of Camshaft.

1. Temporarily refit starting handle jaw to facilitate turning the engine.
2. Set the crankshaft keyway at 3 o'clock, this will position Nos. 1 and 4 pistons 90° anti-clockwise from T.D.C. and ensure no damage can be done by valves striking the pistons while the timing chain is off.
3. Remove jockey chainwheel and carrier.
4. Draw off oil deflector and oil pump driving gear from crankshaft key.
5. Extract pin and withdraw oil pump driven gear from the pump spindle. The oil pump assembly can now be removed if required — 4 set screws on lockwashers — see page C103.
6. If the camshaft chainwheel has to be extracted separately without its centre, first confirm that the chainwheel and centre are marked as indicated in Fig. 131, if not, mark both parts with punch dots as shown, otherwise resetting will be necessary (see under "Valve Timing B" paras 7 — 9). However, should the timing chain be renewed resetting will probably be required, see "Camshaft

Chainwheel and Centre "—page 120.

7. Bend forward corners of locking washer and remove camshaft chainwheel 6 set screws on lock and flat washers and timing chain.
8. The crankshaft chainwheel can now be withdrawn if so desired.
9 Remove fuel tank, rocker and decompression shaft assembly and lift out push rods. See page C107.
10. After carefully recording the relative positions of the injector pump timing marks on the pump and crankcase mounting flanges, remove fuel and governor pipes, cut-off control rod, idling control link rod and injector pump. Remove injectors to avoid turning the engine against compression.
11. Remove oil filler and tappet cover assembly. To prevent the tappets dropping into the engine while the camshaft is taken out, fit clip FT.140. over each tappet as shown in Fig. 128. On the front tappet the shorter leading edge of the clip should be towards the cylinder block.

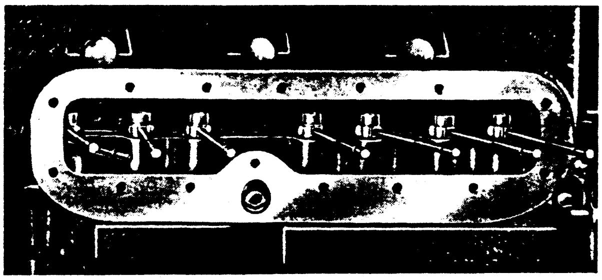


FIG. 128.
RETAINING TAPPETS BY CLIPS FT. 140 WHILE CAMSHAFT IS REMOVED.

12. Unscrew two camshaft front bearing set screws with lockwashers — note that screw holes are offset to ensure correct re-assembly. Withdraw camshaft.
13. With camshaft held in a soft jawed vice, chainwheel centre and front bearing can now be drawn off, after bending back tab washer and removing locknut.

Re-Assembly—Valve Timing.

1. Remount bearing on front of camshaft with set screws and lockwashers fitted, then press on camshaft centre over key and secure with tab washer and locknut.
2. Replace camshaft in cylinder block with front bearing oil holes downwards. Secure with two fixing screws on lockwashers through offset holes in front bearing flange.
3. Remove tappet clips, replace push rods, locating ball ends in tappet cups, and refit oil filler and tappet cover assembly.
4. Loosen off adjusters and replace rocker and decompression shaft assembly.

If any of the chainwheels have been renewed, remove crankshaft chainwheel key then temporarily refit chainwheel by itself. Check crankshaft chainwheel alignment by placing a straight edge across the front faces of the wheels—see Fig. 129.

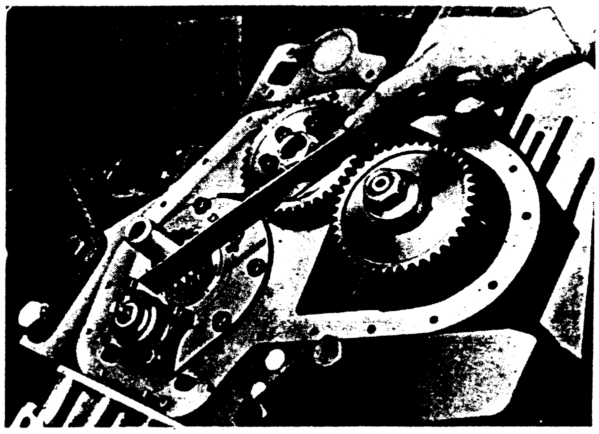


FIG. 129.
CHECKING CHAINWHEEL ALIGNMENT.

Adjust by adding or subtracting shims behind the crankshaft chainwheel. Refit crankshaft chainwheel complete with key.

5. Set valve timing, see page C118, refitting camshaft chainwheel and timing chain and tension chain using Service Tool FT.84A. Fig. 133.
6. Refit oil pump driven gear and secure with pin.
7. Refit oil pump driving gear over key and oil deflector concave outwards.
8. Replace injector pump using new gasket, with timing marks aligning as recorded during dismantling. Replace fuel pipes, injectors, etc.
9. When chain tensioner FT.84A is removed and timing cover fitted, chain tension can be retained by either :—

(*a*) Fitting two lockwashers beneath top left-hand front bearing housing set screw, then temporarily lodging jockey chainwheel assembly against the screw head. Locating the front pivot into the timing cover will automatically release and reposition chainwheel assembly.

or

(*b*) Looping string round jockey chainwheel carrier and then wrapping the other end round injector pump drive shaft locknuts and, after fitting timing cover, removing string through inspection opening.

The chain adjusting screw should be set approximately to ensure the chain cannot slip a tooth.

10. Remove chain tensioner FT.84A.

11. It is suggested that the timing cover and gasket are guided into position by means of two 5/16″ dia. pegs — $2\frac{1}{2}$″ long, and threaded 5/16″ N.C. one end, fitted in the cylinder block at opposite ends of the timing cover flange. Tighten top and bottom fixing screws on either side of the dowels first.

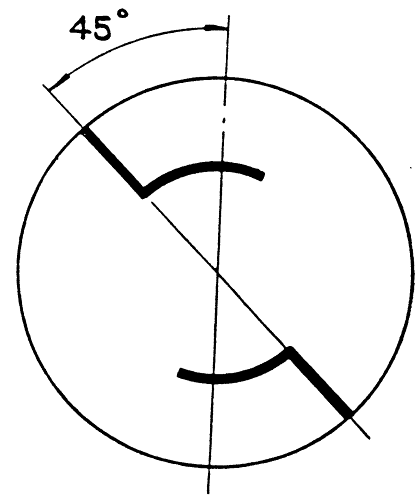


FIG. 130.
ARRANGEMENT OF STARTER JAW FOR BEST CRANKING POSITION.

Note :—Whenever the front cover and timing mechanism has been dismantled and re-assembled, it is advisable for the spill timing of the injector pump to be checked.

Lubricating Pipes.

If timing mechanism lubricating pipes, shown in Fig. 132, are removed, care must be taken to ensure that they are replaced securely with oil holes suitably directed towards the timing chain and jockey chain wheel. At engine No. SA.5614E a drilled stud with lock nut and lead linger replaced the copper pipe previously fitted on the front bearing housing.

12. Adjust tension of timing chain. See page C120.

13. Replace pulley, fan belt and fan, locating balance piece with "BALANCER" to the front and with drilled holes in line. Note fan blades should be to the rear of central mounting plate.

14. Replace starter jaw, shimming as necessary to present the easiest position for cranking the engine as shown in Fig. 130.

15. Replace fuel tank, front axle, radiator assembly, etc.

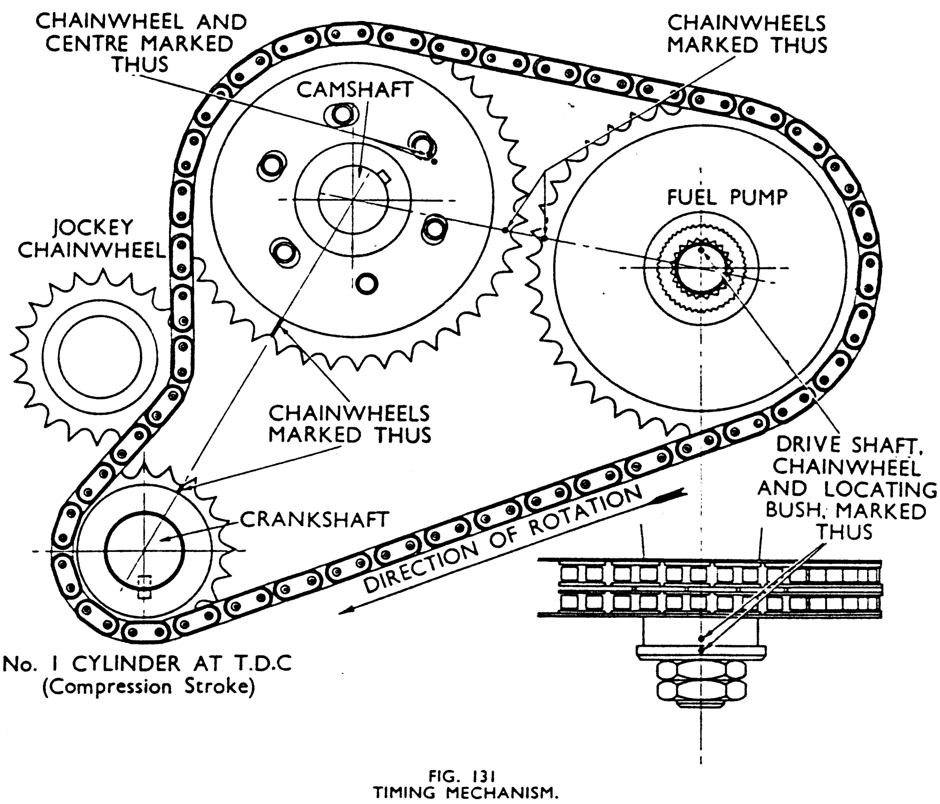


FIG. 131
TIMING MECHANISM.

Valve Timing.

Warning :

At T.D.C. the piston approaches very near the valve heads and, furthermore, as shown in Fig. 134, the valves have an overlap of 10° (crankshaft), 5° each side of T.D.C. Inaccuracies, therefore, in setting valve timing could result in valves striking piston crowns.

A. The following procedure assumes that the adjacent teeth of the camshaft, crankshaft and fuel pump chainwheels are marked as shown in Fig. 131, when No. 1 inlet and exhaust valves are fully closed and with No. 4 inlet valve just opening and exhaust valve just closing.

1. First ensure that Nos. 1 and 4 pistons are positioned 90° anti-clockwise from T.D.C.—see " Removal of Camshaft " para 2. Temporarily remount starter jaw to facilitate turning the engine.
2. To facilitate rotating the camshaft, fit Service Tool FT.117, Fig. 132, on face of camshaft centre and set all valve tip clearances to .012" (.305 mm.) Check and reset decompression cams as required, see page C109.

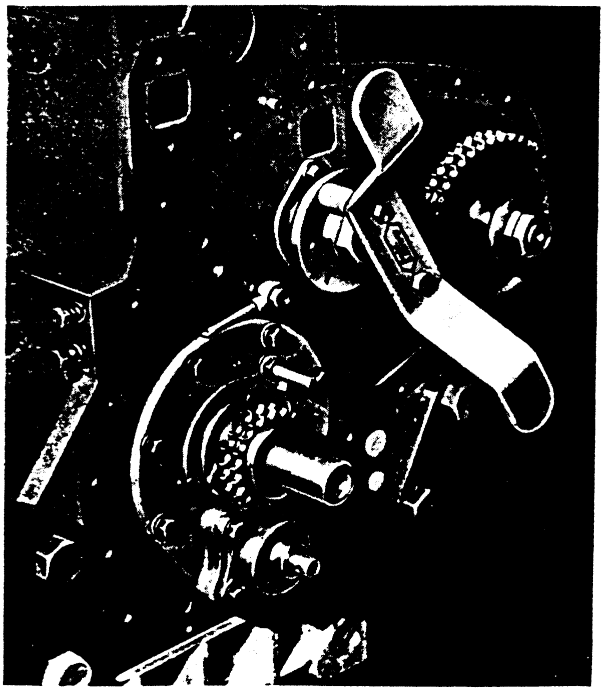


FIG. 132.
CAMSHAFT ROTATING TOOL FT. 117.

3. Turn camshaft until both valves of No. 1 cylinder are fully closed and those of No. 4 cylinder are just open. Then remove Camshaft Rotating Tool.
4. Turn crankshaft clockwise through 90° and set keyway accurately at B.D.C., see Fig. 131, thereby bringing Nos. 1 and 4 pistons to T.D.C. Note also that the centre line of the key passes straight through the tooth diametrically opposite.
5. Fit endless chain over crankshaft and fuel pump chainwheels.
6. Secure camshaft chainwheel to centre, with punch dots coinciding, by means of six set screws on flat and lockwashers, accurately aligning scribe and punch marks of crankshaft, camshaft and injector pump chainwheels as shown in Fig. 131. Ensure all the slack links in the chain are between the crankshaft and camshaft chainwheels.
7. Fit jockey chainwheel and carrier assembly, locating spring in recessed hole in front face of cylinder block.
8. Fit Chain Tensioner FT.84A, using appropriate timing cover set screw holes so that the adjusting screw bears at right angles against the pad of the

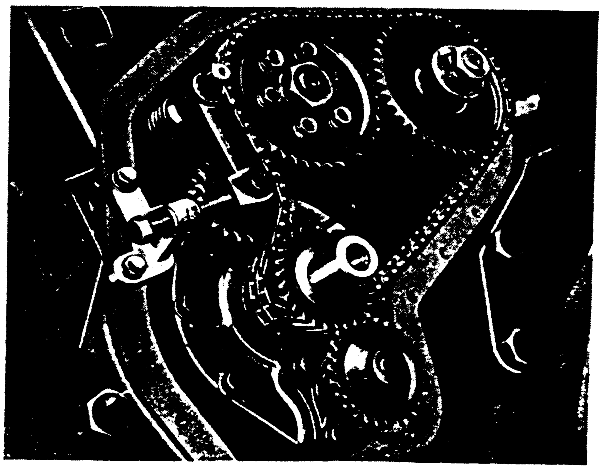


FIG. 133.
TIMING CHAIN TENSIONER FT. 84A.

jockey chainwheel carrier as shown in Fig. 133. Tighten adjusting screw finger tight to take up the slackness in the chain.

9. Recheck alignment of timing marks (see " Camshaft Chainwheel and Centre " page C120).

B. The following procedure assumes that neither crankshaft or camshaft chainwheels or the camshaft centre are marked as shown in Fig. 131.

Note :—If the injector pump chainwheel and adjacent parts of the pump drive are unmarked, spill timing must be conducted later in accordance with published instructions and the parts marked appropriately for future reference.

1. First ensure that Nos. 1 and 4 pistons are positioned 90° anti-clockwise from T.D.C. (see " Removal of Camshaft " para 2).

   Temporarily mount starter jaw to facilitate turning the engine.

2. To facilitate rotating the camshaft, fit Service Tool FT.117, shown in Fig. 132 on face of camshaft centre.

3. Set inlet and exhaust valve of No. 4 cylinder —for setting purposes only— to .015″ (.38 mm).

4. Turn camshaft until the valves of No. 4 cylinder are rocking with the inlet valve just about to open and the exhaust just about to close. The camshaft is now phased for No. 1 piston at T.D.C. of firing stroke.

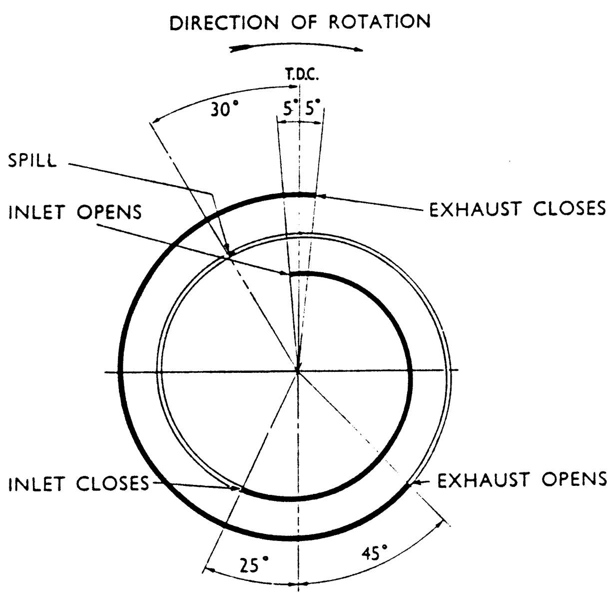


FIG. 134.
TIMING DIAGRAM—CRANKSHAFT DEGREES.

5. Carefully remove camshaft rotating tool.

6. Turn crankshaft clockwise through 90° and set keyway accurately at B.D.C., see Fig. 131, thereby bringing Nos. 1 and 4 pistons to T.D.C.

7. Fit endless chain over crankshaft and fuel pump chainwheels, taking care not to disturb their settings.

A position must now be found wherein the camshaft chainwheel can be secured to its centre, with the chain rollers seating snugly, without strain, between the engaging chain-wheel teeth and with the minimum amount of slack on the pump drive shaft side.

8. Select this position by swivelling the camshaft chainwheel, within the chain, about its centre, until, with the above conditions applying, the only positive locating screw hole aligns with one of the six holes in the chainwheel centre.

9 Fit locating screw and record the correct position by marking chain-wheel and centre as shown in Fig. 131. Fit remainder of screws over flat and lockwashers.

10 With crankshaft and fuel pump chain-wheels set as shown, mark camshaft and crankshaft chainwheels in positions indicated in Fig. 131, on lines passing directly through the middle of the crankshaft and injector pump drive shaft.

11 Ensure all the slack links in the chain are between crankshaft and camshaft chainwheels and fit jockey chainwheel and carrier assembly, locating spring in recessed hole in front face of cylinder block.

12. Fit chain tensioner FT.84A, using appropriate timing cover set screw holes so that the adjusting screw bears at right angles against the pad of the jockey chainwheel carrier as shown in Fig. 133. Tighten adjusting screw finger tight to take up the slackness in the chain.

13. Recheck alignment of timing marks (see " Camshaft Chainwheel and Centre " page C120).

14. Set **all** inlet and exhaust valve tip clearances—resetting also those of No. 4 cylinder—to .012″ (.305 mm.) Check and reset decompression cam clearances.

Important.

Any replacement or relocation of parts affecting valve and injector pump timing must be marked in accordance with Fig. 131.

CAMSHAFT CHAINWHEEL AND CENTRE.

It will be found, on well run in engines, that tensioning the timing chain will tend to misalign the original timing marks owing to the chain having stretched and ' bedded-in '.

To cater for this and allow for variations in chain length both in production and when fitting a service replacement, the chainwheel is secured to its centre by six fixing screws and their spacing allows for $1\frac{1}{2}^{\circ}$ stages of vernier adjustment. The chainwheel has one positive hole and five elongated slots, punch dots as shown in Fig. 131, indicate the relationship.

Note :—Adjustment to the camshaft chainwheel and centre relationship will tend to alter spill timing of the injector pump. See separate instructions covering injector pump spill timing.

TIMING CHAIN ADJUSTMENT.

1. With decompression handle in fully decompressed position turn engine over by hand a few times to take up all backlash.

2. Loosen and screw well back the locknut of timing chain adjusting screw. Check that screw is quite free in its thread so that the amount of tension imparted to chain is clearly felt.

3. Fully tighten chain by means of adjusting screw in timing cover. Do not over-tighten, correct degree of tightness is indicated when wrapping of chain around crankshaft, camshaft and fuel pump chainwheels is felt.

4(a) **New Engines.**

Unscrew adjusting screw **three complete turns** and secure with locknut.

(b) **Well run in Engines.**

(*i.e.*, When timing chain has ' bedded-in ' and chain pitches and shaft bearings have become comparatively free).

(i) Confirm that engine cannot easily be rotated with the starting handle.

(ii) Unscrew adjusting screw gradually by half turns until engine is free to turn without undue pressure on the starting handle, three or four complete rotations of the engine should be made to make sure that there are no " tight spots."

(iii) Unscrew adjusting screw a further half turn and tighten locknut. This setting has been found in practice to be approximately 2 complete turns out.

Anti-Drum Compound.

The hard rubber type compound covering the outside of the timing cover shown in Fig. 26, is applied to deaden any " drumming."

CYLINDER INSERTS, PISTONS, CONNECTING RODS AND LINERS

WITHDRAWAL AND REPLACEMENT OF CYLINDER INSERTS.

Preliminary dismantling : Drain radiator and cylinder block and remove engine hood and cylinder head, see page C107.

Removal.

1. Carefully scrape carbon from top of liner bore, bottom of lower insert and piston head to ensure an even seat for the insert removers.

2. Position piston half-way up stroke and place both halves of remover FT.108, Fig. 35, squarely on top of piston head.

3. Lift piston sharply by turning engine with starting handle to break seal, and then slowly continue to turn crank until inserts and dowel can be removed.

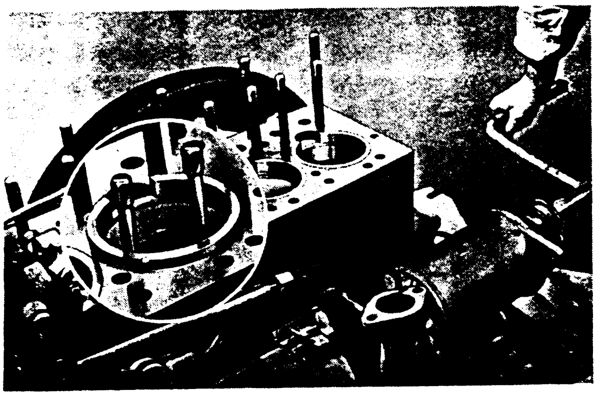


FIG. 135.
REMOVING CYLINDER INSERTS. SERVICE TOOL FT. 108.

4. Hold liners in position by means of Retainers FT.112 secured by adjustable Retainers FT.3B over appropriate cylinder head studs as shown in Fig. 136.

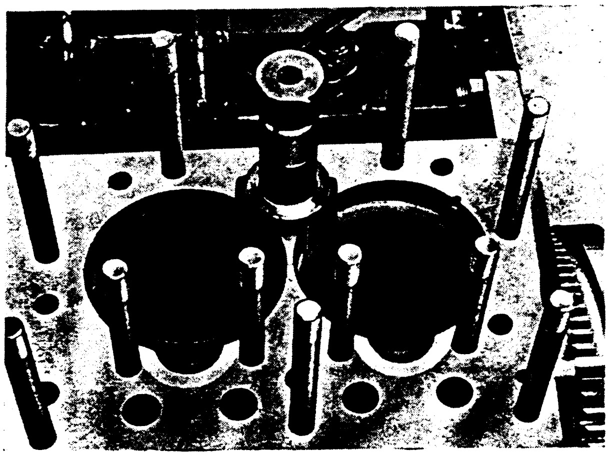


FIG. 136.
CYLINDER LINER RETAINER FT. 112 WITH ADJUSTABLE RETAINER FT.3B.

5. Carry out the same procedure on the remaining cylinders.

Note :—Up to Engine No. SA.415E, upper and lower cylinder inserts were manufactured as a single unit.

Important.

FT.108—both halves are a matched pair and marked and **must** always be used together as such.

Replacement.

The function of the lower cylinder insert is to keep the top land of the piston clean by scraping off excess carbon and it is suggested that it is replaced 90° anti-clockwise from original position, so that a fresh area is adjacent to the combustion space.

Inserts, the cylinder block recess and the top of the liner flange must be thoroughly cleaned before re-assembly.

1. Remove liner retainers and fit lower insert with convex face (marked "Top" on later engines) uppermost, using Piston Assembly Tool FT.109 to ensure that it is fitted squarely and that the liner flange and gasket are firmly seated.
2. Fit appropriate upper insert — see "Interchangeability of Slotted and Unslotted Liners" page C127—with concave face towards the convex face of the lower insert and slot towards the combustion space.
3. Insert locating dowel.
4. Repeat for remaining cylinders.

Note : The upper insert must stand proud of the top face of the cylinder block by .0045/.001" (.115 — .025 mm.) with new liner flange gasket fitted. For details of relevent sizes see Section B Page B16.

REMOVAL OF PISTONS AND CONNECTING RODS.

Note : If the engine has to be completely dismantled, the pistons and connecting rods can best be withdrawn and and replaced (see page C134) together, from below, after the crankshaft has been removed. Otherwise proceed as follows :-

Preliminary dismantling :

1. Drain oil sump, radiator and cylinder block water jacket.
2. Remove :
   (*a*) Main fuel tank, rocker cover, rocker shaft assembly and push rods. See page C107.
   (*b*) Cylinder head and inserts.
3. To facilitate extracting gudgeon pins and cleaning block face, remove water pump and all cylinder head studs right of the cylinder block centre line.
4. Remove oil strainer with gasket from sump — six nuts from studs with lock-washers.
5. Remove sump with gasket — 20 set screws with lockwashers.
6. The oil suction pipe can now be removed—one set screw from bracket and union connection at the front end.

Before proceeding to remove pistons and connecting rods, notice whether the adjacent faces on rods and caps are appropriately marked, as shown in Fig. 137, if not mark with a punch, No. 1 to the front. Mark piston crowns similarly.

Big ends will not pass through liner bores nor will pistons pass crankshaft throws. Lower cylinder insert bores are slightly smaller than cylinder liner bores and pistons cannot be removed with inserts in position.

FIG. 137.
CONNECTING ROD SHOWING WEIGHT GRADE LETTER AND CYLINDER NO. MARKINGS.

Removal.

A. **Engine No. SA.23083E and future**—This procedure assumes cylinder liners have no slot in the bottom of the skirt.

1. Remove big-end cap and **bolts**—2 nuts with split pins—and carefully lift cylinder liner and piston together (using Cylinder Liner Remover FT.85, Fig. 146, if necessary). With big-end held up as high as possible in the clearance slot of cylinder block so that piston rings spring into free air and not into the cylinder block, draw off liner.
2. Fit Piston Ring Clip FT.121, shown Fig. 145, centrally over piston rings—taper leading — and slide piston assembly tool FT.109 over piston into insert recess, displacing the clip into the cylinder block.
   Remove clip from connecting rod inside crankcase portion of cylinder block.
3. With piston skirt supported in Service Tool FT.109, remove circlip from each end of gudgeon pin, using thin nosed

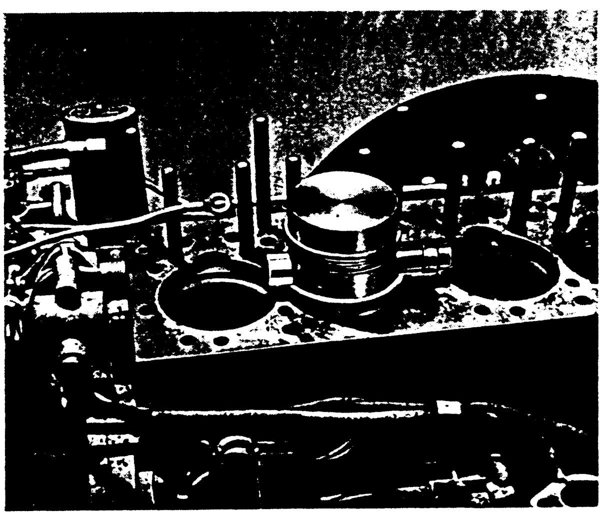


FIG. 138.
REMOVING PISTON USING PISTON ASSEMBLY TOOL FT. 109 AND GUDGEON PIN REMOVER/REPLACER FT. 111.

pliers, and tap out gudgeon pin with drift FT.111, Fig. 138.

4. Extract piston upwards and connecting rod downwards. Replace bearing cap with distinguishing marks adjacent, as shown in Fig. 137.
5. Place gudgeon pin inside piston.
6. Remove cylinder liner flange gaskets.
7. Carry out the same procedure for the remaining pistons and connecting rods.

B. **Prior to Engine No. SA.23083E**—This procedure assumes the slotted type of cylinder liner is fitted.

1. Remove big-end cap and **bolts**—2 nuts with split pins.
2. Carefully scrape carbon from top of liner bore.
3. Place Service Tool FT.109 in insert recess in cylinder block.
4. Holding Service Tool firmly in position, push piston up inside tool and big-end into clearance slot at the bottom of the liner bore.
5. With piston skirt supported in Service Tool remove circlip from each end of gudgeon pin and tap out gudgeon pin with drift FT.111, Fig. 138.
6. Extract piston upwards and connecting rod downwards.

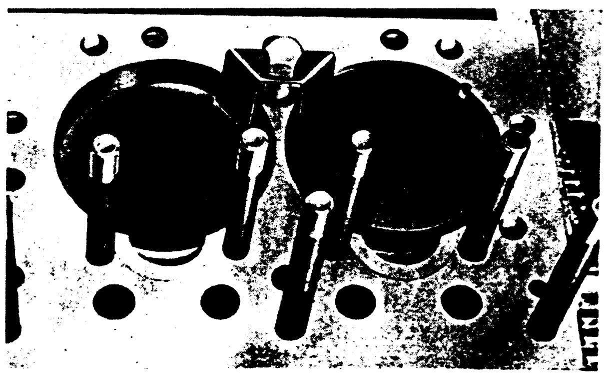


FIG. 139.
CYLINDER LINER RETAINER FT. 112.

7. Secure cylinder liner by means of Retainer FT.112 with screw through appropriate stud hole, Fig. 139.
8. Carry out same procedure for remaining pistons and connecting rods.

To Remove Cylinder Liners see page C127.

Warning.

Driving out gudgeon pins without the piston being supported in FT.109 could easily break off the cylinder liner flange.

PISTON ASSEMBLIES.

The piston has been so designed that at working temperature the gudgeon pin is fully floating in the connecting rod bush and piston. Consequently, at normal room temperature the fit of the gudgeon pin in the piston will be very tight. To facilitate refitting gudgeon pins, an approximation to engine working temperature must be brought about, so that the piston will expand sufficiently to enable an easy insertion of the gudgeon pin.

Accuracy of piston fit in cylinder liner is ensured by grading these components in two grades "F" and "G" which is stamped on the piston crown and marked on the liner outer surface. Details of piston and liner sizes are contained in Section B pages B14 and B15.

A piston should on no account be fitted in a liner of a different grade, although it is, of course, permissible to use paired pistons and liners of different grades in the same engine.

Gudgeon pins with bores greater than $\frac{1}{2}''$ (12.7 mm.) should be discarded and $\frac{1}{2}''$ bore gudgeon pins, stamped "Part No. 105317 EN 352" substituted. The gudgeon pins fitted, however, are specially selected to suit the pistons and they should not be refitted indiscriminately to other pistons within the set.

Whenever a piston has been removed it is always advisable to renew all rings. Moreover, parallel 2nd and 3rd compression rings, as fitted to engines prior to No. SA. 28867E should be replaced by tapered periphery rings Part No. 108644 and a chromium plated top ring fitted. On well run in engines a tapered periphery ring may also be fitted in the top groove. Tapered rings are marked "T" denoting the taper and must be fitted with "T" upwards.

For service purposes, piston rings, +.010" (.254 mm.) oversize are available for use in cylinder liners, which have worn more than .010" (.254 mm.) on diameter. When these are fitted, it is most important for the ring gap to be set to suit the minimum diameter of the bore within the ring travel.

CONNECTING ROD ASSEMBLIES.

Equalisation of Weights.

The maximum permissible variation in connecting rod total weights is $1\frac{1}{2}$ ozs. (42.5 grm). A replacement must, therefore, match those fitted to within this limit. For identification purposes connecting rod assemblies on later engines have a weight grade letter "N," "P," "Q," "S," "T" or "U" stamped on the rod as shown in Fig. 137. Each letter denotes a weight range in $1\frac{1}{2}$ oz. (42.5 grm.) increments between 2 lbs. 11 ozs. and 3 lbs. 4 ozs. (1219 — 1474.2 grms.) The replacement then must be of the same grade letter as those already fitted.

Fine adjustment to connecting rod weights is obtained by removing metal off the web on the cap.

Suiting Connecting Rods and Big End Bearings to Crankshaft Fillet Radii.

Modifications increasing the fillet radii of crankshaft crankpins have necessitated a corresponding increase in the chamfer of the connecting rod big-ends and reduction in the width of big-end bearing liners.

Care must be exercised, therefore, whenever crankshafts are renewed or reground on engines prior to Engine No. SA.13999E, to ensure that the chamfer in the big-end bores of all the connecting rods is increased to .120"/.130" (3.05/3.3 mm.) at 90° (included). This modification will suit all conditions and must always be effected.

The narrow type big-end liners, 1.05"/1.06" (26.67/26.9 2mm.) wide, are the only type now being supplied for replacements and they can be used without reservation.

If a new piston or connecting rod is to be used they should be clearly marked to indicate their intended position.

DISMANTLING AND RE-ASSEMBLY OF PISTONS AND CONNECTING RODS.

After removal of assemblies proceed as follows :—

Piston Assembly.

1. Remove piston rings.
2. Scrape off carbon and wash in paraffin. Pay particular attention to the ring grooves and oil return holes.
3. Using Piston Ring Gauge FT.123, check the fitted gap of all rings with a feeler gauge, see Fig. 140, as follows :—

(*a*) Place ring gauge on a flat metal surface plate and press ring into the gauge against the plate so that the ring is square in the bore.

FIG. 140.
CHECKING PISTON RING GAP USING RING GAUGE FT. 123.

(*b*) The gap of a new ring should be within .009"/.014" (.229/.356 mm.) If the gap exceeds .029" (.737 mm.) the ring must be scrapped.

4. Replace rings ensuring that tapered compression rings are fitted with " T " mark upwards.

REMOVING AND REPLACING GUDGEON PIN BUSH.

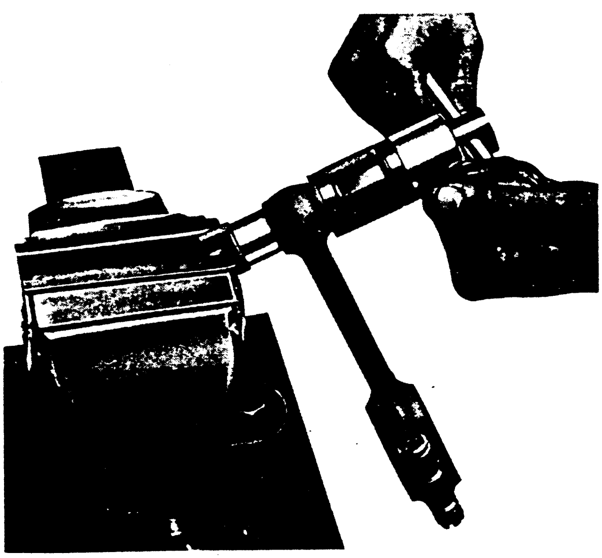


FIG. 141.
RENEWING GUDGEON PIN BUSH. SERVICE TOOL 20S FT.6201 WITH ADAPTORS 9 AND 10.

1. Using Service Tool 20S FT.6201, with adaptors 9 and 10, mounted in a vice as shown in Fig. 141, remove old bush by pressing the replacement into position. The oil hole in the new bush must first be carefully aligned with the drilling feed in the shank of the connecting rod.

2. Treat remaining rods similarly, each time making sure that the bush previously withdrawn has been extracted from the remover.

Before reaming new gudgeon pin bushes it is essential to check the connecting rod for misalignment.

TO ALIGN CONNECTING RODS.

A connecting rod dismantled from an engine should always be checked for straightness and alignment before re-assembly and also before attempting to ream a small end bush. Refer to Fig. 142.

1. Remove big-end bearing liners, wash connecting rod in paraffin and mount vertically on the largest diameter of Arbor FT.335A.

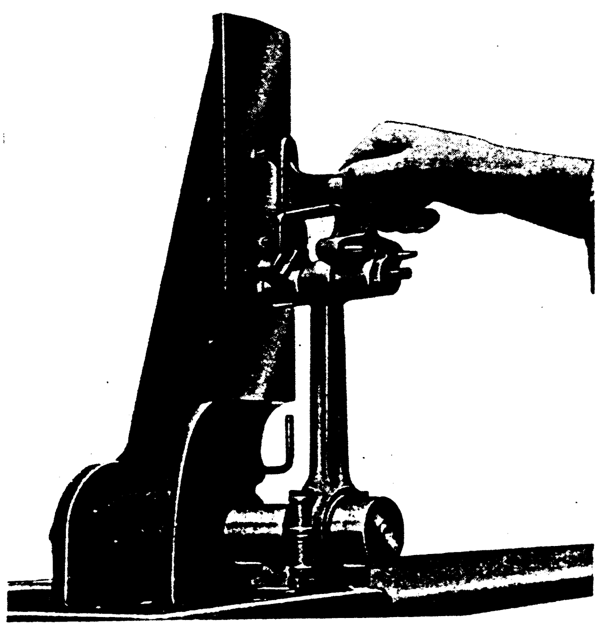


FIG. 142.
CHECKING ALIGNMENT OF CONNECTING ROD WITH ALIGNING JIG NO. 335, ARBOR FT. 335A, DUMMY GUDGEON PIN AND INDICATOR NO. 6202.

2. Fit coned ended halves of Dummy Gudgeon Pin No. 6202, into each side of the small end bush and secure on the threaded shaft by the thumb screws.

3. Place Indicator " Sealion " horizontally across Dummy Gudgeon Pin. Any misalignment in the vertical plane will be apparent between the surface plate of the jig and the indicator studs. By reversing the Indicator any misalignment in the lateral plane will be shown.

4. To correct a misaligned rod, locate the appropriate jaw of Wrench No. 30A, approximately centrally about the rod and bend or twist as necessary.

TO REAM GUDGEON PIN BUSH.

It is essential that the connecting rod is first tested for misalignment and if necessary correctly aligned, see above.

Using Fixture FT.6200A and Reamer Set FT.6200.AD proceed as follows with reference to Fig. 143.

1. Assemble connecting rod in fixture and secure nut adjoining angular collar, leaving nut at back of fixture finger tight.
2. Remove slip bush (A) and pass centraliser (B), with bearing surfaces oiled, through bushes of fixture and small end bush of connecting rod until there is a small even clearance between small end and centraliser.
3. Bring support (C) into contact with the small end boss of connecting rod (not the bush) and clamp.
4. Twist centraliser and at the same time apply as much forward pressure as possible.
5. Securely tighten nut at rear of fixture.
6. Bring support (D) into contact with the connecting rod and tighten clamp.
7. Remove centraliser.
8. Obtain reamer marked " **rough**." Apply thin oil to pilots and insert reamer into bushes in fixture. Apply **paraffin** to cutting teeth and in the small end bush.
9. Proceed with the cut, applying a slight forward pressure until cutting edge is protruding as far as possible through the small end bush, taking care that front of teeth do not foul the small bush in fixture. Then remove swarf from teeth and withdraw by continuing to turn in clockwise direction and applying a slight backward pressure. Take care that teeth are not damaged against the hardened steel bushes.

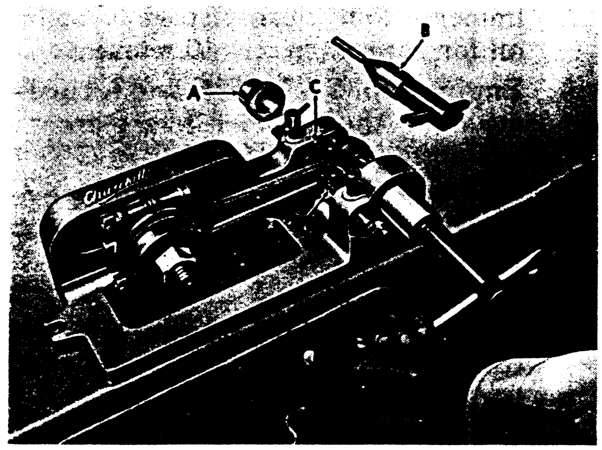


FIG. 143.
REAMING GUDGEON PIN BUSH. FIXTURE FT. 6200A WITH REAMER SET FT. 6200 AD.

10. Repeat 8 and 9, using a reamer marked " **low.**"
11. Loosen nut adjoining angular collar and supports, swing up connecting rod and attempt to fit the gudgeon pin. If satisfactory, proceed with paragraph 17. Otherwise proceed to next paragraph.
12. If gudgeon pin was too tight, centralise again and repeat paragraphs 8 and 9, using " **low** " reamer a second time.
13. As paragraph 11.
14. If gudgeon pin was too tight, centralise again and repeat paragraphs 8 and 9, using " **high** " reamer.
15. As paragraph 11.
16. If gudgeon pin was still too tight, centralise again and repeat paragraphs 8 and 9 using a " **high** " reamer for a second time.
17. Remove connecting rod.

Great care and patience has been given to the sizes and design of these reamers and it is most important that the same is accorded to the reaming operation, to obtain the very accurate fit required by the gudgeon pin.

A good fit can best be confirmed if, with the gudgeon pin oiled and held in a soft jawed vice, the connecting rod, after being worked a few times by hand, will barely fall under its own weight.

TO ASSEMBLE PISTONS AND CONNECTING RODS.

(See also Page C134)

After ensuring that all components and the cylinder block bores are clean and free of carbon, proceed as follows :—

1. Place four gudgeon pins on bench in correct order.
2. Immerse four clean pistons in boiling oil for approximately 10 minutes.

A. **Engine No. SA.23083E and future**—assuming the cylinder liners are the unslotted type.

1. Fit Piston Assembly Tool FT.109, over new liner gasket in cylinder block recess.
2. Remove big-end cap and **bolts** of connecting rod to be fitted. Hold up connecting rod inside appropriate bore with big-end in clearance slot of cylinder block and support appropriate piston with skirt inside Service Tool FT.109. Align small end with holes in gudgeon pin bosses using Gudgeon Pin Pilot FT.110, then press in pin with drift FT.111. See Fig. 144 and 138.

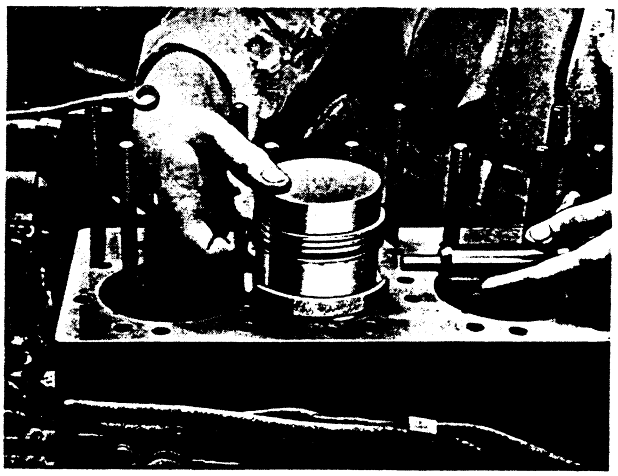


FIG. 144.
FITTING PISTON USING PISTON ASSEMBLY TOOL FT. 109 AND ALIGNING LITTLE END WITH GUDGEON PIN PILOT FT. 110.

3. With thin nosed pliers insert both circlips.
4. Oil inside Piston Assembly Tool and then, with connecting rod supported, pull off tool, taking care not to damage the piston rings.
5. With piston protruding through cylinder block, fit Clip FT.121 — taper leading — centrally over piston rings and, with connecting rod still supported from below, fit cylinder liner over piston, pressing Clip off piston, allowing cylinder liner to house the piston rings. See Fig. 45.

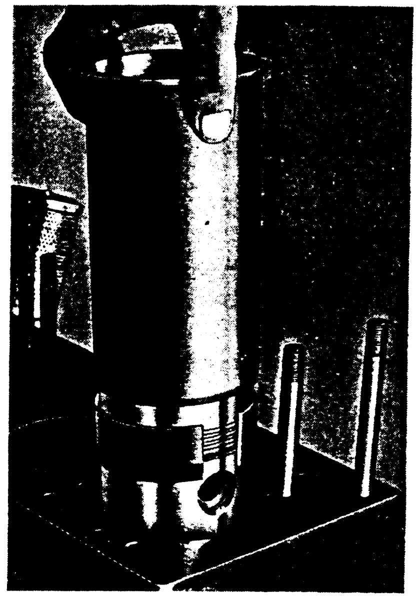


FIG. 145.
FITTING CYLINDER LINER WITHOUT SLOT IN SKIRT USING PISTON RING CLIP FT. 121.

6. After ensuring that all piston rings have been located inside cylinder liner, assemble liner and piston together into cylinder block. Remove clip off connecting rod from inside crankcase portion of cylinder block.

B. **Engines Prior to No. SA.23083E**—Assuming the slotted type cylinder liners are already fitted see page C127.

1. Place Service Tool FT.109 in cylinder insert recess on to liner flange.
2. With connecting rod held up inside appropriate bore—big-end, without bolts, in clearance slot in liner—and appropriate piston supported in FT.109, fit gudgeon pin using Service Tools FT.110 and FT.111 as recommended A para 2 above.
3. Insert circlips using thin nosed pliers.
4. Oil inside piston assembly tool and around piston rings and press piston and connecting rod down into the liner bore. The internal taper at the top of FT.109 eliminates the use of a ring clamp.
5. Remove Service Tool FT.109.

To Complete Assembly.

1. Fit liner retainer FT.112, Fig. 139, to prevent the liner being lifted by the piston when the crankshaft is rotated during re-assembly of the remaining pistons and connecting rods.

2. Mount bearing liner in cap and rod locating on notches. Upper and lower halves are identical and, if the original bearings are to be used again, it is recommended that the half with the most wear is located in the bearing cap.
3. The crankshaft should be turned so that the crankpin intended for connection is positioned at the bottom of its stroke. Smear crankpin with oil and pull connecting rod into position. Fit big end and offer up bearing cap with identification marks adjacent, fit bolts, nuts, tighten to torque reading 65 — 70 lb. ft. (9.0 — 9.7 kgm.) and insert split pins.
4. Treat remainder of pistons and connecting rods similarly.
5. Remove Liner Retainers, replace cylinder inserts page C121 and re-assemble engine pages C109 and C110.

WITHDRAWAL AND REPLACEMENT OF THE SLOTTED TYPE CYLINDER LINERS.

Preliminary dismantling :

Remove :

(*a*) Cylinder head and inserts, pages C107 and C120.

(*b*) Pistons and connecting rods, page C121.

Withdrawal.

1. Remove liner retainers, if fitted.
2. Lift out liners, if necessary using soft metal drift FT.85, Fig. 146, which is designed to suit the liner base.
3. Remove liner flange gasket.

Note :—The copper flange gasket must be renewed whenever the liner has been lifted or disturbed.

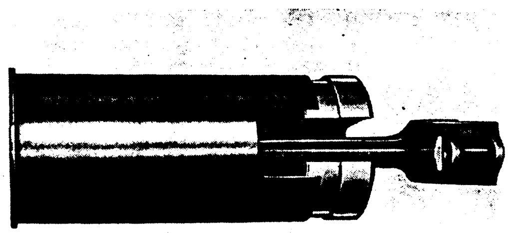


FIG. 146.
CYLINDER LINER REMOVER FT. 85.

Replacement.

Before re-assembly, remove all carbon and grit in the cylinder block and liners, paying particular attention to both sides of the liner flange, the ledge on which it rests and the recesses for the cylinder inserts.

1. Place new copper gasket on ledge of insert recess.
2. Oil around outside of liner and lower carefully into its original position in the cylinder block, taking care that the slot at the base corresponds with the slot in the cylinder block on the camshaft side.
3. Fit pistons and connecting rods page C126 or C134.
4. Fit cylinder liner inserts page C121.

Interchangeability of Slotted and Unslotted Cylinder Liners.

Slotted and unslotted cylinder liners will interchange provided the appropriate upper insert is fitted to compensate for the thicker flange of the latter type liner. The incorrect combination of upper insert and cylinder liner will be apparent as the insert will stand proud or below the top face of the cylinder block by approximately .10″ (2.54 mm.)—this is obviously unacceptable.

USE OF DISMANTLING STAND

For all subsequent dismantling and assembly operations described in this section, the engine should be removed from the tractor. The use of the Tractor Dismantling Stand FT.27A—which includes modifications and additions to FT.27 to suit the diesel engine —is strongly recommended and will be assumed.

ENGINE REMOVAL AND REPLACEMENT.

1st Operation Fig. 147.

1. Disconnect right-hand battery earth lead, drain radiator and cylinder block by opening drain taps and removing radiator filler cap.

2. Lay long rail Pt. 1 centrally beneath tractor, extending rearwards from just behind the engine to transmission mounting flange and with rail link pins to the front.

3. Place trolley jack with cup shaped cradle Pt. 47, underneath the transmission front drain plug and raise until weight is only just relieved from the front wheels—check by feel of steering wheel. Throughout the entire splitting and re-assembly, adjustment of this jack must not be altered—see Note below.

4. Disconnect radiator tie-rod, top and bottom hoses and detach hood stays from front of main fuel tank.

5. Disconnect steering drag links at rear from drop arm taper pins. Until drag links are reconnected on assembly care should be taken that the drop arms and steering wheel are not disturbed.

6. Disconnect radius rods at rear by removal of footrests.

7. Remove four large and two smaller bolts securing front axle support to crankcase and sump respectively.

8. Draw assembly, comprising front axle, radiator, hood, radius rods and track rods, clear.

9. Position stands, with Engine Brackets Pts. 61 and 62 fitted, on each side of the engine, fixed mounting plates to the front. The rear, detachable, plates should be removed until the engine has been uncoupled from the Tractor.

2nd Operation. Fig. 148.

1. Using stand wing nuts, accurately adjust brackets to the engine height and secure front mounting plates to crankcase with four large bolts previously removed from front axle support. Do not use spring washers. Ensure all four bolts are located before tightening stand wing nuts.
2. Roll tractor rearwards, drawing stands towards front of long rail and lay short Pt. 66 between the feet, located in the slots, and link on to the first rail.
3. First remove four screws on flat washers attaching rear of sump to transmission flange, then position trolley jack with cradle Pt. 63 under engine sump, adjust so that support comes in contact with flange at rear of sump and raise until load is only just felt.

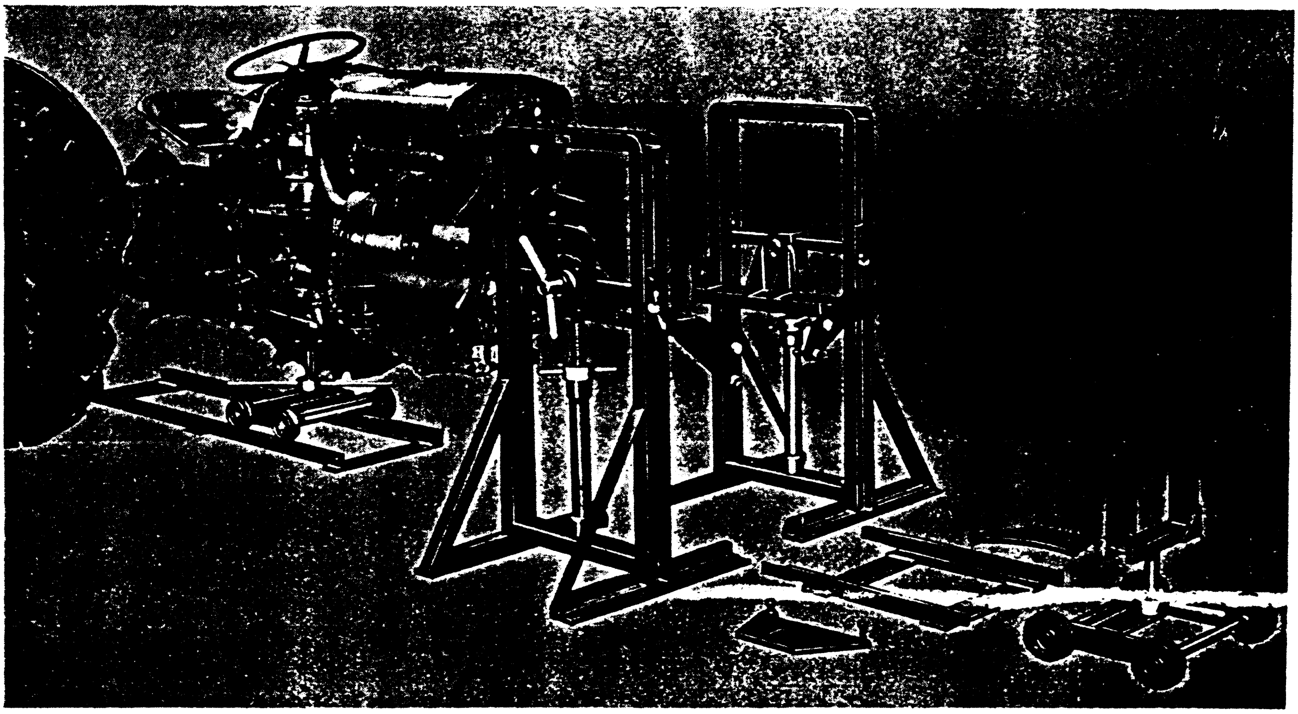


FIG. 147.
MOUNTING ENGINE ON STAND. 1ST OPERATION.

Note :—Subsequent uncoupling of the engine will be facilitated if alignment is maintained by the weight being evenly distributed between the two jacks.

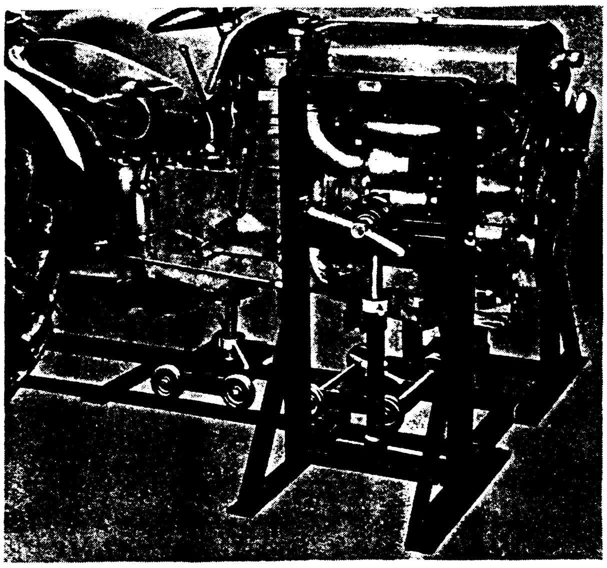


FIG. 148.
MOUNTING ENGINE ON STAND. 2ND OPERATION.

To Uncouple Engine from Transmission.

Remove main fuel tank, see page C107. Remove air pre-cleaner and pipe with bracket ; exhaust pipe, detaching clip.

Disconnect :—

Fuel pipe to injector pump at filter.

Fuel cut-off control link—split pin with washers—unhook return spring and pull rod rearwards.

Idling control link rod—nut from ball joint.

Lead to heater plug and fuel line connection to kigass atomiser.

Governor vacuum pipe from venturi.

Sleeve coupling external decompression operating shaft—two taper screws. (On tractors prior to Serial No. 301185, the shaft must be dis-connected from the front decompression handle operating lever).

Decompression link rod at rocker cover—split pin with washers.

Electrical leads at dynamo, starter motor pilot switch and, after tractor Serial No. 326889, solenoid, with two cable clips from manifold attachment. Do not alter the setting of the pilot switch on the starter motor.

Starter motor operating rod—split pin and clevis pin. Do not alter the length of this rod.

Remove :—

Starter Motor—one nut from stud and remaining screw with lockwashers.

Oil gauge pipe from oil gallery and union connection in front of auxiliary support bracket assembly with clip off engine mounting screw.

Remainder of engine mounting screws and nut off stud at top of flange all with lockwashers.

Top and bottom nuts attaching venturi to inlet manifold. These will have to be fed off as the engine is separated.

Push tractor rearwards, separating the transmission from the engine off two dowels in the engine flange.

3rd Operation Fig. 149.

1. Fit rear attachment plates, securing engine with 4 — 7/16" x $1\frac{1}{2}$" bolts and nuts.

2. Ensure stand wing nuts are tight with the latch engaged then remove jack from beneath engine sump.

The engine can now be pivoted and locked in required positions.

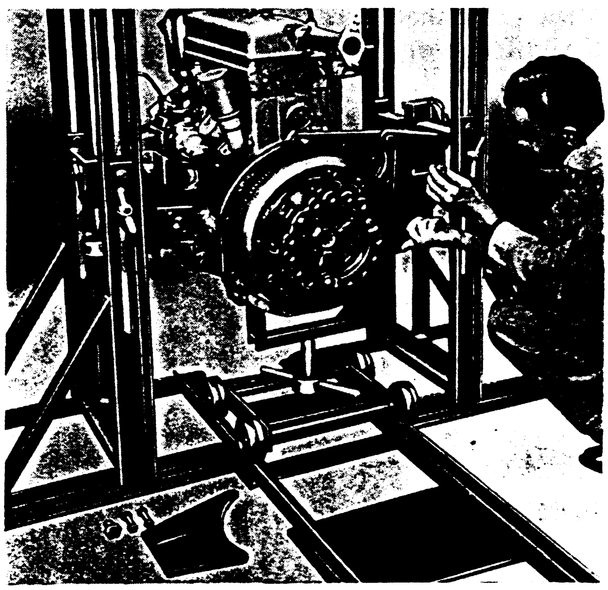


FIG. 149
MOUNTING ENGINE ON STAND. 3RD OPERATION.

Engine Replacement.

Procedure for engine mounting is a reversal of that given for removal. Before removing rear attachment plates, Fig. 149, ensure that the weight of the engine is just supported by jack located at the rear of the sump flange.

When securing engine, note that :—

(*a*) The transmission case is an electron casting and the gasket, set screws, studs and bolt should, therefore, be scraped clean and coated with "Titanine" before mounting the engine.

(*b*) To align clutch friction plate with main drive shaft splines, it will probably be necessary, as the rear half is pushed forewards, to crank the engine slowly, with low gear engaged, until engagement is felt.

(*c*) Feed on nuts attaching venturi to inlet manifold before engine is secured.

(*d*) Take care not to disturb the setting of the starter motor pilot switch or operating rod.

When replacing front axle support, the heads of the four large bolts should be to the front, while those of the two small bolts should be to the rear.

CRANKSHAFT AND MAIN BEARING HOUSINGS

Whenever crankshaft or main bearings are to be removed, the engine should be completely dismantled for renewal of oil seals and cleaning of all components connected with oil and water distribution.

Advantage should also be taken of the crankshaft reconditioning service operated by the makers. Journal and crankpin bearing liners are available .010", .020", .030", .040" (.254, .508, .762, 1.016 mm.) undersize and also .060" (1.524 mm.) undersize for the crankpin only.

If the crankshaft is renewed or reground or if the front or rear main bearing housings are renewed, the replacement must be compatible with the other two components, see table below. A modification increasing width of the crankshaft front and rear webs was introduced at engine No. SA.6154E. This required modification to the front and rear main bearing housings.

Crankshaft Part No.	*Fitted up to Engine No.*	*Front Bearing Housing Pt. No.*	*Rear Bearing Housing Pt. No.*
58273	SA.6153E	102216 or 104623	104051
300869	SA.6154E to SA.13998E	104623	104274
301133	SA.13999E and future	104623	104274

Important.
Refer also to page C123 "Suiting Connecting Rod Big-End Bearings to Crankshaft Fillet Radii."

Preliminary Dismantling.

Remove :—

Engine and mount on dismantling stand—see pages C127 to 129.

Clutch—6 set screws on lockwashers.

Cylinder head—see page C107.

Cylinder inserts—see page C120.

Big end caps and bolts of connecting rods and push connecting rods and pistons as far as possible up into liners.

Timing cover, camshaft, tappets, chainwheels and lubricating pipes—see page C115.

Oil pump and drive gears—see page C103.

Dynamo and Bracket.

Oil filter assembly—4 set screws on lockwashers.

Flywheel—6 set screws locked in pairs, tap off dowel in crankshaft end flange.

Injector pump and attachments.

Tappet cover and oil filler and breather assembly.

REMOVAL OF CRANKSHAFT AND MAIN BEARING HOUSINGS.

1. Remove front main bearing housing and gasket, six set screws on lockwashers.
2. Remove rear oil seal cover with gasket, complete with seal—8 set screws with lockwashers. Renew oil seal as recommended below.
3. Invert engine in stand and remove special bolt with lockwasher securing centre main bearing housing in cylinder block.

It is recommended that the crankshaft assembly is drawn out of the crankcase with the aid of a hoist, with the sling fastened on to the end of the flywheel spigot by means of a suitable attachment plate held by two screws, see Fig. 150. This will avoid the risk of damaging the bearing housings or crankcase by attempting to lift the heavy assembly out manually.

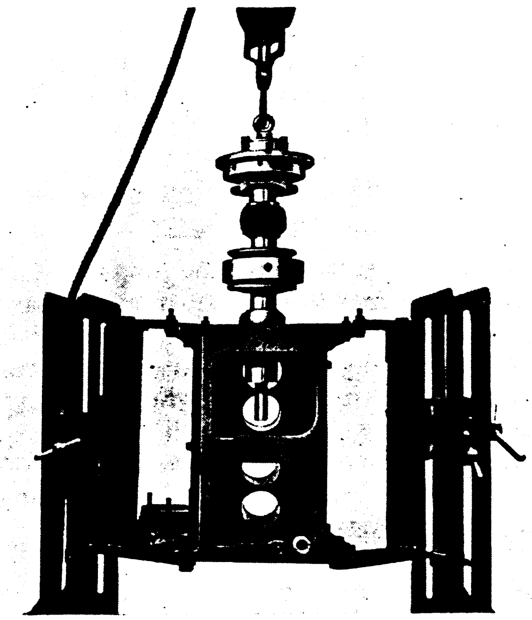


FIG. 150.
LIFTING CRANKSHAFT ASSEMBLY FROM CYLINDER BLOCK.

4. With the rear of the crankcase up-ended in the stand, carefully draw the crankshaft assembly upwards, guiding webs through the centre partition.
5. Draw out piston and connecting rod assemblies through the crankcase portion of the cylinder block and lift out cylinder liners and flange gaskets.
6. Using Service Tool FT.113 (FT.86 up to Engine No. SA.306E) shown in Fig. 155, unscrew socket screws attaching upper and lower halves of all bearing housings and extract bearing liners.

RENEWAL OF CRANKSHAFT REAR OIL SEAL.

1. Drive out oil seal from cover, using Remover Adaptor, Service Tool FT.104, with Universal Handle No. 550, as shown in Fig. 151.

Important.

Before fitting, the new seal must initially be opened out by passing it up over the taper of Service Tool FT.105A/1, oiled, with **lip trailing**. This will ensure the leather is not creased during assembly.

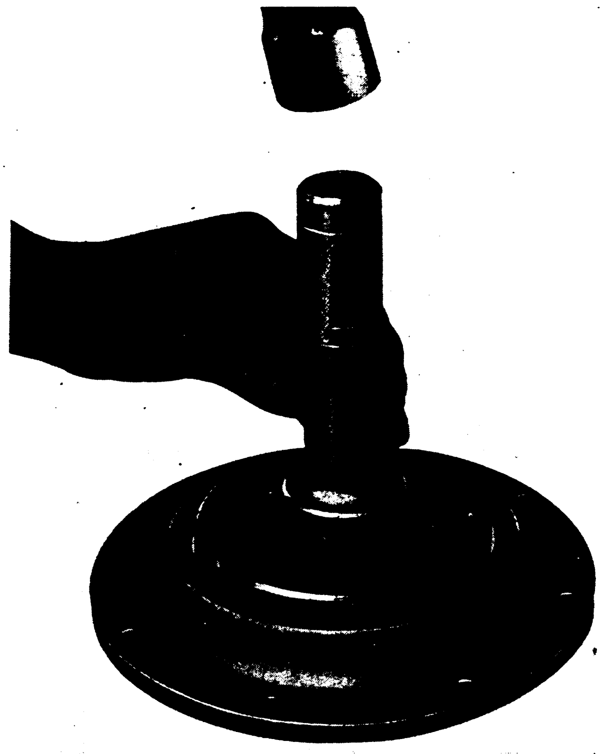


FIG. 151.
REMOVING CRANKSHAFT REAR OIL SEAL. SERVICE TOOL FT. 104 WITH HANDLE NO. 550.

2. Then mount FT.105A/1 over Replacer Adaptor FT.105B/2 as shown in Fig. 152. Using taper of the former as a guide, press new seal, **lip leading,** on to the Replacer Adaptor.

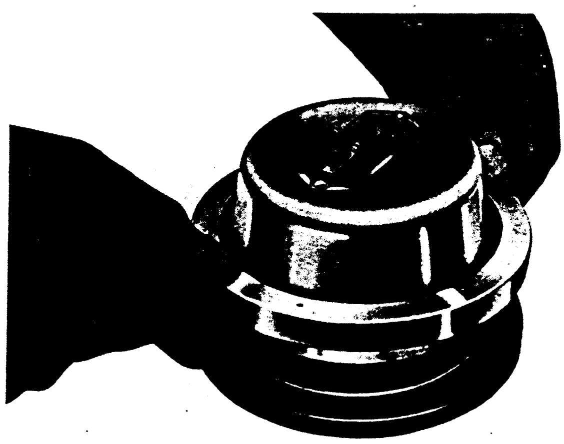


FIG. 152.
FITTING NEW REAR OIL SEAL ONTO REPLACER ADAPTOR FT. 105B/2 USING FT. 105A/1 AS GUIDE.

3. With seal mounted on the Adaptor FT.105B/2, using Handle No. 550 drive seal into place from inside of cover. The replacement is, in principle, similar to removing, Fig. 151.

Warning.

To prevent damaging the seal during replacement, it is most important to use the appropriate replacer and to avoid continuing to hammer the seal once it is in position. The latest adaptor FT.105B/2 incorporates a stop, which butts on the front cover just before the seal contacts the shoulder.

FRONT BEARING HOUSING.

Examine the oil pump recess in the front bearing housing. It is most important for this recess to be free from grooves or wear as the oil inlet and outlet ports are adjacent and seepage across the face of the pump inner rotor will mean loss of oil pressure. See Fig. 102.

1. If necessary, skim the face of the recess clean, at the same time refacing the oil pump mounting face on the front bearing housing to compensate for the increase in depth, using Service Tool FT.142 in conjunction with the Hand Machining Equipment FT.6056. Fig. 153.

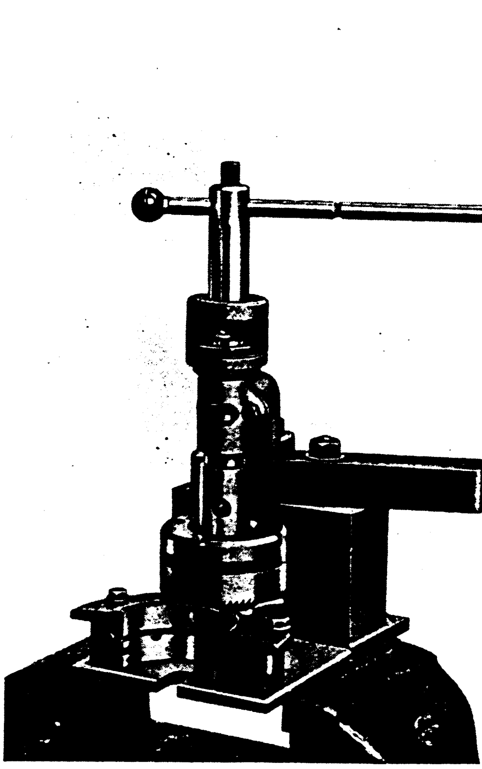


FIG. 153.
FACING WORN OIL PUMP RECESS IN FRONT BEARING HOUSING SERVICE TOOL FT. 142 WITH HAND MACHINING EQUIPMENT FT.6056.

It is essential to load the Cutters by applying the knurled screw feed and to **complete the operation with the Cutters still loaded.** Remove only sufficient metal to produce a smooth flat surface on the bottom face of the recess. If there is any danger of the cutter fouling the end of the spindle bush, the bush should be removed as instructed on page C103.

2. Finally remove the bearing housing and re-chamfer the mouth of the recess to .025″/.035″ (.63/.89 mm.) at 45°.

Note :—This operation will reduce the length of the bore for the pump spindle bush. Ensure, therefore, that the bush is not now, or when replacements are fitted, protruding at either end. If so, the bush should be shortened.

REPLACEMENT OF CRANKSHAFT AND MAIN BEARINGS.

Before re-assembly of the engine, closely examine all machined faces of crankcase and cylinder block and remove all traces of dirt, carbon, sealing compound or old gasket material. After thoroughly washing in paraffin, blow out all oil galleries and passages with compressed air. (See "Lubrication System" page C101). Remove oil gallery plugs before blowing out.

Re-assembly should not commence until you are absolutely certain that cylinder block and crankcase are absolutely clean.

Before fitting crankshaft, bearing housings, new bearing liners and thrust washers, they should be washed thoroughly in paraffin and smeared with engine oil. All oilways in crankshaft and bearing housings must be completely clear and blown through with compressed air.

Note :—Centre bearing liners which carry the heaviest load are .1″ (2.54 mm) wider than the centre and rear liners which are identical.

Proceed as follows :—

Important.

It is essential to use a torque spanner, set to 25 — 30 lb. ft. (3.5 — 4.1 kgm), with Service Tool FT.113 (FT.86 up to Engine No. SA.306E), when tightening the socket screws securing the two halves of all bearing housings. By this means only can the correct fit of the the main bearings on the crankshaft journals be obtained.

1. Place each main bearing liner in position by locating their notches in grooves in the two halves of the bearing housings. If the existing bearing liners are to be used again, it is recommended that the half with the most wear is fitted in the top half of the bearing housing.

2. Rear Main Bearing Housing : Fig. 154.

(*a*) Place thrust washers, oil grooves outwards, in recesses on either side of the two halves of the bearing housing, note top thrust washers have no locating tags.

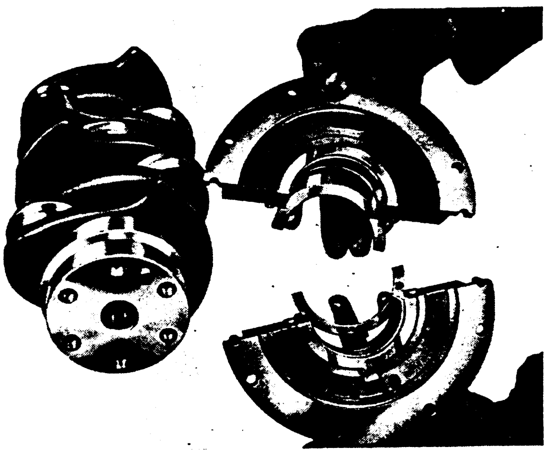


FIG. 154.
REAR MAIN BEARING HOUSING ASSEMBLY AND CRANKSHAFT.

(*b*) Mount top and bottom halves—flange to the rear—over crankshaft rear journal, with rubber dowels fitted between mating faces of mounting flange to prevent oil leaking along these surfaces, and with hollow dowels in socket screw recesses.

(*c*) Tighten socket screws on flat and lockwashers to the specified torque.

3. Centre Main Bearing Housing :

(*a*) Mount both halves of the centre main bearing housing located by hollow dowels—with liners—over crankshaft centre journal, stamped numbers, marked on the web, on the same side and bottom locating screw hole offset towards the rear.

(*b*) Tighten socket screws on flat and lockwashers to the specified torque.

4. Front Main Bearing Housing Fig. 155.

(*a*) Using soft jawed vice, assemble both halves located by hollow dowels, with bearing liners, tightening socket screws on lock and flat washers to the specified torque.

FIG. 155.
TIGHTENING SOCKET SCREWS OF FRONT BEARING HOUSING USING SERVICE TOOL FT. 113 (OR FT. 86) WITH TORQUE WRENCH

(*b*) After carefully positioning housing gasket to align with fixing screw holes, mount assembly on front face of crankcase and secure with fixing screws and spring washers. Fitting two washers beneath the top left hand screw will facilitate positioning jockey chainwheel assembly when fitting timing cover. (See page C117.)

5. Insert cylinder liners, pistons and connecting rods. (See page C134.)

6. Crankshaft :

(*a*) Lubricate all bearing surfaces and carefully fit gasket over rear bearing housing mounting face to align with the unevenly spaced fixing screw holes.

(*b*) Rear bearing housing must have the two drain holes towards the sump and small oil drilling towards the camshaft.

(*c*) Position centre bearing housing with oil drillings towards the camshaft and base fixing screw hole at the bottom.

(*d*) With the rear of the crankcase up-ended in the stand, gently lower the crankshaft assembly into position with the aid of a hoist, as previously recommended when removing, guiding webs through the centre partition and carefully inserting front journal into its bearing. See Fig. 150.

(e) Line up accurately the centre bearing housing; and, taking care not to cross the threads, insert base fixing screw with lockwasher. Tighten to a torque reading of 39 — 42 lb. ft. (5.4 — 5.8 kg.m).

(*f*) Carefully align rear bearing housing and gasket — holes are unevenly spaced to ensure correct assembly.

7. Fix gasket on flange mounting face of crankshaft rear oil seal cover, carefully aligning the unevenly spaced screw holes.

8. Slide rear oil seal and cover assembly on to spigot of crankshaft, using Service Tool FT.105A/1, well oiled, as guide to prevent damaging the seal. See Fig. 156.

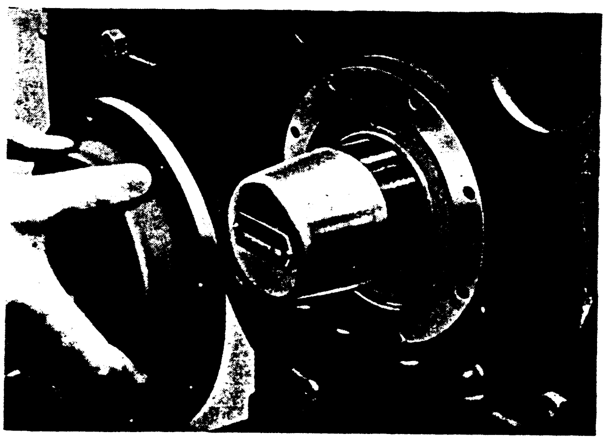


FIG. 156.
GUIDING REAR OIL SEAL AND COVER ASSEMBLY ON TO CRANKSHAFT WITH SERVICE TOOL FT. 105A/1.

9. After carefully aligning holes, insert fixing screws and secure rear bearing housing and oil seal cover assembly to the cylinder block.

10. Check crankshaft for "tight spots."

Completion of Engine Re-Assembly.
This procedure is a reverse of that given for "Preliminary Dismantling."

TO ASSEMBLE PISTONS, CONNECTING RODS AND LINERS WHILE THE CRANKSHAFT IS OUT.

Before inserting the crankshaft into the cylinder block, fit pistons, connecting rods and liners as follows :—

1. Insert cylinder liners with new flange gasket see page C127.

2. Mount each piston assembly, outside the engine, on to its appropriate connecting rod by inserting gudgeon pin and circlips.

3. Ensure that all piston rings are fitted—tapered compression rings with 'T' mark upwards—and fit piston ring clip FT.121 (illustrated in Fig. 145) centrally over the rings with the taper on the clip towards the connecting rod.

4. Insert each piston and connecting rod assembly into its appropriate liner from below.
The liner must be displaced upwards by the clip until the latter covers the clearance slot in the cylinder block at the bottom of the liner bore. Then, holding the liner, press the piston assembly well into the liner, displacing the clip so that the rings are housed inside the liner.

5. Remove clip and push piston, connecting rod and liner, as an assembly, until big-end of connecting rod is inside and as high as possible in the cast slot in the cylinder block. This position then allows crankshaft to be inserted.

REVISED SMALL END BUSH LUBRICATION.

At Engine No. SA.69601E.

The oil pressure feed from the big end of the connecting rod was deleted and the method of lubricating the gudgeon pin revised. The gudgeon pin now receives oil through a countersunk hole in the top of the connecting rod and small end bush. A second hole in the bottom of the bush connects with a blind drilling approximately $\frac{3}{4}''$ which acts as an oil reservoir.

The small end bush supplied for all service replacements has one hole with radiating oil grooves. This must fitted with the hole aligned with the existing oil feed from the big end on earlier connecting rods. On later type connecting rods, the bush must be fitted with the hole aligning with the countersunk hole in the top of the connecting rod, and a second hole drilled to connect with the oil reservoir before reaming.

COOLING SYSTEM

INDEX

COOLING SYSTEM

DESCRIPTION Fig. 1.

The system comprises four major components : radiator (11), thermostat (5), fan (25) and water pump (21). Circulation of cooling water through the radiator and jacketing is brought about principally by convection assisted by the impellor type pump.

while tendency to boil has been arrested by sealing the system, relief being obtained through a valve provided in the radiator filler cap (12). The four-bladed fan, driven by a vee-belt (24) from the crankshaft pulley (35), is mounted on the water pump spindle which runs in ball bearings. Air flow through the radiator is assisted by a fan cowl (15).

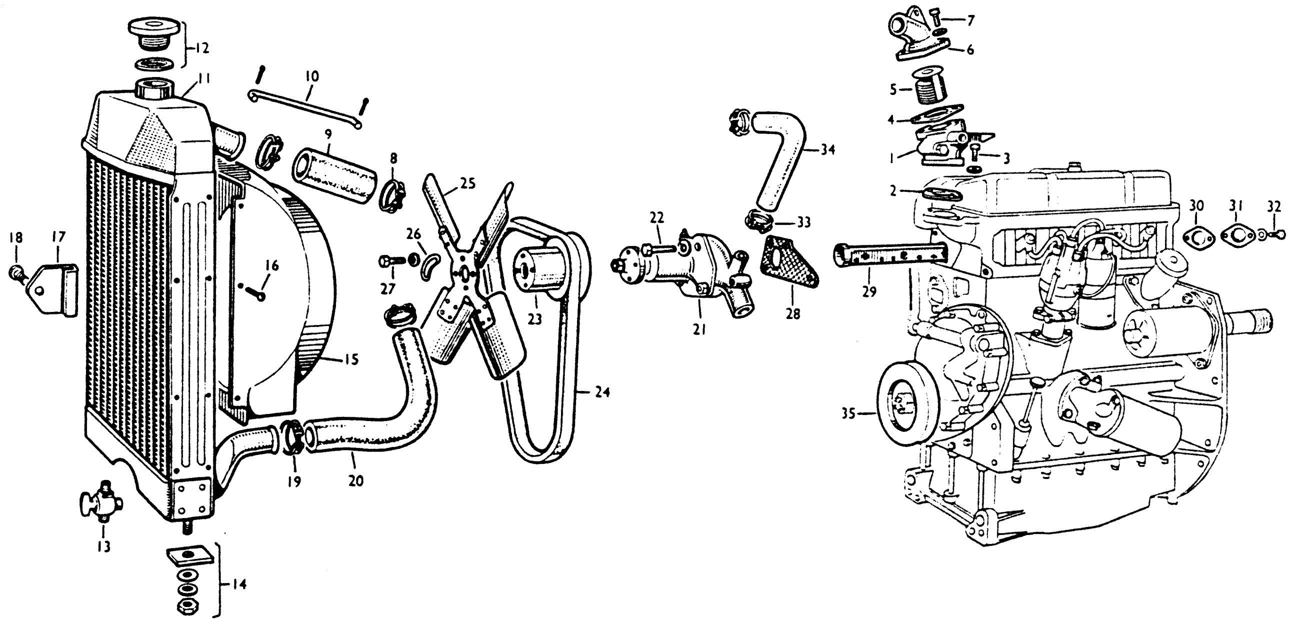


FIG. 1.
EXPLODED VIEW OF PARTS WHICH MAKE UP COOLING SYSTEM ON TE-A20 TRACTORS AFTER SERIAL No. 172,597
(USED AS A STANDARD REFERENCE THROUGHOUT TEXT).

Rapid warming up is assured by the action of the bellows-type thermostat unit, housed on the cylinder head on TE-A20, and in the top hose (9) on TE-20 Tractors,

System Capacity.

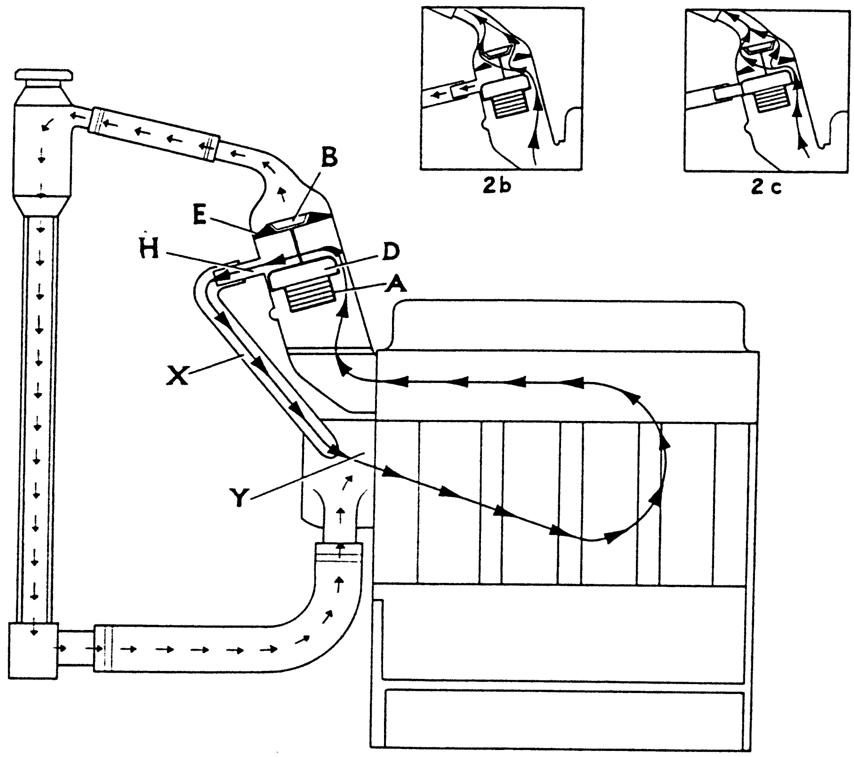
TE-20 — 20 pints (11.3 litres)

TE-A20 — 15 pints (8.5 litres)

WATER CIRCULATION
Fig. 2a, 2b, 2c.

The engine is started and cooling water is circulated into the thermostat housing (1). See Fig. 2a. Until the engine reaches the desired working temperature, valve B remains closed and the circulating water must, therefore, pass through orifice H down the by-pass pipe X (34), from the cylinder head to pump, where it is expelled by revolving impellor blades through duct Y, back to cylinder block—on later models via a cylinder head water distribution tube sufficiently to allow a small quantity of cooling water to pass into the radiator system, where it is cooled and re-circulated. As more power is taken from the engine, so water temperature continues to rise, and bellows A lifts valve B higher, so that more water is passed through the radiator, see Fig. 2b.

As the engine temperature rises to a maximum, or cooling capacity is reduced by high air temperature, the thermostat stop engages. This condition arises when water temperature around the bellows is about 77°C (171°F.). Thus, whenever water temperature is above this figure, the



2 a

FIG. 2.
SYSTEM SHOWING CIRCULATION AND OPERATION OF THERMOSTAT.

(29). The only circulation to the radiator occurs through the thermostat bleed, and the relatively small amount of water in the by-pass system is quickly heatedby the engine.

This rapid water heating continues until a temperature of about 60°C (140°F.) is reached. At this point, valve B lifts thermostat valve is fully open and has no further effect on the cooling system, which becomes a normal closed circuit, see Fig. 2c.

As the water temperature falls, so thermostat valve B closes and less water passes through the radiator to maintain the desired working temperature of 60°C. (140°F.).

Cut-off ring.

Where cut-off ring D is fitted it progressively restricts orifice H so that a smaller proportion of water by-passes the radiator, until orifice H is completely cut off, and all the cooling water is circulated through the radiator, see Fig. 2c. As water temperature falls and valve B closes, orifice H is progressively uncovered and an increasing proportion of water is allowed to by-pass the radiator.

Even when the thermostat is perfect and properly fitted, jamming may occur due to particles of dirt, scale, rust, etc. between the cut-off ring and thermostat body. In this case the cut-off ring should be removed by cutting through, midway between each spoke and twisting the sections off so that the spokes break at the centre spindle.

CYLINDER HEAD WATER DISTRIBUTION TUBE. Fig. 3.

After Tractor Serial No. 172,597 the water pump has been mounted on the forward end of the cylinder head, which is fitted with a water distribution tube (29) connecting directly to the outlet port of the pump. Thus a constant water flow is impelled through a series of holes in the tube directly on to the combustion chamber walls, exhaust valve seats and into the relatively stagnant water around the sleeves, promoting extensive and uniform cooling of the combustion chamber walls and exhaust valve seats with consequent reduction in wear.

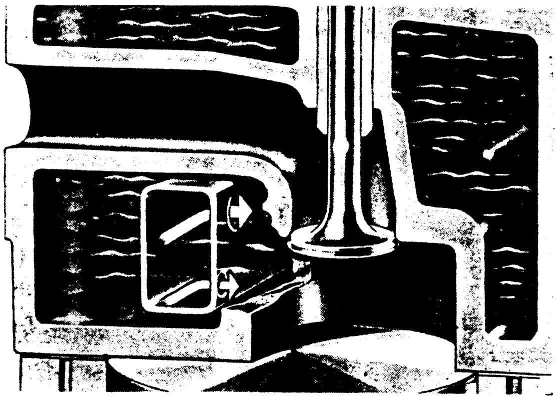


FIG. 3.
CYL. HEAD WATER DISTRIBUTION TUBE.

THERMOSTAT

Operation

TE-A20, Fig. 4.

The thermostat unit, as shown in Fig. 4 consists of bellows A containing a saturated vapour of ether or alcohol mixture or similar substance, and valve B secured to the top of bellows A by spindle C, which up to Engine No. S.85471 E also carries the by-pass cut-off ring D. Support ring E,

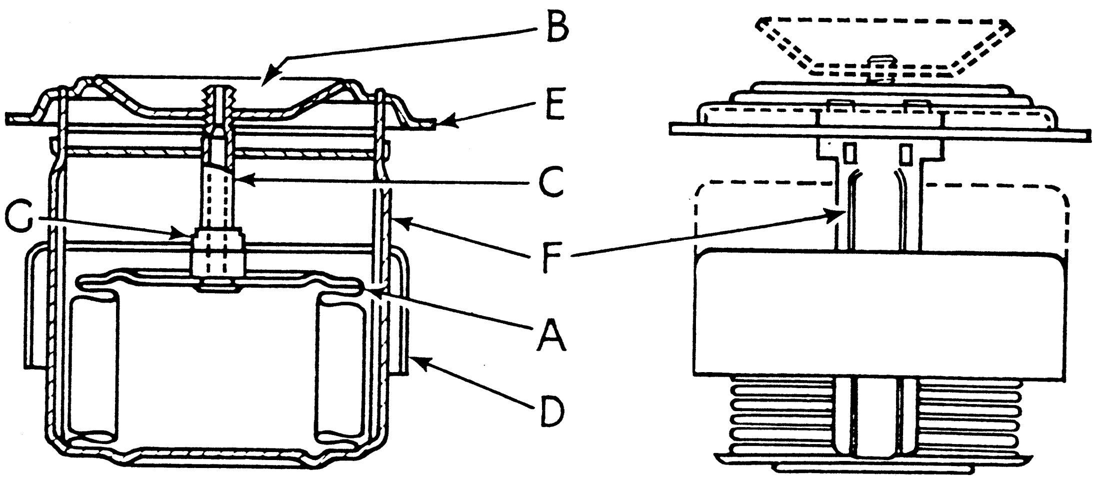


FIG. 4.
THERMOSTAT TE-A20 TRACTORS

which fits in a machined recess in the thermostat housing, incorporates a seat for valve B and carries bellows A on mounting struts F.

Bellows A is normally held compressed due to the pressure difference between atmosphere and the internal vapour pressure. When heat is applied to the bellows, internal vapour pressure increases, and at a predetermined temperature the bellows expands, lifts valve B from its seat E, (and raises cut-off ring D, if fitted). As temperature increases the bellows continues to expand until valve B is fully open, i.e. about $\frac{3}{8}$" (1 cm.) from its seat. At this point, further movement of valve is arrested by stop G.

TE-20, Fig. 5.

The thermostat unit, shown in Fig. 5, is a push fit in the top radiator hose. As there is no by-pass system between cylinder head and block, water circulation is restricted to a very small flow through the thermostat bleed hole until the valve begins to open : this takes place at 60°C. (140°F.) and maximum lift is $\frac{1}{4}$" (6.35 m.m.) at 93°C. (199°F.). Bellows A, secured to strap B expands to lift valve C off its seat on bellows case D.

The function of the water pump is similar to that described for the TE-A20 unit.

Thermostat Valve Bleed.

Valve disc B, Fig. 4 (TE-A20) or C, Fig. 5 (TE-20) has a small orifice which acts as a bleed hole when the valve is seated. This bleed has two main purposes :—

1. Prevention of an air lock—when an empty system is being filled, air trapped around the cylinder block can escape and give way to incoming water.

2. Prevention of freezing in radiator matrix—until working temperature is reached, the thermostat valve is closed, and without the bleed hole the radiator water would be stagnant and liable to freeze due to the effects of cold air drawn through by the fan.

In very cold weather, the bleed hole may be large enough to pass more than the required amount of cooling water through the radiator. Under these conditions the water will be too cool, and some benefit can be obtained from the intelligent use of a blanking plate, particularly for light work.

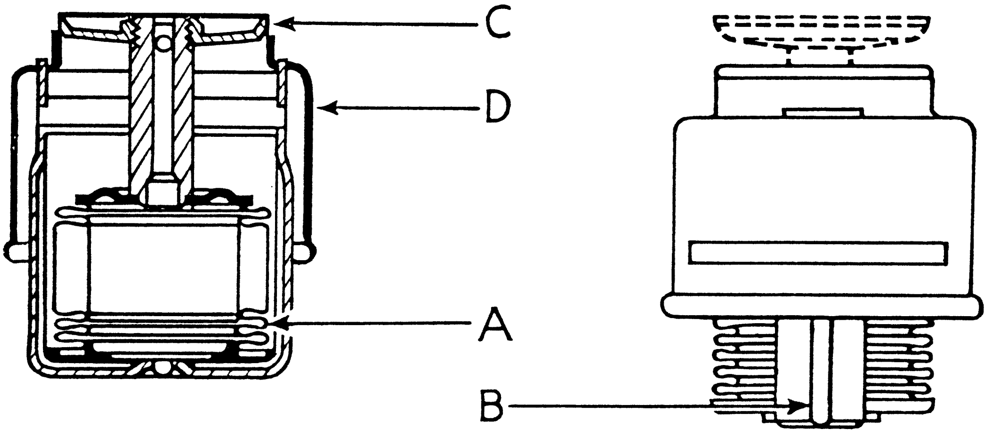


FIG. 5.
THERMOSTAT TE-20 TRACTORS

Testing the Thermostat.

Fill a quart can with clean water, immerse the bulb of a mercury-in-glass thermometer, and heat steadily while stirring. With the thermometer bulb adjacent to the bellows but not touching the side of the can, observe the valve opening temperature. To check the precise point of valve opening, gently ease the valve from its seat and trap a .002″ (.05 mm.) feeler gauge or wire. Suspend the thermostat by the feeler and as soon as the valve opens, the thermostat will fall. Continue heating water slowly and note if readings are within the required limits given in the table below. A rod of the specified dia. slipped between the valve and its seat can be used to check valve lift.

Type	Crack open. Temp.	Fully open. Temp.	Maximum Valve Lift
TE-20	60°C. (140°F.)	93°C. (199°F.)	$\frac{1}{4}$″ (6.3 mm.)
TE-A20	56°–64°C. (133° – 147°F.)	77°C. (171°F.)	$\frac{1}{4}$″ – $\frac{3}{8}$″ (6.3–9.5 mm.)

When the water has boiled, the tests should be repeated as it cools again.

COOLANT TEMPERATURE.

A constant high coolant temperature assures long engine life, smooth idling, good acceleration and good load pick up.

In cold weather, engine starting and operating will be greatly assisted if the hood grilles are blanked off. Reversing the fan will also considerably reduce the air flow through the radiator and help to maintain a high coolant temperature in cold climates. Take care to locate fan and balance piece (26) in original position. See Page D.6.

DISMANTLING AND REASSEMBLY

FAN BELT.—Fig. I.

Removal and Replacement.

On Tractors prior to Serial No. 200,001, a small plate (17) let into the right hand side of the cowl (15) can be detached after loosening screw (18) to facilitate removal and replacement of the fan belt. Belt tension must first be released by slackening dynamo mounting bolts and swinging dynamo inwards.

Important.

Replacement must be made by hand only, forcing on with a lever will damage the internal cords and considerably shorten the belt life. If necessary the dynamo must be detached to facilitate fitting.

THERMOSTAT.

Removal. Fig. I.

1. Drain water. See page D.9.
2. Disconnect radiator tie rod (10) and top hose (9) from water outlet elbow (6).
3. TE-20 : Remove radiator top hose and push out thermostat unit.

   TE-A20: After removal of two set screws (7), lift water outlet elbow with gasket (4) and remove thermostat unit (5).
4. TE-A20: Removal of thermostat body (1) entails removal of fuel tank, and "U" bolt assembly at forward end of throttle rod, which will necessitate re-adjustment of governor linkage —See Section F.

Replacement.

This is a reversal of instructions given above for removal. Care should be taken in the case of TE-20 Tractors to replace thermostat unit with bleed hole to bottom, so that the upper portion of top radiator hose can be completely drained.

WATER PUMP AND DISTRIBUTION TUBE

Removal. Fig. 1.

1. Drain water and remove radiator (11) —see page D.9.
2. TE-A20 only—Disconnect hose (34) at water pump.
3. Remove fan (25) and balancer piece (26), if fitted—4 set screws (27) on lock-washers.
4. Slacken vee belt (24) by swinging dynamo inwards on its mounting, then withdraw pulley (23) from hub.
5. At this stage either :

   (*a*) Remove assembly comprising bearing housing, gasket, with bearings, and impellor :

   TE-A20—two nuts from studs and 1 setscrew, all with lock washers.

   TE-20—3 nuts and lock washers from studs.

   or :

   (*b*) Remove pump assembly (21) complete with gasket (28) :

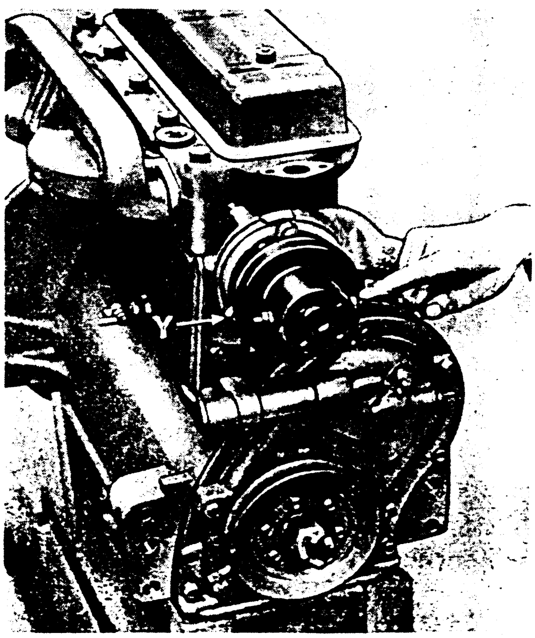


FIG. 6
TE-20 WATER PUMP PULLEY

TE-A20 (80 mm.)—3 setscrews (22), one of which may be fitted with a plain washer and lead packing washer besides lockwasher.

TE-A20 (85 mm.)—4 set screws (22), the top bearing housing set screw passes through pump body to secure both housing and body.

The water distribution tube (29) can now be withdrawn with pliers or, if seized in position, by gently drifting forwards from the rear, after removing cover plate (31) with gasket (30) held to rear face of head by two screws (32).

TE-20—nuts from 3 studs, the one marked Y, Fig. 6, being long enough to accommodate one of the securing nuts for bearing housing.

Replacement.

The procedure for replacement is reversal of that given for removal. If grease nipple is fitted to TE-A20 pump, inject with grease until it exudes from the vent hole. Alignment of pulley on tractors TE-20 can be adjusted by slackening nuts indicated by finger in Fig. 6 and twisting pulley which is held to its housing by bolts through helical slots. Balance piece (26) must be replaced with its locating hole ($\frac{1}{16}''$ dia.) in line with the hole in the fan assembly.

BEARING AND IMPELLOR ASSEMBLY. Fig. 7.

To Dismantle.

A cross-sectional view of the assembly fitted to Tractors TE-A20 is shown in Fig. 7 from which a comparison can be made between earlier and later types as illustrated respectively below and above the drawing centre line. Fig. 8 shows three seal and impellor sub-assemblies which may be encountered during dismantling. Sub-assembly B is fitted to TE-20 pumps but impellors of certain TE-A20 pumps have been modified to take type B.

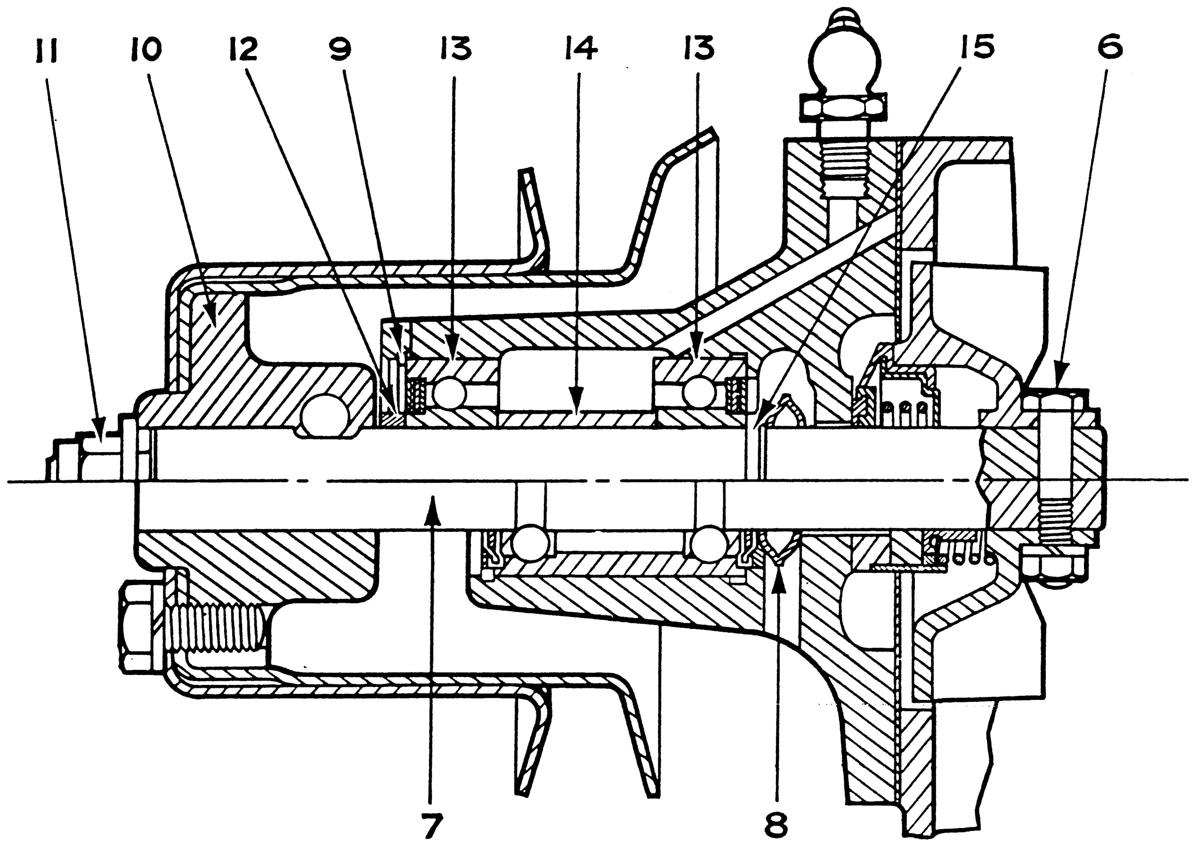


FIG. 7

SECTION OF EARLY AND LATER TYPE WATER PUMPS, ILLUSTRATED RESPECTIVELY BELOW AND ABOVE THE CENTRE LINE.

Note :

Each impellor requires its own type of seal, make sure the correct one is used when replacements are fitted.

After removal of bearing housing assembly, proceed as follows, with reference to Fig. 7 :—

1. Remove small bolt (6) securing impellor on shaft and prise or twist off impellor levering behind vanes.

2. Remove seal assembly—See Fig. 8.

3. TE-A20—Remove pinch bolt from pulley hub clamp and tap out shaft to detach hub (10). On later type bearing assemblies, a self locking nut (11) must be removed from shaft end before withdrawal of clamp.

4. Tap out bearing and shaft assembly (7) with water thrower, (8) after removal of vent plug or circlip (9). The plug is fitted on TE-A20 Tractors between Engine Nos. S57,041E and S73,526E ; it was the subject of a service modification and may therefore be found on earlier engines.

TE-A20 Later type—Distance washer (12), bearings (13), and distance piece (14) can now be pressed off shaft, after removal of retaining circlip (15).

TE-20—Tap shaft free from pulley hub.

Re-assembly.

Scrape seal contacting face of bearing housing until it is clean and smooth. Wash all components in paraffin and blow out with compressed air, smear bores of bearing housing and pulley hub with grease, then proceed as follows :—

1. TE-A20 later type—Press on bearings (13), oil seals outwards, with distance piece (14) between, locating on circlip (15), which should be mounted in groove

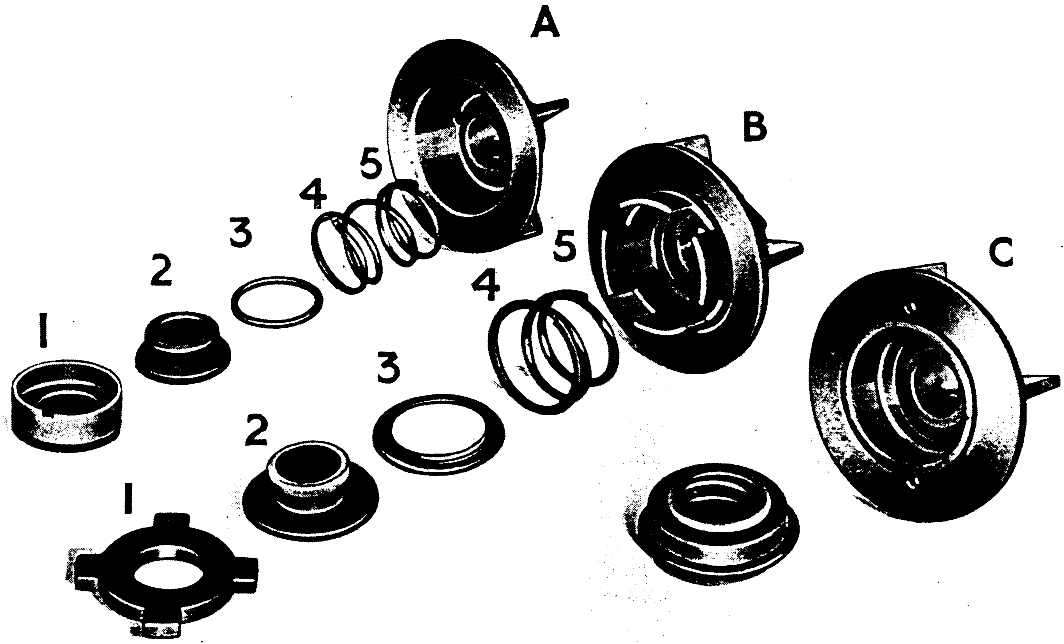


FIG. 8
WATER PUMP SEALS WHICH MAY BE ENCOUNTERED DURING DISMANTLING.

in shaft. Place outer circlip (9) over shaft end and mount distance washer (12) before fitting pulley hub (10). Tighten self locking nut (11) on shaft nose before tightening pulley hub pinch bolt.

TE-A 20 Early Type—Secure pulley hub (10) on shaft by pinch bolt.

TE-20—Press pulley hub on shaft.

2. Locate water thrower (8) on shaft against inner end of bearing.

3. Press or tap bearing and shaft assembly into housing bore, locating outer circlip (9) where necessary.

   TE-A20 only—Before pressing in earlier type assembly, align dowel hole in bearing casing with vent plug hole in housing, then locate shaft end in hole at rear of housing. After pressing bearing in position, replace vent plug.

4. Replace seal and impellor assembly—See Fig. 8.

   TE-A20 Detail A.
   Place seal (1) over rear shaft end, rubber packing (2) behind seal, brass ring (3) over packing. Locate front end of spring (4) in slot in brass ferrule of seal, mount impellor (5) on shaft, locating rear end of spring in one of the two holes drilled in impellor.

   TE-A20 and TE-20, Detail B.
   Procedure same as for detail A but spring (4) has no locating tangs, and should be placed with large diameter to brass ring (3) and impellor mounted on shaft so that notches in cup engage tangs of seal.

   TE-A20, later type, Detail C.
   Seal and spring enclosed and non-demountable.

5. Ream out impellor boss $\frac{5}{8}''$ dia. then apply a good quality flexible type jointing compound such as " White Adhesive L6."

   Secure impellor on shaft by inserting small bolt and tightening its nut on lock washer. Then apply a further coat of jointing compound to cover outside of impellor boss, bolt, nut and spindle end. Do not permit any sealing compound to contact seal.

RADIATOR ASSEMBLY

The water system is fully sealed, and can operate at pressures up to 4 lb. per square inch (.28 kg. per sq. cm.) at which the boiling point of water is about 107°C. (225°F.). Should the pressure exceed the rated figure, relief is obtained through a spring-loaded valve housed in the radiator filler cap, which allows steam or water to escape to a drain pipe.

To Drain, Remove and Dismantle Radiator Assembly, Fig. I.

1. Remove filler cap (12) and open drain tap (13) which is housed at radiator base. If the whole system is to be drained, it is essential that the cylinder block drain tap is opened as water below the level of the pump cannot otherwise escape.

2. Detach hood. This entails removal of two support attachment bolts from forward end of fuel tank and two shoulder screws from radiator support bracket.

3. Disconnect hoses (9) and (20) and remove radiator (11), which is secured to its support bracket by two nuts (14) on studs and connected to water outlet elbow (6) by a tie rod (10).

4. Detach cowl (15) by removal of seven self tapping screws (16).

5. Unscrew and remove drain tap (13).

To Reassemble.

Before refitting, the radiator should be flushed out thoroughly in the opposite direction to the normal water flow and any dirt or foreign bodies, which would restrict air flow, removed from the radiator element. The procedure for reassembly is the reversal of instructions given above.

> **Note :** The use of soft water to refill radiator and cooling system will reduce the formation of fur and scale due to mineral deposits.

PRECAUTIONS AGAINST FREEZING

Water in the cooling system should be drained if atmospheric conditions are such that any possibility of freezing is suspected e.g. when the tractor is left standing in the open over-night.

However, if anti-freeze solution is used, it is essential that the correct proportion is introduced to provide a reasonable margin of safety against an unsuspected degree of frost while at the same time ensuring satisfactory coolant circulation immediately from a cold start.

The following Data is based on information supplied by the makers of a well-known anti-freeze solution :—

"When considering frost protection at very low temperatures, it is necessary to decide whether it is desired to prevent damage caused by the expansion of the coolant when it solidifies, or whether in addition to this protection it is desired to ensure satisfactory circulation of the coolant immediately from a cold start. The need for this differentiation lies in the fact that a mixture of anti-freeze solution and water, when cooled, does not give a sharply defined freezing point but has a freezing range, i.e. when the temperature which is termed the freezing point is reached, crystals commence to deposit, but the solution does not become completely solid, and as the temperature is further lowered the concentration of crystals increases until ultimately a temperature is reached at which the whole mass solidifies."

DEFINITION OF MAXIMUM SAFE LIMIT

By Volume. Percentage.	Formation of minute crystals. Deg. of Frost. Fahr.	Slightly Mushy. Deg. of Frost F.	Hard Mush. Deg. of Frost F.
10	$5\frac{3}{4}$ (– 3°C.)	10 (– $5\frac{1}{2}$°C.)	14 (– 8°C.)
15	10 (–$5\frac{1}{2}$°C.)	16 (– 9°C.)	25 (–14°C.)
20	$15\frac{3}{4}$ (– $8\frac{1}{2}$°C.)	23 (–$12\frac{1}{2}$°C.)	39 (–$21\frac{1}{2}$°C.)
25	22 (–12°C.)	32 (–$17\frac{1}{2}$°C.)	55 (–$30\frac{1}{2}$°C.)
30	$28\frac{1}{2}$ (–16°C.)	39 (–$21\frac{1}{2}$°C.)	71 (–$39\frac{1}{2}$°C.)
	Flows freely, safe for driving.	Incapable of flowing, but unlikely to crack radiator or cylinder block.	

FLUSHING PROCEDURE

It is recommended that the following procedure is adopted both before the introduction and after the final removal of anti-freeze solution.

1. Drain the system.
2. Close drain taps and fill system with a solution of 1 lb. (.45 kg.) washing soda in water.
3. Use the tractor on normal work for 2 days.
4. Drain and flush with clean water until running clear.
5. Check and treat as necessary :—

   (1) cylinder head bolts for tightness.

   (2) water hoses for deterioration.

   (3) hose connections for tightness.

   (4) radiator for leaks.

COOLING SYSTEM

AS INCORPORATED ON V.O. ENGINE TRACTORS TYPE TE-D 20.

GENERAL

The cooling system of the V.O. tractor is very similar to that of the petrol tractor, there are, however, one or two minor variations which should be noted.

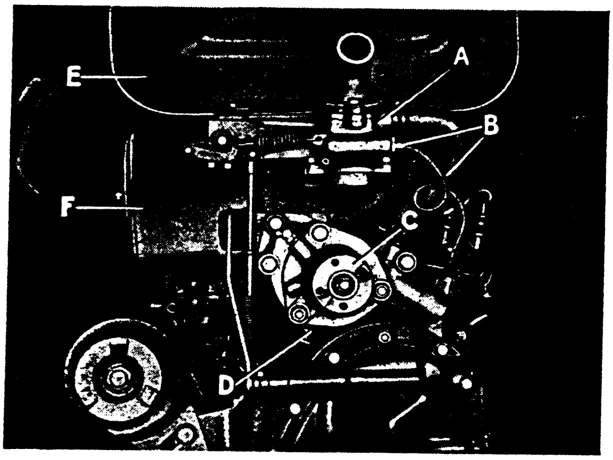


FIG. 9. FRONT VIEW OF ENGINE.

KEY TO ANNOTATION

A. Thermostat Housing.
B. Thermometer and Capillary Tube.
C. Water Pump.
D. Water Pump Drain Tap.
E. Fuel Tank.
F. Manifold Shield.

The thermostat provides a higher water temperature to assist in vaporising the lower grade of fuel. Furthermcre, for the same reason, the engine must have reached working temperature before it is operated on V.O. Petrol is therefore used for starting purposes and change-over to V.O. should never be made until 75°C. is registering on the temperature gauge, which is specially provided on the instrument panel for guidance of the operator. A capillary tube running along the left-hand side of the engine joins the temperature gauge with the thermometer which is fitted in the thermostat housing as shown in Fig. 9. It is important that no attempt should be made to warm the engine on vaporising oil, as incomplete combustion of fuel resulting from the use of vaporising oil at lower temperatures will result in sump oil dilution, bearing and liner wear and loss of oil pressure.

THERMOSTAT

When testing the thermostat fitted on V.O. engine tractors in accordance with the instructions on page D.5., the required limits are :

Crack Open Temp.	Fully Open Temp.	Maximum Valve Lift
75° — 85° C.	95° C.	$\frac{1}{4}$" — $\frac{3}{8}$"

CYLINDER HEAD WATER DISTRIBUTION TUBE. (Refer to Page D3.)

The introduction of the water distribution tube and the fitting of the water pump on the cylinder head was effected on V.O. engines at Engine No. S.170174E, Tractor No. 209810. The small cover plate (17, Fig. 1) previously fitted at the right hand side of the cowl to facilitate removal of the fan belt was at this time, superseded by a suitable indentation in the cowl (See page D.5).

WATER PUMP

On earlier tractors, before the introduction of the water delivery tube, the water pump is mounted on the cylinder block. The pump itself is identical with that of the petrol engine. (Illustrated above centre line Fig. 7, page D.7.)

COOLING SYSTEM

AS INCORPORATED ON LAMP OIL ENGINE TRACTORS TYPE TE-H 20.

GENERAL

The cooling system of the L.O. tractor is very similar to that of the V.O. tractor.

Thermostat settings are identical and the thermometer and temperature gauge are fitted. To compensate for the increased depth of the cylinder head the thermostat housing differs. Coolant capacity of the system increases to 17 pints (9.7 litres).

The L.O. engine, since its introduction, is fitted with the water distribution tube and the water pump on the cylinder head. The small cover plate on the R.H. side of the cowl was fitted to tractors up to Tractor No. 209661 only (See Page D5).

COOLING SYSTEM

AS INCORPORATED ON DIESEL ENGINE TRACTORS TYPE TE-F20

GENERAL

The cooling system of the Diesel tractor is similar in principle to that of the early petrol tractor (See Page D1) i.e., those on which the water pump is mounted on the cylinder block.

THERMOSTAT.

When testing the thermostat in accordance with the instructions on page D.5, the required limits are :—

Crack Open Temp.	Fully Open Temp.	Maximum Valve Lift
Up to Engine No. SA 17122E 77° — 80° C.	95° C.	$\frac{1}{4}$" — $\frac{3}{8}$"
Engine No. SA.17123E and future 68° — 73° C.	85° C.	$\frac{1}{4}$" — $\frac{3}{8}$"

WATER PUMP.

The water pump is similar to that shown above the centre line in Fig. 7, Page D.7. It differs from the pump fitted to carburettor engines in the design of the impellor housing, which is modified for installation purposes.

On Diesel engine tractors the small cover plate is still mounted at the right-hand side of the cowl and may be used to facilitate removal of the fan belt. (See instructions on page D.5)

RADIATOR.

At Tractor Serial No. 350800 solder dipping of the Diesel radiator block was introduced. A plate marked 'D.B.' (denoting Dipped Block) affixed to the top tank, denotes radiators strengthened by this treatment.

TROUBLES IN SERVICE

OVERHEATING OF THE COOLANT.

Caused by—A. Engine faults

B. Cooling system faults

C. Very heavy work in extreme tropical conditions.

A. Engine Faults.

The following engine faults can produce overheating of the coolant.

POSSIBLE CAUSE	ATTENTION REQUIRED
Excessive detonation and pre-ignition due to :—	
(a) Deposit of carbon in combustion chambers.	(a) Decarbonise engine.
(b) Fuel of low octane value.	(b) Use only fuels supplied by reputable producer.
(c) High oil consumption caused by :—	(c)
(i) Worn or gummed piston rings—excessive ring gap.	(i) Renew worn rings, clean if sticking.
(ii) Worn cylinder liners.	(ii) Renew or rebore liners, renewing rings and pistons as required.
(iii) Excessive clearance in valve guides.	(iii) Renew worn parts.
(iv) Wrong oil grade or level too high.	(iv) Change oil and check level.
(v) Blocked breather valve.	(v) Clean valve.
(vi) Worn big end bearings.	(vi) Renew bearings and regrind crankshaft if necessary.
(vii) Excessive engine speeds or idling.	(vii) In operators' hands.
(d) Deposit from coolant in cylinder head and channels between head and block. (Restriction of heat flow)	(d) See Section C, page C.12.
(e) Burned valves and seats (hot spots).	(e) Renew burnt valves and regrind. Check valve seats, clearances and carburetter settings, and check fuel grade.
(f) Faulty Spark Plugs.	(f)
(i) Carbon deposit, (hot spots).	(i) Clean Plugs.
(ii) Damaged insulators (hot spots).	(ii) Renew plugs affected.
(iii) Wrong type plug.	(iii) Fit recommended make and grade.
(g) Ignition too far advanced.	(g) Retard ignition.
(h) Faulty water pump.	(h) Service water pump.

TROUBLES IN SERVICE

B. Cooling System Faults.

The following Cooling system faults can produce overheating of the coolant :

POSSIBLE CAUSE	ATTENTION REQUIRED
(a) Slack fan and pump driving belt.	(a) Adjust belt to specified tension.
(b) Front of radiator choked with dirt (restricted air flow).	(b) Clean radiator fins and tubes.
(c) Radiator covered inside with coolant deposit. (restricted heat transfer.)	(c) Cleaning the inside of radiators should only be entrusted to mechanics experienced in this type of work. If necessary the radiator should be returned to the makers nearest service station.
(d) Radiator pressurising cap faulty. Leaking due to distortion, faulty washer, dirt. Opening pressure too low.	(d) Renew or service as necessary.
(e) Thermostat cracked—restricted coolant flow through radiator.	(e) Renew Thermostat.
(f) Thermostat sticking in closed or partially open position—closing or restricting coolant flow through radiator.	(f) Service or renew Thermostat.
(g) Cooling fan blades reversed for winter setting—restricted air flow.	(g) Re-assemble for summer operation..

C. Extreme tropical conditions.

Atmospheric conditions which can accelerate the coolant boiling.

(a) High atmospheric temperature.
(b) Overhead sun rays.
(c) High barometric pressure.
(d) Extremely dry air.
(e) Back or side winds.

RADIATOR BOILING PREVENTION.

In the case when radiator boiling occurs, but not at extremely critical conditions, the engine must be checked and all faults rectified. In the case of highly deteriorated engines or radiators, it is recommended to fit re-conditioned units.

If boiling occurs with the tractor in the best available state, it is recommended to proceed step by step as below until trouble is cured.

(1) If possible speed up the engine and slightly reduce power consumption.
(2) Retard ignition, by one division on quadrant, from the recommended setting.
(3) Enrich carburetter from recommended main jet setting by :—
  (a) I turn at min/max jet.
  (b) half turn at fully-variable jet.
(4) Remove thermostat and blank by-pass.
(5) Remove grilles from front of tractor bonnet.
(6) Remove tractor bonnet.

IDENTIFICATION OF THERMOSTATS

Thermostats, as fitted to tractors type TE-A 20, TE-D20, TE-H20, and TE-F20, are similar in design and construction, and the temperature ranges have been selected as the most suitable for each type of engine. Thermostats however, may be interchanged to suit the particular operating conditions or characteristics of individual engines.

The selected thermostat may be identified by reference to the following marking on the base.

Tractors type :	Thermostat No.
TE — A20	X 43570/10 or /19 †
TE — D20	X 43570/11 or /25 †
TE — H20	,, ,,
TE — F20 (Up to Eng. No. SA17122E)	X 43570/11 or /25 †
TE — F20 (Engine No. SA 17123E and future)	X 43570/16 or /21 †

† These alternative thermostats incorporate a jiggle pin in the valve vent hole. They have the same setting as those previously specified, with which they are fully interchangeable.

In addition, thermostats used on early TE-D20 and TE-H20 tractors may be marked with a blue paint spot.

COOLING SYSTEM

The following modifications have recently been incorporated in the Cooling System. In those instances where the alterations affect servicing procedure, further instructions have been added.

At Tractor Engine Nos.:—

Petrol—SC.38629E. *L.O.*—SB.9496E.
V.O.—S.207894E. *Diesel*—SA.10802E.

WATER PUMP IMPELLOR AND SPINDLE ASSEMBLY.

In order to prevent the ingress of water between the impellor and spindle to the pump bearings, lead linger was fitted on both sides of the impellor fixing bolt, and the end of the spindle and impellor dipped in low melting point solder (min 150° C.) to ensure a good seal.

At Tractor Engine Nos.:—

Petrol—SC.41539E. *L.O.*—SB.9586E.
V.O.—S.210171E. *Diesel*—SA.14655E.

WATER PUMP IMPELLOR AND SPINDLE ASSEMBLY.

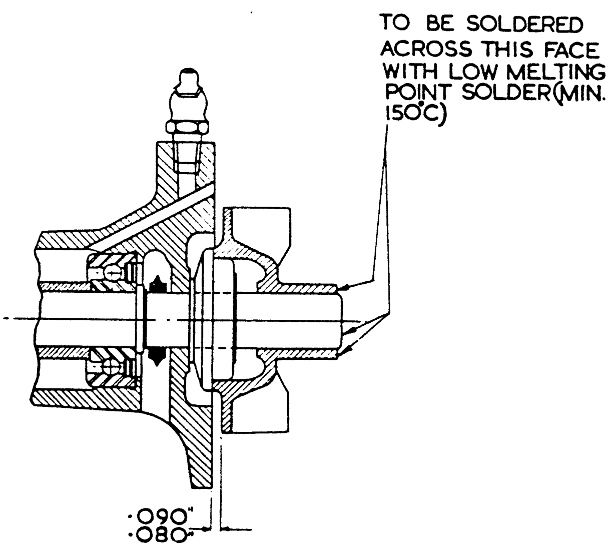


FIG. 10. WATER PUMP AND IMPELLOR.

A further modification, deleting the impellor fixing bolt, was introduced. By reducing the bore of the impellor, the drive to the spindle was imparted by the interference fit of the impellor on the spindle. The spindle and impellor were still sealed with low melting point solder.

Interchangeability.

The new impellor can be used with an old type spindle, provided the end is effectively sealed with low melting point solder. The old type impellor may be used in conjunction with the new spindle provided that the spindle is drilled, using a No. 8 drill, at a point 1.774"/1.770" (44.06/44.96 mm.) from the rear edge of the circlip groove. The impellor must be secured by means of the fixing bolt, nut and lockwasher, with lead linger on both sides. The impellor must then be sealed on the spindle end with low melting point solder.

To Remove Impellor.

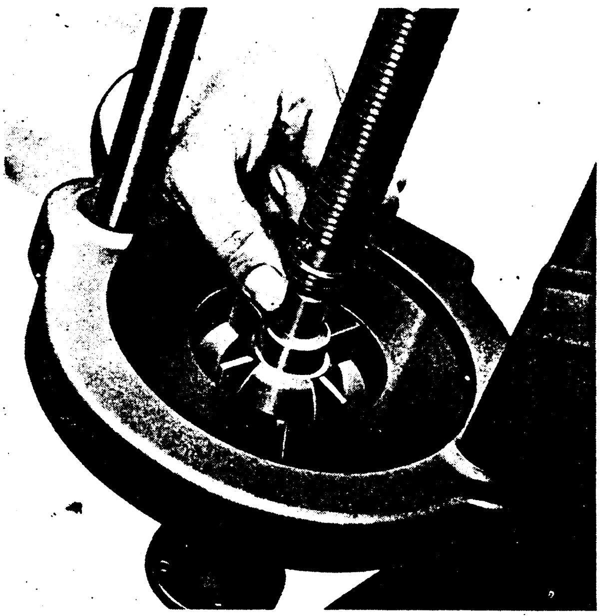


FIG. 11. REMOVING WATER PUMP IMPELLOR

Using Service Tool FT/S127 in conjunction with FT.4221A, mount water pump with lip of split pressure plate, code 1, under impellor. With centre screw adaptor, code 5, on end of shaft, press off impellor. On earlier pumps it will be necessary first to remove the impellor fixing bolt.

To replace impellor.

FIG. 12. REPLACING IMPELLOR.

Screw threaded end of water pump shaft into support ring, code 4, and mount on split pressure plate, code 1, in Service Tool, FT 4221A. Mount impellor on shaft and, with centre screw adaptor code 5 over shaft end, press on impellor, using plate gauge code 6 to obtain the necessary clearance of .080"/.090" (2.03/2.29 mm.) between the latest press fit impellor and the housing. See Fig. 12.

At Tractor Engine Nos.:—

Petrol—SC.48478E.

V.O.—S.215517E.

L.O.—SB.9783E.

(*Carburettor Engine Tractors only*).

WATER PUMP DRAIN TAP

An additional Drain Tap was introduced, located at the base of the Water Pump Body, see Fig. 9.

To ensure complete drainage of the cooling system, this Tap must be opened in addition to those previously listed (Refer to Item 1, page D.9).

SERVICE TOOL 6300 AND ADAPTORS FT. 126

FT126 comprises two guide adaptors, which are used with the main tool No. 6300 for re-surfacing the face of the water pump bearing housing against which the seal rides.

Detail 1. Suitable for Continental, 80 mm. and early 85 mm. engines.

Detail 2. Suitable for current 85 mm and Diesel engines.

APPLICATION.

Mount water pump body in vice as shown, Fig. 13. Insert Service Tool 6300, and mount appropriate adaptor, thrust bearing and tensioner, with ball race end of thrust bearing against the tensioner.

Tighten tensioner, using tommy bar provided. Rotate tool, tightening tensioner to maintain load on cutter. Remove only sufficient metal to give a smooth surface on housing face.

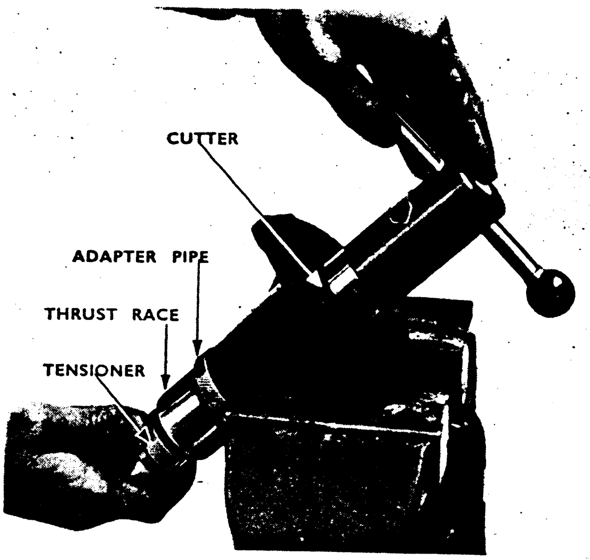


FIG. 13. SERVICE TOOL NO. 6300 WITH ADAPTORS FT. 126 REFACING PUMP HOUSING FOR WATER SEAL.

FUEL SYSTEM

Including :

Petrol Tank, Fuel Valve Filter and Sediment Bowl, Air Cleaner, Air Breather Valve (except Tractors Type TE-20) Exhaust System and Carburetter.

	TE-20	TE-A-20
Petrol tank capacity.	8 gals — 36 litres. Including reserve of I gal. — 4.5 litres.	8 gals — 36 litres Including reserve of I gal. — 4.5 litres.
Petrol Valve and Filter	Off-Main-Reserve	Off-Main-Reserve
Air Breather Valve	Not fitted	Fitted
Carburetter	Schebler " Marvel "	Zenith 24T-2 Holley 859-A
Air Cleaner	Burgess or A.C. Sphinx (oil capacity $\frac{3}{4}$ pint). or .4 litres	Burgess or A.C. Sphinx. (oil capacity $\frac{3}{4}$ pint). or .4 litres

Fuel System

Petrol, supplied by gravity feed from the tank, passes through a two-way valve and sediment bowl to the carburetter. Air supplied to the carburetter, and in the case of all tractors except type TE-20, to the crankcase, passes through an air cleaner.

Petrol Tank

The tank holds 8 gallons (36 litres) of which one gallon (4.5 litres) is held in reserve by means of the two-way valve.
The filler cap is vented.

Tank Mounting.

There are three methods of tank mounting, depending on the date of tractor manufacture :—

Method (i) Fig. I.

The tank is mounted by set screws and lock washers directly to the battery platform at the rear (X) and on the water outlet elbow at the front (Y).

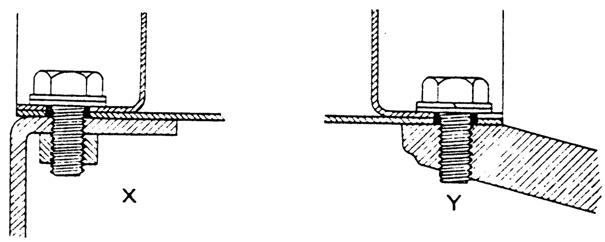


FIG. I

Method (ii) Fig. 2. (Tractors serial No. 71,001 to 74,539 only).

The tank has flexible mountings :—
rearward (X) — double pad.
forward (Y) — single pad.

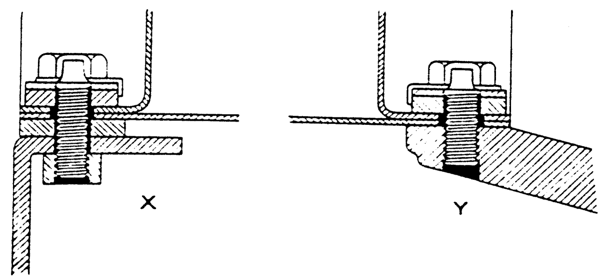


FIG 2

Method (iii) Fig. 3. (Tractors serial No. 74,540 on).

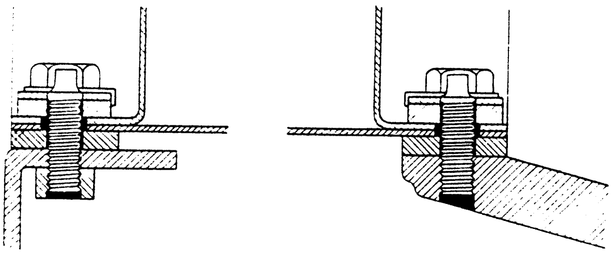


FIG. 3

The tank has double-pad flexible front and rear mountings.

Note : As the tank is modified for the provision of double-pad flexible forward mountings, this method of mounting cannot be used on tractors earlier than Serial No. 74540.

To Remove the Tank. Fig. 4.

It is first necessary to disconnect the hood support from front of tank and lower the hood forward over the radiator. Remove battery. Disconnect fuel pipe at petrol valve, remove four bolts securing tank. If the petrol valve and sediment bowl assembly is left in position when the tank is removed, take care that this part is not damaged when setting the tank down.

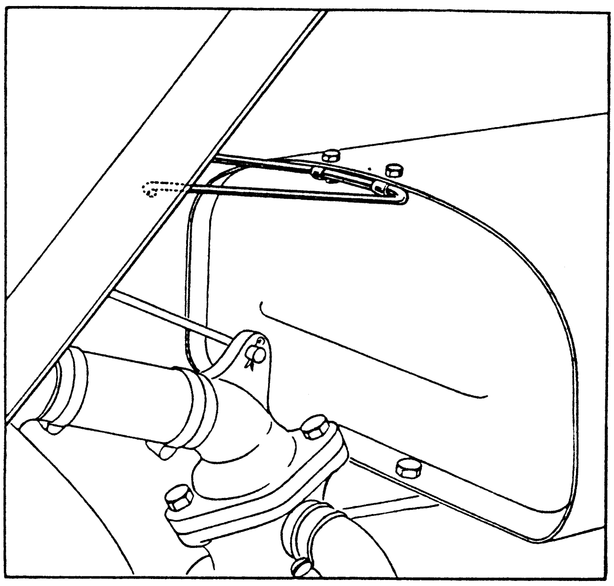


FIG. 4

Petrol Valve and Sediment Bowl Assembly. Fig. 5.

The two way valve and sediment bowl assembly is shown in Fig. 5. It consists of a valve assembly (1) to which is attached a sediment bowl (2) by means of a retainer (3). Located between the bowl and the valve are a filter gauze (4) and a gasket (5). A cross-section through the valve and sediment bowl assembly is shown in Fig. 6.

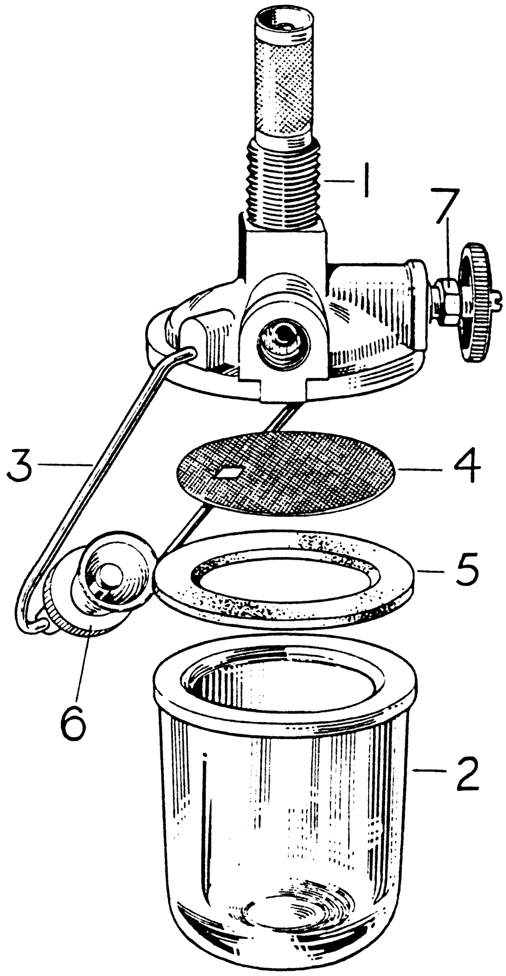


FIG. 5

Function of the Petrol Valve and Sediment Bowl. Fig. 6.

When the valve stem seats at (A) .... petrol is cut off.

When the valve stem is unscrewed two turns .... main petrol supply flows through the stand pipe.

When the valve stem is screwed back to its limit .... reserve petrol supply flows through (B).

The direction of petrol flow through screen (4) is upwards so that sediment falls from the screen to collect in the bottom of sediment bowl (2). Water in the fuel will also accumulate in the bottom of the bowl.

To Remove Sediment Bowl.

It is periodically necessary to clean the sediment bowl and screen by washing in petrol. The bowl is easily detachable by unscrewing knurled nut (6).

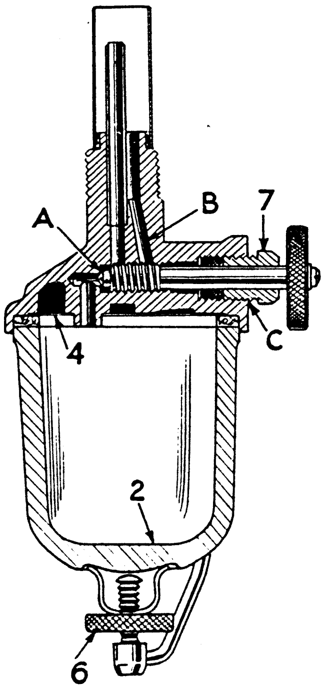


FIG. 6

To Replace Sediment Bowl.

Hold the bowl loosely in position and allow to fill before tightening knurled nut (6). This allows air to escape from the bowl, preventing an air lock.

> **Note:** If petrol leaks at (C), tighten packing nut (7).

The Air Cleaner.

For illustration of air cleaner fitted to tractors type TE-20 see Fig. 7, or to all other tractors see Fig. 9.

> **Note:** Although alternative makes and sizes of air cleaners are fitted, they function on the same principle.

The air cleaner unit is situated at the right-hand side of the engine, to the rear, and mounted on the battery platform. The unit

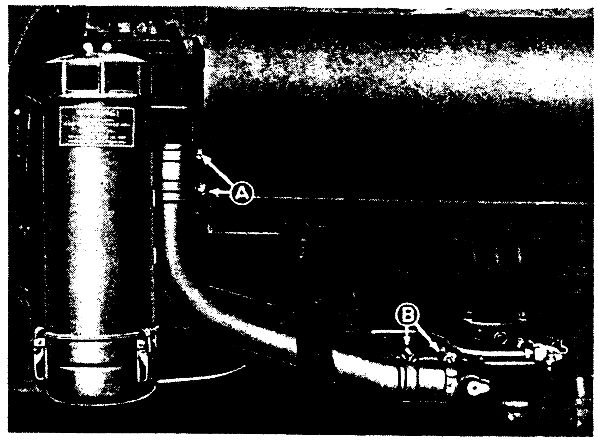


FIG. 7

consists of a cleaner element and body, an oil container and a top cover. The top cover acts as a pre-cleaner for separating coarse material either by louvres or a wire mesh screen.

Function of the Air Cleaner. Fig. 8.

A typical section through the air cleaner is shown in Fig. 8. Air entering from the top into the central air duct (A) passes through the oil bath (B) and cleaner element (C) to the outlet pipe (D) which is connected to the engine by rubber hoses.

When the oil container at the base of the air cleaner is filled to the correct level, the bottom of the centre tube (A) inside deflector ring (E) is immersed. The partially filtered air from the top cover, passing down the centre tube, must displace the oil contained in this ring in order to pass into the cleaner element. The ring forces the air, travelling at high velocity from duct (A), to make a sharp 180° turn to pass through the cleaner element to the outlet pipe. Centrifugal force due to the sudden change of direction of the air throws a large proportion of foreign particles down into the oil. Holes around the top of the deflector ring allow for a continuous flow of oil back into the central ring, while the foreign material is deposited in the oil outside the ring, and settles to the bottom of the cup.

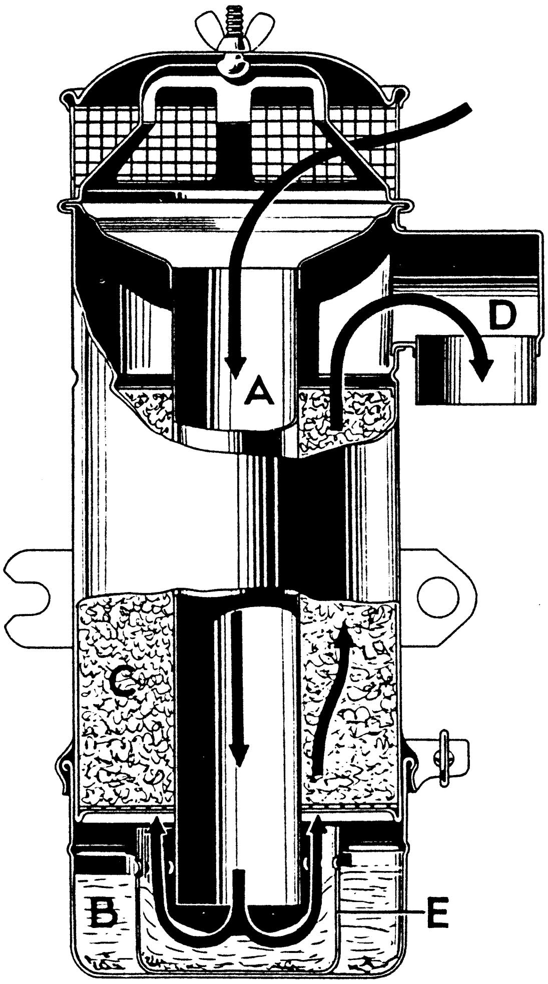


FIG. 8

The air, with any remaining foreign material, continues up through the packing material around the centre pipe, the packing acting as a filter and removing the remaining foreign material. The oil carried up into the packing by the air washes the foreign matter off the packing and carries it back down into the oil cup where it settles to the bottom. The clean air reaches the top of the air cleaner and passes into a steel tube connected by flexible hoses to the carburetter.

Note : Most of the oil is drawn up into the cleaner element when the engine is running.

Service Recommendations.

1. The oil container should be cleaned and refilled every 10 hours, or daily—in dusty conditions twice daily.
2. Use oil of engine grade. It is permissible to recommend the use, in very cold weather, of 25% paraffin so that the oil may flow freely.
3. Do not overfill the oil container. Inspect the inside of the air inlet pipe at carburetter for oil carried over due to high oil level or the use of oil which is too heavy. The depression in the carburetter air system caused by an overfilled container or a dirty cleaner element will enrich the fuel mixture and increase fuel consumption.
4. Ensure that no caked dirt or oil restricts the air flow to the pre-cleaner. Clean the top cover by washing in petrol.
5. The entire cleaner unit should occasionally be removed from the tractor and thoroughly washed with petrol.
6. Ensure that the hose connections A and B, Figs. 7 and 9, on the air pipe leading from the cleaner to the carburetter (also, in the case of all tractors except type TE-20, from the cleaner to the crankcase) are air tight and the hoses not cracked or swollen.
7. Inspect for broken seams which allow air to bypass the cleaner. Paint worn away at unusual points will indicate probable leaks.
8. Inspect for loose oil container or worn bracket.

Note : Tractors except type TE-20 —see Fig. 9. The air cleaner has a second, smaller, outlet connected by a rubber hose to a pipe leading through an elbow to the crankcase.

Air Bleed to Induction Manifold — Engine Ventilation. Except Tractors type TE-20. Figs. 9 and 10.

An air breather valve assembly (1), Fig. 9, is fitted to the induction manifold. Through this valve is induced a bleed of warm oil-saturated air, from the chamber enclosed by the rocker cover (C), assisting carburation and providing upper cylinder lubrication. The consequent depression in the rocker cover creates a flow of air through the push rod passages from the crankcase, which is replaced by air from the small outlet of the cleaner. The original design of the valve provided for an automatic weakening of mixture with increasing engine speeds. A modification subsequently incorporated in production above engine serial No. S.12771E, recommended the fitting of sufficient washers (7) as illustrated in Fig. 10 to seat the valve (8), thus providing a constant air bleed irrespective of engine speed. To ensure that the valve makes a seal on its seat, a gap must be maintained between the valve body (5) and nut (4). All figures given for carburetter adjustment apply only if this modification has been carried out.

Note : A redesigned and simplified valve, is fitted on later tractors.

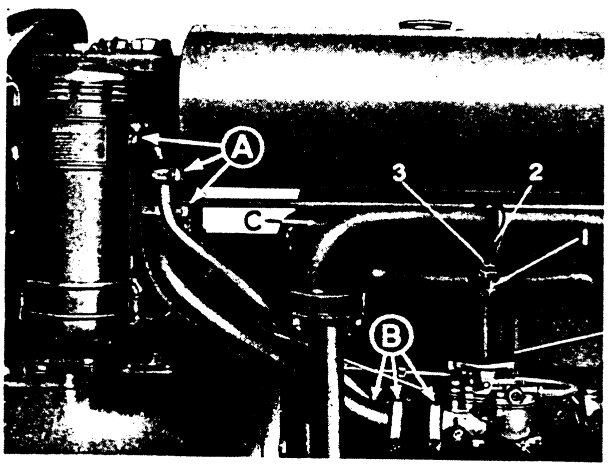


FIG. 9

To Remove Air Breather Valve Assembly. See Fig. 9.

1. Unscrew union screw (3) on valve assembly and pull up air bleed tube (2).
2. Remove valve assembly (1) from housing in manifold by unscrewing.

To Replace Air Breather Valve Assembly.

1. Place union screw (3) over end of tube (2) and fit olive.
2. Offer valve assembly to tube-end and screw in union two or three turns.
3. With tube loosely located screw valve assembly into manifold housing.
4. Tighten union screw, ensuring that tube (2) is pushed well down so that it can be gripped by olive.

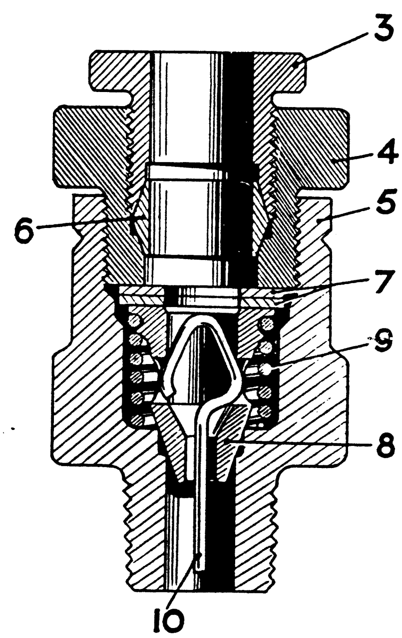


FIG. 10

To Dismantle and Clean Air Breather Valve. See Fig. 10.

1. Unscrew valve nut (4) from body (5) and remove olive (6).
2. Remove washer(s) (7), valve (8) and spring (9).
3. Clean valve components and tube by washing in petrol and blowing out with compressed air.

Ensure that the small cleaner wire (10) is quite free to vibrate in the valve bleed hole. This movement of the wire keeps the hole from becoming clogged by oily condensate.

Induction and Exhaust Manifolds.

The induction and exhaust manifolds are attached to the right-hand side of the engine cylinder head and form a single casting. Thus, heat from the exhaust gases is conducted to the induction manifold, pre-heating the mixture passing from the carburetter to the combustion chambers.

The manifold assembly is located on studs in the cylinder head and secured by nuts with lockwashers. A gasket is fitted between the manifold and the cylinder head. A clearance exists between the exhaust and induction manifold flanges to allow for their different expansion rates.

To Remove Manifold Assembly. Fig. 11.

Special Tool F.T.B./2 — Manifold Nut Wrench.

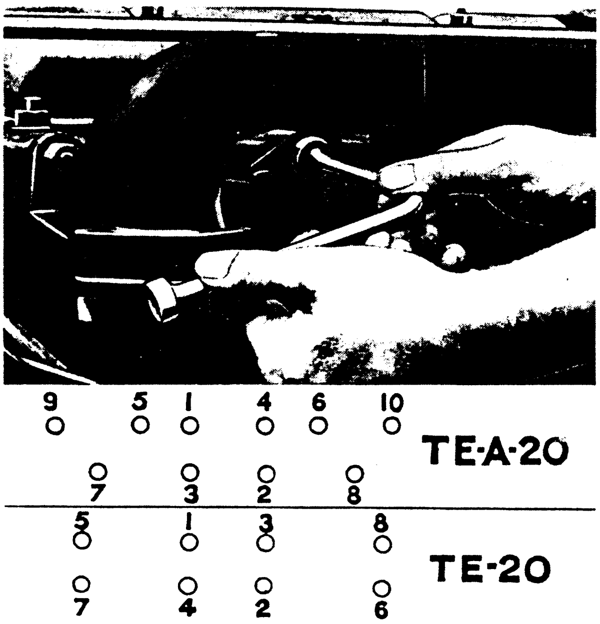


FIG. 11

Tractors type TE-A-20.

1. Turn off petrol.
2. Remove petrol tank (see "To Remove Petrol Tank").
3. Disconnect carburettor linkage, petrol pipe, and loosen hose connections—see "To Remove Carburetter."
4. The carburetter can be removed, either individually or with the manifold assembly.
5. Disconnect air bleed tube from rocker cover and air breather valve in manifold — see "Air Bleed to Induction Manifold."
6. Disconnect exhaust pipe at manifold flange.
7. Using manifold nut wrench, Fig. 11, remove nuts and lockwashers from manifold securing studs in cylinder head.
8. Remove manifold assembly and gasket.

Tractors type TE-20.

1. Turn off petrol.
2. Disconnect carburettor linkage, petrol pipe, and loosen hose connections.
3. Remove carburetter, either individually or with manifold.
4. Disconnect exhaust pipe at manifold connection.
5. Using manifold nut wrench, Fig. 11, remove nuts and lockwashers from manifold securing studs in cylinder head.
6. Remove manifold assembly and gasket.

To Replace Manifold Assembly.

Proceed in the reverse order to instructions "To Remove Manifold Assembly."

1. Ensure that the faces of the manifold flanges (and in the case of TE-A-20 exhaust pipe flanges) are clean and true before assembly.
2. If gaskets show any sign of damage or "blowing" — discard and renew.
3. Tighten manifold and exhaust pipe securing nuts gradually and evenly until dead tight. The order in which to tighten the manifold nuts is shown in Fig. 11.

Exhaust Assembly

The exhaust pipe, silencer and tail pipe form an assembly supported forward at the right-hand side of the crankcase and rearward at the right-hand rear axle housing flange. The silencer is secured to the pipe by a clip.

The exhaust pipe is fitted with a detachable shield, as shown in Fig. 12.

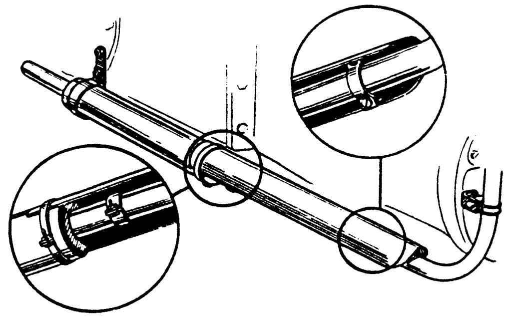


FIG. 12

The Schebler " Marvel " Carburetter
Tractors type TE-20 only.

	DATA	ADJUSTMENT
Main Jet	130 (controlled by adjusting needle)	$1\frac{1}{8}$ turns open approx.
Slow Running Jet.	115	$2\frac{1}{2}$ turns open approx.
Choke Tube	$\frac{5}{8}''$ (16 m.m.) dia.	——

General Description. Fig. 13.

The carburetter is of the balanced, up-draft type, fully sealed against the entrance of dust.

The principle of operation is the same as that of any up-draft carburetter in that air entering the air intake and travelling through the venturi (15) passes at a high velocity over the top of the discharge tube (3), thereby picking up liquid fuel which is instantly atomised with the air. From this point onwards the air-fuel mixture is drawn through the manifold to the cylinders.

The fuel is gravity fed from the fuel filter and before entering the carburetter bowl must pass through a special 90° elbow fitting, which incorporates a fine screen. The flow of the fuel is controlled by means of a float (17) which operates a needle valve (19) and shuts off the fuel supply when it reaches the specified level in the carburetter bowl (14).

As the carburetter is of the balanced type, the air intake passage is connected with float chamber and also with the throat of the carburetter above the venturi (15) or just below the closed position of the throttle plate (28). The pressure on the fuel in the carburetter bowl is, therefore, the same as in the air passages of the carburetter and is less than atmospheric pressure by an amount depending on the R.P.M. of the engine and the position of the throttle. This maintains a constant air fuel mixture under all conditions.

The carburetter incorporates two fuel systems which are sufficient to provide the correct fuel and air mixture from idling to top governed speed and from no load to full load. These are the idle fuel system and the main fuel system.

In the idle fuel system, with the throttle valve closed, a vacuum is created above the throttle plate (28). A passage (A) is drilled from just above the throttle plate down into the fuel well and allows fuel to be drawn up by the vacuum. Into this passage is screwed the idle jet (27). A second drilling (B) is made in the idle jet passage from the space surrounding the venturi, through which air is mixed with the fuel. An adjusting screw (4) is threaded into this passage so that the amount of air may be controlled to give the correct air and fuel mixture. Another passage (C) is drilled into the idle jet from just below the closed throttle plate which allows additional air to enter the idling fuel and air mixture. This provides sufficient air and fuel in the

fuel that may enter the fuel well, a metering jet (2) which controls the maximum amount of fuel that may enter the discharge tube (3) and the discharge tube itself, which discharges into the carburetter at the centre of the venturi tube.

To obtain mixture balance at wide throttle openings and to assist in atomising the fuel, the discharge tube is drilled in three locations, and air is allowed to enter from

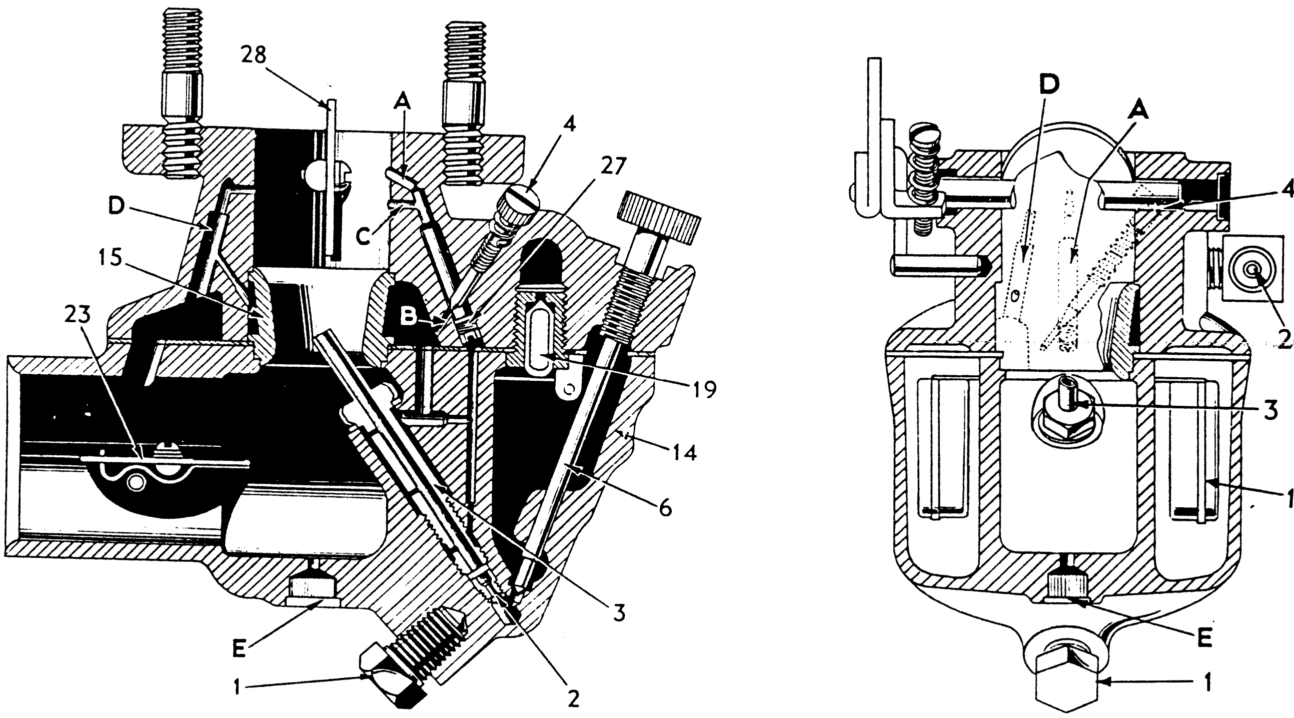


FIG. 13

proper proportions to permit the engine to run smoothly at low R.P.M. However, when the throttle plate begins to open there will be a rush of air past its edges which cuts down the vacuum and tends to upset the proportions of the air and fuel mixture. This is off-set by the fact that the passage that was below the throttle plate is now just above it, and allows additional fuel to be drawn up from the well and maintains the correct fuel and air relationship.

With further opening of the throttle, the main fuel system comes into operation. This system consists of a manual adjusting screw (6) which controls the amount of

the space surrounding the venturi. As the amount of fuel passing through the discharge tube is dependent on the velocity of the air passing through the venturi and the size of the main metering jet (2), the fuel level around these holes will fall as the engine speed increases. An "economiser" passage (D) is drilled from the passage surrounding the venturi to a point in the throttle body throat, just below the closed position of the throttle plate. This passage allows air to by-pass the fuel systems and thus weakens the mixture, giving an economising effect. In addition to the two fuel systems incorporated in the carburetter, the choke (23) is of vital importance for starting. It is manually controlled by the operator and shuts off the main supply of air to the carburetter, thereby bringing the vacuum from above the throttle plate down into the carburetter proper. A spring-loaded valve, incorporated in the choke plate, opens to allow some air to enter when the vacuum in the carburetter becomes high. However, the air balancing passage mentioned previously allows air from outside the choke plate to pass around the venturi, entering the float chamber. The pressure of this air forces raw fuel up through the jets which, when mixed with the air entering past the valve, results in a very rich fuel and air mixture.

The carburetter is completely sealed from dust by means of cork gaskets between the upper and lower parts as well as by felt washers around the choke and throttle shafts. A felt packed drain opening (E) is provided in the bottom of the carburetter bowl which will allow manifold condensation or excessive fuel collection to escape, but which prevents the entrance of dust and dirt. The float chamber can be drained by unscrewing the drain plug (1).

Adjustable Main Jet

The adjustment of the main jet permits weakening or strengthening of the mixture for various speed and load conditions. With the adjusting screw removed, the engine will continue to run, although the mixture will be over-rich. On the other hand, if the adjusting screw (6) is turned clockwise to its limit, the petrol supply will be completely cut off.

Slow Running Adjustment

This should be carried out when the engine is hot, the minimum running speed usually being set at 400 — 450 r.p.m. by adjustment of screw (5), Fig. 16, on throttle shaft arm. The head of this screw should be turned clockwise to increase the idling speed and vice versa.

An approximate setting for the slow running mixture screw (4), Fig. 14, is $2\frac{1}{2}$ turns open from the fully closed position. If, however, there is evidence of rich running, *i.e.*, black smoke from the exhaust or "hunting," the screw should be gradually turned in an anti-clockwise direction until the engine runs cleanly and evenly.

Main Jet Setting

Thoroughly warm the engine and adjust slow running jet as instructed. Screw in main jet adjusting screw gently until seated, and then unscrew $1\frac{1}{8}$ turns open. When the adjustment is correct and the engine warm, it should be possible to open the throttle quickly and obtain an immediate response in engine speed. Should the engine hesitate, open the main jet one eighth of a turn at a time until the immediate response is obtained. For maximum economy, when operating under load in the field, the adjuster should have the least possible opening consistent with the above conditions.

To Remove Carburetter. See Fig. 14.

1. Turn off petrol and disconnect petrol supply pipe (7) from carburetter.

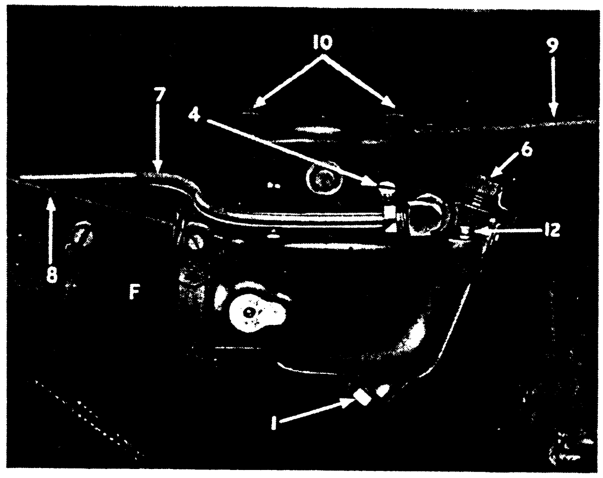


FIG. 14

2. Remove knob and locknut from choke control rod (8) at bulkhead.
3. Disconnect throttle control tie rod (9) from governor lever by removing pin from fork.
4. Disconnect rubber hose (F) from carburetter air intake to air cleaner pipe.
5. Remove the two nuts (10) and lockwashers from the studs in the carburetter flange. Lift clear carburetter assembly with control rods and remove flange gasket.
6. Disconnect choke control rod and throttle control tie rod from carburetter by removal of cotter pins.

To Replace Carburetter.

Before fitting the carburetter to the manifold, the choke control rod (8) and the throttle control tie rod (9) should, if necessary, be disconnected from their respective housings in the bulkhead and governor lever. This will facilitate the attachment of these rods by means of cotter pins to the appropriate levers on the carburetter.

1. Offer the carburetter, with gasket (11) fig. 16, to the manifold flange, locating the choke control rod in the bulkhead.
2. Tighten nuts (10) evenly on studs in carburetter flange.
3. Replace locknut and knob on choke control rod, and pin and cotter in fork attachment to governor lever.

Use a thin flange gasket between carburetter and manifold as a thick gasket may tend to squeeze out, causing the flange to bend and allowing an air leak to occur. A bent flange must be trued-up.

Ensure that no air is admitted at the rubber hose connecting the air cleaner pipe to the carburetter.

Before attempting to start the engine subsequent to refitting the carburetter it is a good plan to check the throttle control and choke control to make quite sure that the full amount of travel is obtained.

To Dismantle Carburetter. Fig. 15 and 16.

Special Tool — Carburetter Wrench — F.T.B.4.

A special combination tool which is illustrated in fig. 15. has been designed to fit all jets and nuts on the carburetter, Fig. 16. Its use is highly recommended, especially for the withdrawal of the main jet.

When working on the carburetter always remove the entire assembly from the manifold and clean externally before dismantling.

1. Remove main jet adjusting screw (6).

Damage to the seat will be avoided if the adjusting screw is removed before the carburetter is split.

2. Separate carburetter by removing the four screws (12) which hold the barrel (13) and bowl (14) together. Remove venturi or choke tube (15) and discard gasket (16).

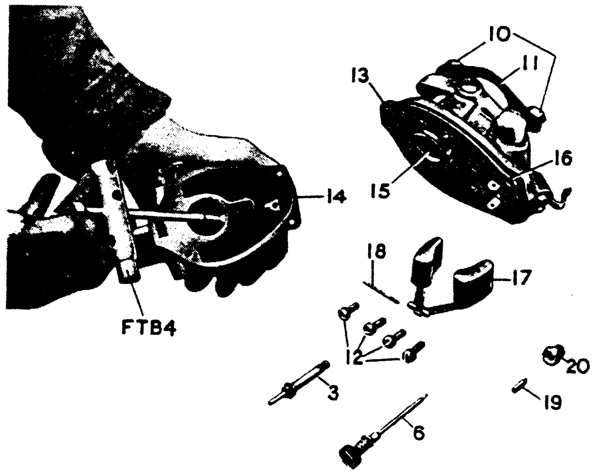


FIG. 15

3. Remove float (17) by pulling hinge pin (18).

Handle float carefully; it is very thin and is easily damaged. Float needle valve (19) will now drop out.

4. Remove float valve seat (20). A poorly seated valve caused by foreign matter between this seat and the needle valve, or a leaking float are the main causes of carburetter leakage.
5. Remove main discharge tube (3) and main jet (2) from the carburetter bowl.
6. Remove idle adjusting screw (4) and idle jet (27).
7. Remove the two screws (21) which pass through the choke valve shaft (22). Pull out the choke valve plate (23). Ensure that the small coil spring which holds the poppet valve of the choke valve plate in its closed position is in good condition and functioning correctly, otherwise air will always be able to pass through poppet valve opening.
8. Remove choke valve shaft (22). The dust seal on this shaft is not sold as a service part, since the choke shaft is not

operated often enough to produce wear.

9. Remove throttle valve plate (28) and shaft (24). When the throttle shaft wears, dust may be drawn into the carburetter barrel and hence through the manifold directly into the engine. The throttle shaft dust seal (25) is replaceable and sold as a service part, since the

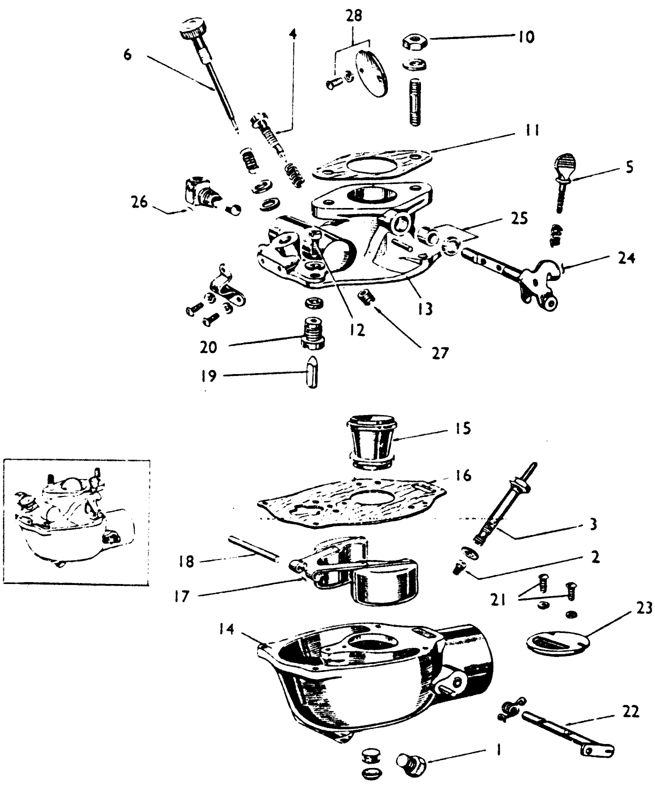


FIG. 16

throttle shaft is subjected to wear through continuous operation. The seal should always be carefully examined and replaced if there is any evidence that it is not securely seated on the shaft. Leaks around the throttle shaft at this seal will allow air to enter and affect idling adjustment.

10. Unscrew and remove the elbow strainer assembly (26). Dust that collects on the inside of the strainer should be removed by shaking in petrol or by the application of air to the outside of the screen.

All openings in the carburetter are now ready to be cleaned with air. Never attempt to " blow out " the carburetter through the elbow in case the strainer ruptures, allowing dirt blown in the carburetter to clog the jet.

To Assemble Carburetter.

Proceed in the reverse order to the instructions given above.

The correct float setting is $\frac{1}{4}'' \pm {}^{1}/_{32}''$ (6.5 mm. $\pm$ .5 mm) from the surface of the gasket to the top of the float. Hold the carburetter bowl upside down to make this measurement, as shown in fig. 17.

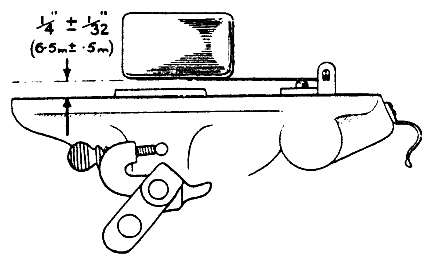


FIG. 17

This setting should shut off the fuel when it reaches a level of $\frac{1}{2}''$ (13mm) below the top of the carburetter bowl. To check, remove drain plug and attach a rubber tube fitted to a glass tube. Check the level of the fuel in the glass tube against the outside of the carburetter.

Do not fit main jet adjusting screw (6) until the barrel (13) and bowl (14) are screwed together.

Ensure that the screws (12) which hold together the barrel and bowl are tightened evenly.

Note : The given adjustments of the carburetter and settings for the main jet adjuster provide the correct mixture strength for all conditions up to about 3,000 ft. (900 metres), altitude above sea level. When operating at higher altitudes it may sometimes be necessary to deal with symptoms of rich running and, possibly, loss of power. In these cases, the main jet adjuster will be found most useful in obtaining a clean running exhaust. Turning the adjuster in a clockwise direction one eighth of a turn at a time will be found effective in weakening the mixture delivered by the carburetter.

The Zenith Carburetter 24T-2
Tractors Type TE-A-20.

	DATA	ADJUSTMENTS
Main Jet		
Standard Type	120 (adjustable needle)	$1\frac{3}{4}$-2 turns open approx.
Min./max. type	100 (adjustable setting)	1 turn open approx.
Slow Running Jet	50	1 turn open approx.
Air Jet	.079″ (2.0 m.m.)	—
Choke Tube Dia.	.669″ (17 m.m.)	18 m.m. (.709″) for high altitude conditions.

General Description. Fig. 18.

The 24T-2 carburetter shown in the cross-section is of the up-draught type with the float chamber off-set in order to keep it as close as possible to the main discharge tube. This feature ensures high angle operation in any direction without flooding or stalling. For simplicity, one main adjustable jet (30) and one idle jet (38) have been used. The air bleeding to the main jet system is controlled by air jet (37) and this air supply is taken from the main air intake. It will be noticed that this air issues progressively from holes (A) (B) and (C) as the engine speed increases, when the petrol in the main discharge tube (D) falls to its lowest level. Petrol metered by idle jet (38) is atomised by an air supply taken through the main air intake and controlled by the screw (45). This mixture issues through the idle discharge channel (E) and the progression orifice (F). The float chamber contains a normal type float (40) and the usual combined needle seating valve (42). The float chamber may be drained by unscrewing drain valve plug (36).

Slow Running Adjustment.

This should be carried out when the engine is hot, the minimum running speed usually being set at 400 — 450 r.p.m. A spring-loaded adjusting screw (6), Fig. 18, is provided close to the throttle lever by means of which the exact throttle opening can be adjusted for idling. It should be turned clockwise to increase the idle speed and vice versa. The slow running mixture screw (45) will provide a richer mixture if turned in a clockwise direction. If, however, there is evidence of rich running, *i.e.* black smoke from the exhaust or hunting, this screw should be gradually turned in an anti-clockwise direction until the engine runs cleanly and evenly. The usual setting is about one complete turn open from the fully closed position.

Adjustable Main Jet.

The combination of choke tube, main jet, and air jet has been found suitable for efficient operation and it should not be necessary to alter these parts when dealing with ordinary running trouble.

Standard Type Adjustable Main Jet (Fig. 18 detail X).

The main jet adjuster (34), fitted with a torque lever, is a tapered needle passing into the main jet orifice and controlling the flow of petrol into the jet. When turned in a clockwise direction as far as possible, all petrol flow to the main jet will be completely cut off. On the other hand, if opened in an anti-clockwise direction, petrol flow to the main jet will be provided.

or adjuster seating and the correct setting specified will no longer apply.

Main Jet Setting.

Thoroughly warm the engine and adjust the slow running jet as instructed. Screw in main jet adjusting screw gently until seated, and then unscrew 2 turns (Standard Adjustment) or 1 turn (Min./max. adjustment). When the adjustment is correct and the engine warm, it should be possible to open the throttle quickly and obtain an immediate response in engine speed.

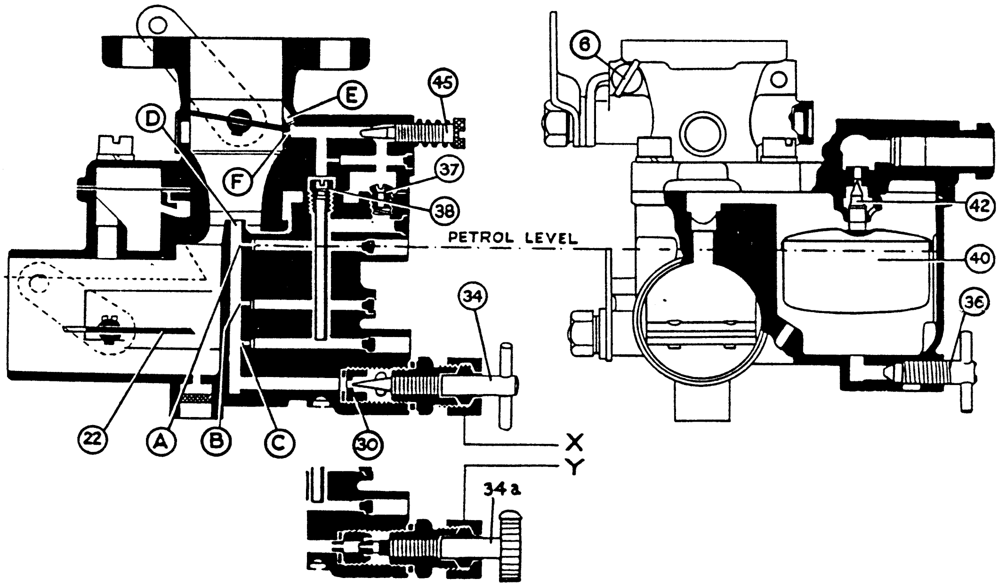


FIG. 18

Min. Max. Adjustable Main Jet (Fig. 18 detail Y).

The main jet adjuster (34a) is fitted with a knurled head. When it is screwed fully home on to its seating the petrol supply to the main jet is restricted by the small orifice in the adjuster, giving a positive setting for minimum flow. On the other hand, due to the fairly steep conical end of the adjuster, a small amount of lift (2 turns anti-clockwise) off the seating will completely relieve restriction and provide maximum flow at the calibrated main jet.

Do not screw in the adjuster with excessive force as this will damage the tapered needle

Final adjustments should be made in the field, where it will be found that a setting of 2 to $2\frac{1}{4}$ turns (Standard Adjustment) or 2 turns (Min./max. Adjustment) will give maximum power. Users should be informed that for light work the setting should be reduced to approximately $1\frac{3}{4}$ to 2 turns (Standard Adjustment) or 1 turn (Min./max. Adjustment) to effect greatest economy.

If results obtained from these suggested settings appear unsatisfactory it is possible that the main jet requires tightening. This may be done after removal of needle valve, packing nut and adaptor.

If the standard type Main Jet Adjuster is screwed too tightly into the main jet orifice it is possible that the jet will unscrew with the needle, with the result that the settings given will be rendered inaccurate.

If the adjusting screw is tight to turn, it will probably be found that the packing in the packing nut has become hardened. On no account should a tool be used when adjusting, but the packing nut should be removed and the assembly withdrawn, when the adjusting screw may be oiled, freed and replaced.

If the petrol drips from the adjusting screw the packing nut should be slightly tightened.

Cold Starting.

The rich mixture necessary to meet this condition is provided by closing the choke or air strangler (22) and it will be noted that this action has the effect of opening the throttle the correct amount to ensure easy starting, Fig. 19. As soon as the engine is

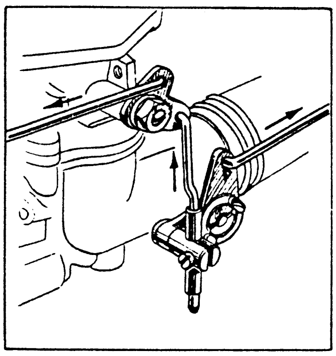


FIG. 19

running the strangler flap will open automatically to admit air, but as the engine warms up the control operating the strangler must be moved to the fully open position.

Hot Starting.

When the engine is hot or warm, the strangler is not required and the throttle is closed back to the normal idling position. If the engine does not immediately respond, check that both the petrol and ignition are turned on before operating choke. If at any time an over-rich mixture condition is suspected, a few rotations of the crank shaft with the throttle held wide open may be helpful.

To Remove Carburetter. Fig. 20.

Turn off petrol, disconnect petrol supply pipe at plug (46).

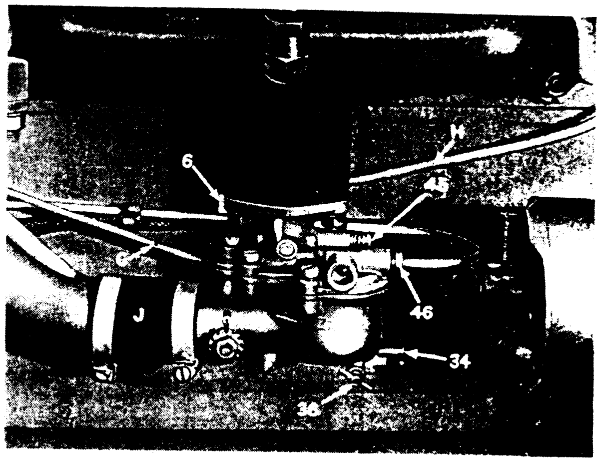


FIG. 20

Remove knob and locknut from choke control rod (G) at bulkhead.

Disconnect throttle control tie-rod (H) from governor lever by removing pin from fork.

Disconnect rubber hose (J) from air intake to air cleaner pipe.

Remove the two nuts and lockwashers connecting carburetter barrel to studs in induction manifold.

Lift carburetter assembly clear and remove gasket.

Disconnect choke control rod (G) and throttle control tie-rod (H) from carburetter by removal of cotter pins.

Before Fitting Carburetter.

Check the inter-connection between the choke and throttle lever to ensure that this works quite freely, see Fig. 19. The choke plate, complete with its spindle should move quite freely against the light anchoring spring when plate is held in the closed position and pushed with the finger.

To Fit Carburetter.

It is suggested that before fitting the carburetter, the choke control rod and the throttle tie rod are disconnected from their respective housings in the bulkhead and governor lever. This will facilitate the attachment of these rods by means of cotter pins to the appropriate levers on the carburetter.

Offer the carburetter, with gasket, to the studs in the flange of the manifold, locating the choke control rod in the bulkhead. Tighten nuts with spring washers evenly on studs in manifold flange. Replace locknut and knob on choke control rod and pin and cotter in fork attachment to governor lever.

Note : When replacing the carburetter take care to use a thin flange gasket as a thick gasket may tend to squeeze out, causing the flange on the carburetter to bend, allowing an air leak to occur. A bent flange must be trued-up.

Before attempting to start the engine, subsequent to re-fitting the carburetter, check the throttle control and the choke control to make quite sure that these parts work correctly, giving the full amount of travel.

In common with all air intake choke valves, the plate must be completely closed against the air intake bore when the external lever is moved out to the fully-closed position. Should the choke plate stick in the fully open position it will be possible to turn the spring anchor plate anti-clockwise but not clockwise. This sticking can usually be overcome by locating the choke plate spring one notch further round the anchor plate thus increasing the tension. Ensure that no air is admitted at the rubber hose connecting the air cleaner pipe to the carburetter.

To Dismantle Carburetter. Fig. 21.

When the carburetter has been removed, it is a good plan to clean the outside of the unit thoroughly before any dismantling takes place.

On dismantling, the component parts should be carefully set out on a clean sheet of paper and the main castings blown out with compressed air.

When re-assembling, always fit new gaskets, washers and springs.

Remove inter-connection tube (20) by loosening screw (27) in swivel (25).

Remove nut (14) and spring washer (13) from throttle spindle (8).

Remove throttle and inter-connection lever (10) spacer washer (12) and throttle stop (9).

Remove inter-connection rod (11) from throttle and inter-connection lever (10).

Remove five screws (3) and lockwashers (4) and separate barrel (7) from bowl assembly (24).

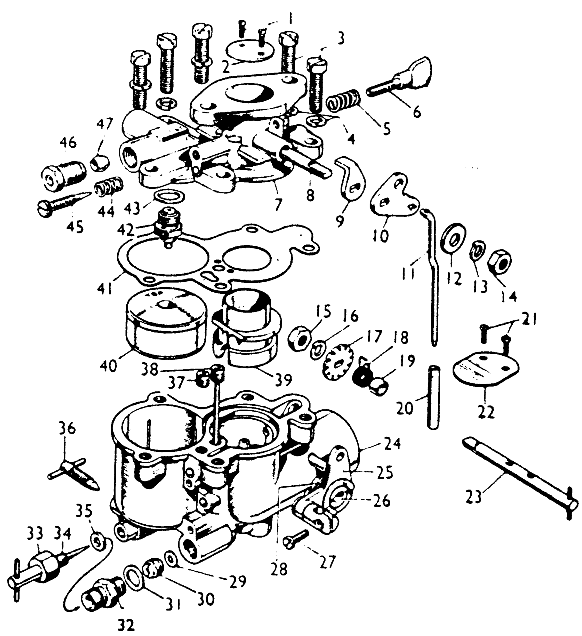


FIG. 21

Remove gasket (41).

Remove float (40) from bowl.

Unscrew float needle and seating assembly (42) and remove washer (43).

Remove air regulating screw (45) and spring (44).

Remove throttle stop screw (6) and spring (5).

Note: Screws (1), fixing throttle plate (2) to spindle (8), are " peened " and should not be removed.

Lift out choke tube (39) from bowl assembly (24).

Remove slow running jet (38) and air jet (37).

Remove main jet adjustment packing nut (33), packing (35), and needle valve (34) or (34a—min./max.), adaptor (32), washer (31), main jet (30) and fibre washer (29).

Remove drain plug (36).

Remove screws (21) securing choke plate (22).

Remove choke spindle nut (15) and spring washer (16).

Disconnect choke spindle spring (18) from spring anchor plate (17). Remove anchor plate, spring and choke spindle sleeve (19).

Pull-up choke plate (22) from slot in spindle, out of air intake.

Remove choke spindle and pin assembly (23).

Screw out choke lever bearing (26) and remove lever (25).

Remove choke lever spring (28).

To Assemble the Carburetter.

Mount choke lever (25) and spring (28) on bearing and screw latter into its boss on air intake body, locating the spring in its own boss (above that of the choke lever) and behind the lugs on the choke lever.

Insert choke spindle (23) in its bushes so that when choke lever (25) is rotated against the action of its spring (28) and the pin is held firmly against the lugs on the lever (the action of the choke spindle spring) the chamfered ends of the choke plate screw holes are seen.

Insert choke plate (22) in slot in spindle ensuring that the slanting edges of the plate will seat squarely on the bore of the air intake duct when closed.

Mount choke spindle sleeve (19) on spindle.

Locate choke spindle spring (18) in its boss on air intake duct and fit spring anchor plate (17) on cut-away end of spindle, securing with spring washer (16) and nut (15).

Pull choke plate (22) two-thirds out of slot in spindle and hold in fully open position with finger down air intake duct. Locate choke spindle spring (18) in notch in line with boss on air intake duct (12 o'clock position). Holding plate closed by choke lever (25), secure by screws (21).

Note : Grease applied to the top of the screw driver will be of assistance in replacing these screws.

Mount drain plug (36) and main jet (30) with fibre washer (29).

Screw down adjustment adaptor (32) on to washer (31).

Place packing (35) in packing nut (33) and screw finger-tight on to adaptor.

Insert adjuster and screw into adaptor until firmly seated.

Mount slow running and air jet (38) and (37).

Place choke tube (39) in bowl assembly.

Mount throttle stop screw (6) and spring (5), air regulating screw (45) and spring (44), float needle seating washer (43), seating and needle (42).

Note the mark " TOP " on the float (40) and place in carburetter bowl accordingly.

Fit gasket (41) and screw barrel (7) to bowl (24) evenly tightening five screws (3) on spring washers (4). Mount inter-connection rod (11) on throttle and inter-connection lever (10).

Mount throttle stop (9), spacer washer (12), and throttle and inter-connection lever (with rod attached) on to cut-away end of throttle spindle (8), locating the rod in the inter-connection tube hole in choke lever (25).

Fit and tighten spring washer (13) and nut (14).

Push inter-connection tube (20) into its seating in choke lever and adjust so that with a slight pre-load on the throttle lever (10) tending to keep the throttle in closed position, closing movement of the choke lever (25) will slide tube up rod to "kink" and open throttle just sufficiently to uncover progression orifice (see Fig. 18, item F).

The given adjustments of the carburetter and setting for the main jet adjuster provide correct mixture strength for all conditions up to about 3,000 ft. (900 metres) altitude above sea level.

When operating at higher altitudes it may sometimes be necessary to deal with symptoms of rich running and possibly loss of power. In these cases, the main jet adjuster will be found most useful in obtaining a clean running exhaust. Turning the adjuster in a clockwise direction one quarter of a turn at a time will be found effective in weakening the mixture delivered by the carburetter. The mixture may be further weakened if the standard 17 m.m. choke tube is replaced by the 18 m.m. tube which has been designed for use in high altitude conditions. In any case of difficulty the Ferguson Service Department or the nearest Zenith Carburetter Service Station should be consulted.

Holley Carburetter 859-A
Tractors Type TE-A-20

	DATA	ADJUSTMENTS
Main Jet	112 (adjustable needle)	2 to 2½ turns open approx.
Slow Running Jet	177	½ to 1 turn open approx.
Choke or Venturi tube.	21/32″ dia. (17 m.m.)	—

Note : The jet adjustments of this carburetter are very critical, and great care must be taken to obtain the most suitable settings for the particular engine to which the carburetter is fitted.

General Description. Fig. 22.

The Holley Carburetter is fitted to certain of the later tractors type TE-A-20.

Its function is very similar to that of the Scheber Marvel, with the following exceptions :

1. There is no "economiser" drilling.
2. The idle mixture adjusting screw controls the amount of suitably mixed fuel through the idle discharge and progression drillings, whereas, in the Marvel carburetter, it is the proportion of air in this mixture which is controlled.

Choke and Throttle Inter-Connecting Linkage.

Fig. 22 illustrates the inter-connecting linkage between the choke and throttle plates whereby closing of the choke plate brings about a small automatic opening of the throttle plate.

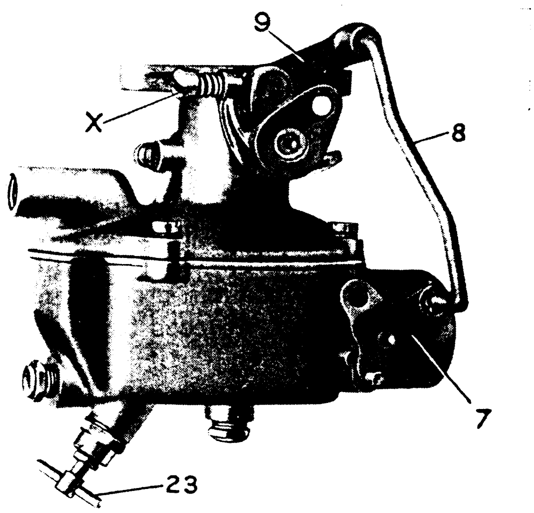


FIG. 22

Fuel System.

The detachable venturi (I) Fig. 23 is of a suitable shape and size to provide sufficient flow of air to the carburetter for all throttle settings.

The carburetter receives its fuel through the fuel line connection (A) and the opening (B) in the float needle seat.

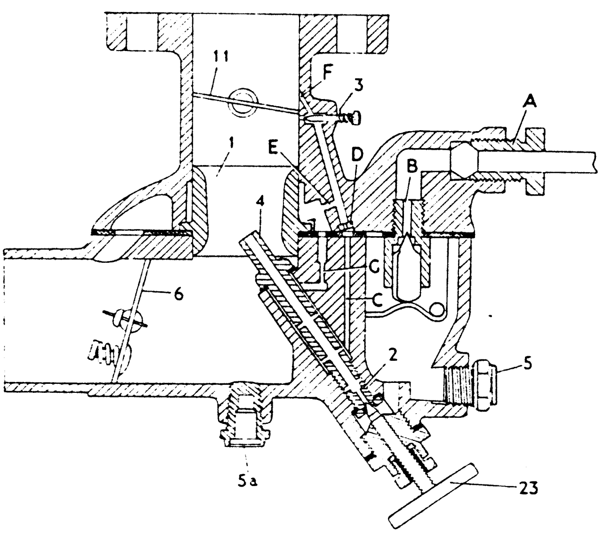


FIG. 23

The idling system draws its fuel from the main fuel supply beyond the main metering jet (2). This fuel rises through the vertical channel (C), idling jet (D) which is a press-fit and meets primary atomising air from channel (E). This emulsion passes up through the annular channel in the throttle body, and is discharged into the main air stream through the idle ports (F) located near the edge of the throttle plate. The strength of the idle mixture at slow idling speeds is controlled by the idle adjusting screw (3). Turning this needle to the right weakens the mixture, and to the left enriches it.

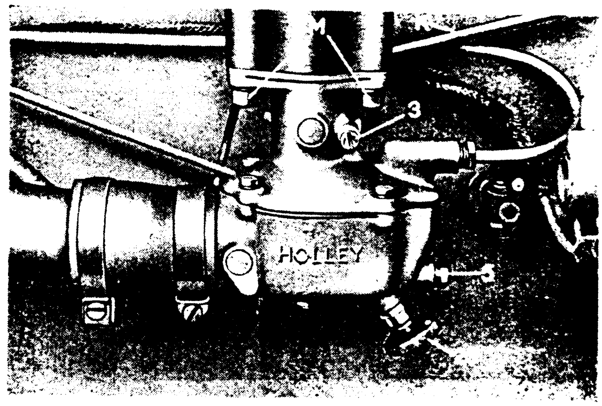


FIG. 24

Slow Running Adjustment.

This should be carried out when the engine is hot, the minimum running speed usually being set at 400 — 450 r.p.m. by adjustment of screw (X) Fig. 22, on throttle shaft lever. This should be turned clockwise to increase idling speed and vice versa. An approximate setting for the slow running mixture screw (3), fig. 24, is $\frac{1}{2}$ to 1 turn open from the fully closed position. If, however, there is evidence of rich running i.e. black smoke from the exhaust, or " hunting," the screw should be gradually turned in an anti-clockwise direction until the engine runs cleanly and evenly.

Full Power System.

The wide-open or full power characteristics of this carburetter have been obtained by balancing the sizes of the main metering jet (2), the high-speed bleed passage (G) and the main discharge nozzle (4) so that the required delivery characteristics are obtained.

Main Jet Adjustment and Setting

Thoroughly warm the engine and adjust slow-running mixture as instructed. Screw in main jet adjusting screw (23) gently until seated, and then unscrew 2 turns open. Figs. 22 and 24 show alternative types of main jet adjuster (23). When the adjustment is correct and the engine warm, it should be possible to open the throttle quickly and obtain an immediate response in engine speed. Should the engine hesitate, open the main jet one eighth of a turn at a time until the immediate response is obtained, without evidence of black exhaust smoke or " hunting."

Drainage.

The carburetter float chamber is fitted with an easily removed drain plug (5), whilst manifold condensation and excess petrol collecting in the bottom of the inlet air chamber can escape through a felt-packed drain plug (5a).

To Remove Carburetter. Fig. 24.

1. Turn off petrol and disconnect petrol supply pipe from carburetter.
2. Remove knob and locknut from choke control rod (J) at bulkhead.
3. Disconnect throttle control tie-rod (K) from governor lever by removing pin from fork.
4. Disconnect rubber hose (L) from carburetter air intake.
5. Remove the two nuts (M) and lock-washers from the studs in the manifold. Lift clear carburetter assembly with control rods and remove flange gasket.
6. Disconnect choke control rod and throttle control tie-rod from carburetter by removal of cotter pins.

To Replace Carburetter.

Before fitting the carburetter to the manifold, the choke control rod (J) and the throttle control tie-rod (K) should, if necessary, be disconnected from their respective housings in the bulkhead and governor lever. This will facilitate the attachment of these rods by means of cotter pins to the appropriate levers on the carburetter.

1. Offer the carburetter, with gasket, to the manifold flange, locating the choke control rod in the bulkhead.
2. Tighten nuts (M) evenly on studs in manifold flange.
3. Replace locknut and knob on choke control rod, and pin and cotter in fork attachment to governor lever.

   Note : Use a thin flange gasket between carburetter and manifold, as a thick gasket may tend to squeeze out, causing the flange to bend and allowing an air leak to occur.

4. Ensure that no air is admitted at the rubber hose (L) connecting the air cleaner pipe to the carburetter.
5. Before attempting to start the engine subsequent to refitting the carburetter, it is a good practice to check the throttle control, choke control, and inter-connection linkage, to make quite sure that the correct amount of travel is obtained.

To Dismantle Carburetter. Fig. 25.

1. Holding the choke plate (6) closed, remove the two screws securing it to lever and shaft assembly (7) and pull out from slot in shaft.
2. Remove cotter pin and washer from the choke and throttle inter-connecting link (8) at the throttle cam arm (9).
3. The assembly comprising :
   (*a*) inter-connecting link (8)
   (*b*) choke lever and shaft assembly (7)
   (*c*) choke return spring (10)

can now be removed from its housing.

4. Holding the throttle plate (11) closed, remove the two screws securing it to throttle shaft, pull out plate, and withdraw lever and shaft assembly (12). The plate is sometimes more easily removed after the carburetter upper body has been separated from the lower body.

5. Remove the four screws (13) with lock washers and separate the carburetter upper body (14) from the bowl (15). Remove the venturi tube (1).

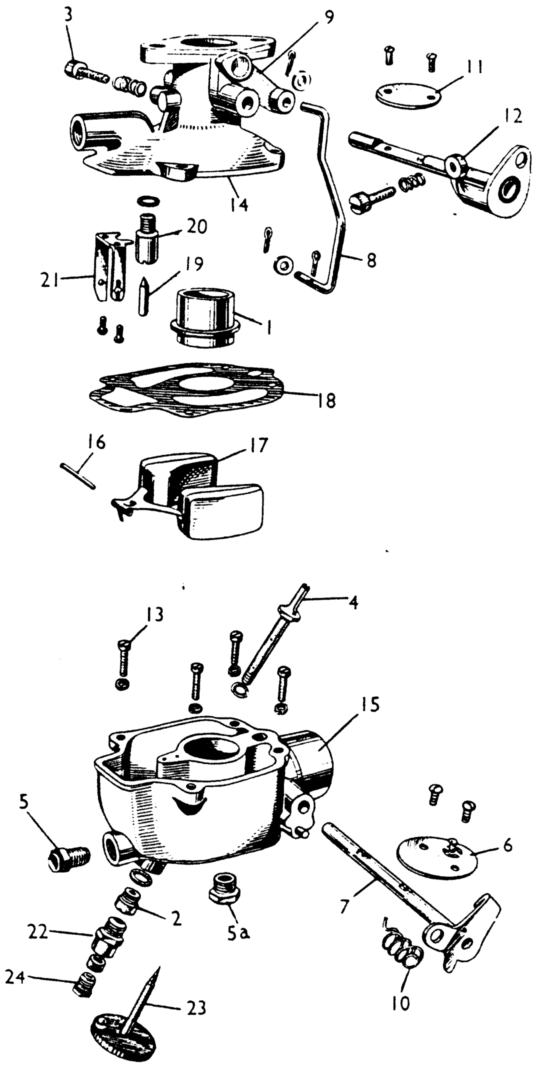


FIG. 25

6. The following parts are pressed into position in the upper body and should not, during normal service, be removed.
   (a) throttle cam arm spindle.
   (b) slow running jet.
   (c) throttle shaft dust cap.
7. Pull float lever pin (16) and remove float (17), carburetter body gasket (18), and float valve needle (19).
8. Using Carburetter Wrench FTB. 4, unscrew and remove float valve seat (20) and fibre washer.
9. The float bracket (21) can now be removed.
10. By unscrewing the larger hexagon (22), the main jet adjusting needle assembly with fibre washer can be removed from the carburetter lower body.

This assembly can be further dismantled by :
   (a) unscrewing the knurled finger screw (in some instances a torque lever is fitted) and removing the adjusting needle (23).
   (b) unscrewing the small hexagonal head of the packing retainer (24) and removing packing.

11. Unscrew and remove main jet (2) with fibre washer.
12. Unscrew and remove main discharge nozzle (4) with fibre washer.
13. Drain plugs can now be removed.
14. The choke shaft dust cap is pressed in position and should not, under normal service, be removed.

To Assemble Carburetter.

Proceed in reverse order noting the following points :—

1. The stiffness of the main jet adjusting needle can be regulated by tightening or loosening the small hexagon of the packing retainer (24).
   If in service petrol leaks at this gland, the packing retainer should be tightened, or a new packing fitted.
2. Grease applied to the screwdriver end will be of great help when replacing screws in throttle and choke shafts.
3. The ventûri should be replaced so that its flange makes a metal-to-metal contact with the face of the carburetter **upper** body.
4. When replacing choke valve plate ensure that the poppet valve spring is pointing back out of the air inlet duct.
5. Set float to give a fuel level 9/16" (14.3 m.m.) ± 1/32" (.8 m.m.) from top face of carburetter bowl. Adopt a similar check as for Marvel carburetter.

The given adjustments of the carburetter and setting for the main jet adjuster provide correct mixture strength for all conditions up to about 3,000 ft. (900 metres) altitude above sea level.

When operating at higher altitudes it may sometimes be necessary to deal with symptoms of rich running and possibly loss of power. In these cases, the main jet adjuster will be found most useful in obtaining a clean running exhaust. Turning the adjuster in a clockwise direction one quarter of a turn at a time will be found effective in weakening the mixture delivered by the carburetter.

FUEL SYSTEM FAULT TABLE

Heavy petrol consumption, bad starting and running can often be wrongly attributed to the carburetter, when the real cause lies in lack of engine tune.

A remedy for engine " surge " will be found under " Governor Control," section F.

FAULT	ATTENTION REQUIRED
Will not Start.	
Fuel Supply Restricted	Ensure that fuel is turned ON and that float needle valve is not sticking. Examine filter screens, strainers and filler cap vent for blockage. Examine sediment bowl for air-lock.
Choke Plate Not Closing Fully.	Inspect and adjust as instructed.
TE-A-20 only—Incorrect adjustment of Inter-connecting Linkage between throttle and choke.	Inspect and adjust as instructed.
Too rich a mixture due either to use of choke when engine is hot, or " pumping " throttle hand lever when operating starter.	Push choke control fully home. Open throttle hand lever to its limits and operate starter. After first few revolutions of the engine, excess fuel will be cleared. Reset controls and engine should start.
Difficult Starting—Poor Idling.	
Incorrect setting of either or both of the idle adjusting screws.	Re-adjust as instructed.
Dirt below idle jet.	Remove jet and clean by blowing out.
Air leak due to loose carburetter bowl	Tighten bolts. Renew gasket if defective.
Air leak at induction manifold, carburetter unions, throttle spindle bushes or hose connections to air cleaner.	Tighten nuts, renew seals, gaskets, or hoses as necessary.
Sticking float needle.	See " Fuel Supply Restricted."
Poor Response From Engine on Opening Throttle.	
Non-Standard main jet.	Fit correct main jet.
Incorrect main jet adjustment.	Adjust according to instructions.
Choke plate not opening fully when dash control is released.	Inspect and adjust linkage.
Jets not screwed down tightly.	Check jets for tightness.
Fuel level in float chamber too low.	Re-adjust float setting as instructed.
Air cleaner oil bath over-filled or cleaner element dirty.	Wash out air cleaner and refill oil bath with clean oil to correct level.

FUEL SYSTEM FAULT TABLE (*continued*)

FAULT	ATTENTION REQUIRED
Leakage and Flooding.	
Grit on float needle seating.	Caused by damaged filter screens in carburetter or fuel sediment bowl. Inspect, clean and replace screens where necessary. Remove needle and clean seating by blowing out. When re-assembling ensure that all washers are perfect and tightened adequately.
Fuel level in float chamber too high.	Re-adjust float setting as instructed.
Leaking float.	Replace.
Leakage through packing of main jet adjustment.	Tighten packing nut. If leakage persists replace packing or adjuster assembly as necessary.

FUEL SYSTEM

TRACTORS TYPE TE-D20, VAPORISING OIL AND TE-H20 LAMP OIL

General.

Vaporising Oil and Lamp Oil tractor engines are designed to operate on low octane fuels which require a minimum engine temperature of 75°C for efficient combustion. Since at lower engine temperatures the use of these fuels will cause sump oil dilution, with risk of resultant liner and bearing wear and loss of oil pressure, provision is made for the use of petrol when the tractor is on work involving numerous engine stops and for starting and warming up.

The thermostat setting of these engines is higher than that of the petrol engine, and a temperature gauge is fitted. This gauge is marked to indicate the temperature (75°C) at which the change from petrol to V.O. or L.O. may be made.

In order to afford additional protection to the engine against damage resulting from possible sump oil dilution, a heavier grade engine oil is recommended, and the period between engine oil renewals is halved.

While the fuel system of the V.O. and L.O. engines is similar in principle to that of the petrol engine, certain modifications, relative to the requirements of these engines, have been incorporated.

The main differences are as follows :—

Fuel Tank Valve and Sediment Bowl Assembly.

The fuel tank fitted to V.O. and L.O. tractors is divided into two compartments, the small rear one B, for petrol — serving both for cold starting and reserve — the other A, for vaporising oil or lamp oil.

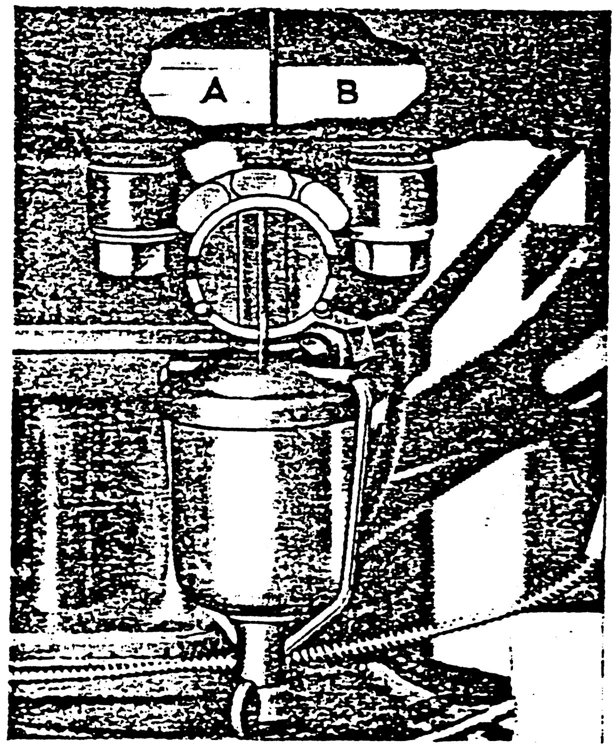


FIG. 26 FUEL TANK VALVE & SEDIMENT BOWL ASSEMBLY.

Selection is made by a three way tap which connects the two compartments to the fuel system (Fig. 26). The illustration shows the tap in the OFF position.

It is necessary to remove the sediment bowl periodically, and clean the sediment bowl and screen by washing in petrol (See page E.3).

Zenith Carburettor 24 T.2

Tractors Type TE-D20 ; TE-H20

	DATA	ADJUSTMENT
Main Jet	—	—
Min Max. Type	1·05	1 turn approx. open
Slow Running Jet	60	1 turn approx. open.
S.R. Bottom Feed	150	—
Air Jet	·079" (2·0 m.m.)	—
Choke Tube Dia.	·669" (17 m.m.)	—

The Zenith Carburettor 24 T2 designed for use with V.O. and L.O. engines is similar to that fitted to petrol engine. An extra slow running fuel feed, however, is incorporated to enrich the mixture at low speeds. (See Fig. 27).

The instructions regarding adjustments, dismantling, etc., given on pages E12 — 17 apply equally to V.O. and L.O. carburettors.

Manifolds and Heat Shield

In order to assist vaporisation of the fuel/air mixture entering the cylinders, the manifold assembly fitted to the V.O. and L.O. engines is designed so that heat is conducted directly from the exhaust to raise the temperature of the inlet manifold.

A heat shield is fitted over the manifolds and this also assists in the retention of engine heat, providing a stable and relatively higher working temperature at the inlet manifold.

IDENTIFICATION OF CARBURETTORS
ALL CARBURETTOR TRACTORS EXCEPT TE-20

The top and bottom halves of all carburettors are marked with letters P (denoting Petrol) or V.O. (vaporising oil) according to type at the following points. (See Fig. 27).

Barrel portion	Adjacent to fuel inlet connection.
Carburettor—bowl	Above spring and anchor for strangler spindle.

These carburettors have an extra slow running fuel feed drilling, to enrich the mixture at low speeds. Lamp oil carburettors, which are identical with the V.O. model are also stamped V.O.

It is not possible to identify the type of carburettor, unless marked, by external examination, as all carburettor bowls have holes die cast in the bottom to permit drilling the main discharge tube and, if

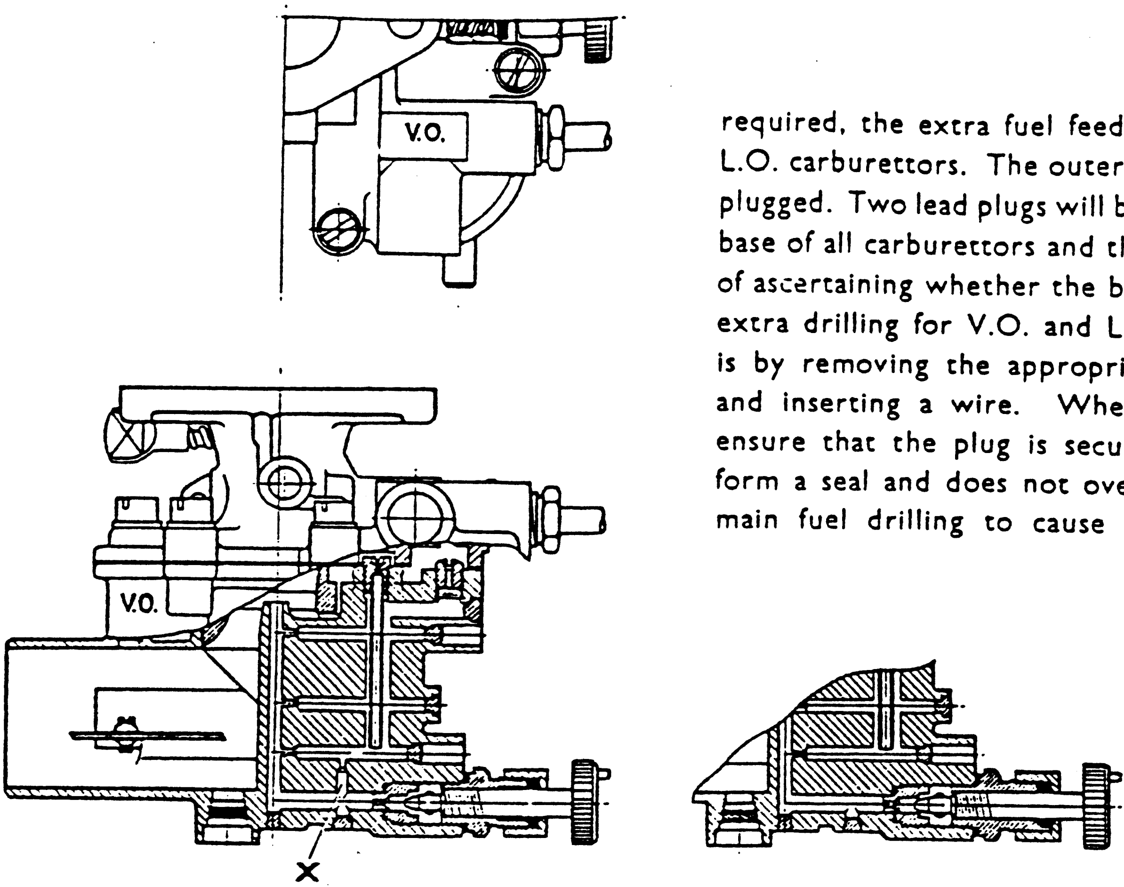


FIG. 27. IDENTIFICATION OF CARBURETTORS.

required, the extra fuel feed for V.O. and L.O. carburettors. The outer casing is then plugged. Two lead plugs will be found at the base of all carburettors and the only means of ascertaining whether the bowls have the extra drilling for V.O. and L.O. operation is by removing the appropriate lead plug and inserting a wire. When replugging, ensure that the plug is securely fitted to form a seal and does not overlap into the main fuel drilling to cause a restriction.

The following modifications have been incorporated in the carburettor engine fuel system. In those instances where alterations affect servicing procedure, further instructions have been added.

At Engine No. :—

85 m.m.	Petrol	SC.2828E
,,	V.O.	S.173890E
,,	L.O.	SB.3786E.

Zenith Carburettor 24T-2

On Zenith Carburettors the min./max. adjustable main jet was superseded by a fully variable type.

This later fully variable main jet needle can be identified by the $\frac{3}{4}''$ diameter knob, which has either a hole, peg or rivet head in the position shown. (See Fig. 27).

	DATA	
Fully variable type	Main Jet Size m.m.	Main Jet Setting Normal
Petrol	1·00	1
V.O.	1·05	1
L.O.	1·05	1

Needle 25° included angle not drilled

SETTING

The recommended settings under normal conditions for the carburettors fitted with the fully variable main jet are :—

1. One complete turn open from the fully closed position for normal setting.
2. One and a quarter turns for maximum power during heavy loading. The use of an excessively weak mixture must be avoided as this will cause burning of the exhaust valves.

The above settings apply to normal working conditions in the British Isles. Excessive cold or heat, high altitude or differences in fuel will modify these recommendations.

At Tractors Engine No. :—

Petrol	SC.12031E
V.O.	S.183053E
L.O.	SB.5166E

AIR BREATHER ASSEMBLY

The air breather valve assembly previously fitted at the induction manifold (See Page E.5) is replaced by one mounted in the rocker cover.

This latest resticter valve, mounted in the cover, can be used to replace valves of earlier design, provided that the old type washer and split pin are removed from the induction manifold, and replaced by distance piece Part No. 103950, or by the original washer, with the centre hole opened out to $\frac{9}{32}$" diameter.

The inclusion of either the washer or the distance piece is important, as this forms a seat for the breather pipe, preventing air leaking into the induction manifold.

When the restrictor valve is re-positioned in the rocker cover, it is essential that the existing restrictor valve is removed from the manifold otherwise engine breathing will be impaired.

At Tractor Serial No. 200.001.

AIR CLEANER AND INLET SCREEN

A new air cleaner was introduced ; this functions on the same principle as those fitted to earlier type tractors, but differs in that air is drawn through a detachable screen on the instrument panel.

Service instructions given on Page E.4, apply equally to this air cleaner.

At Tractor Serial No. 294147 and future
Petrol Engine Tractors only

FUEL VALVE & SEDIMENT BOWL ASSEMBLY

A modified fuel valve and sediment bowl assembly was introduced in which the valve and gland assembly has the seal integral with the spindle, and a rectangular instead of a round handle.

At Tractor Serial No. 325572
Petrol Engine Tractors only

SPILL OFF PLATE

A spill off plate was introduced in production. This plate, which runs the full length of the R.H. side of the tank, is designed to protect the high tension leads from petrol during refuelling, thus avoiding deterioration of insulation and risk of fire.

At Tractor Engine Nos. :—

Petrol	SC.93795E
V.O.	S.235776E
L.O.	SB.11045E

The 28G Carburettor was introduced in production.

28G. CARBURETTOR

Adjustments

Petrol Engine Tractor

Main Jet .... $1\frac{1}{4}$ turns open, $\pm\frac{1}{4}$ turn
Slow Running Jet .... $1 - 1\frac{1}{2}$ turns open

V.O. Engine Tractors

Main Jet .... $1\frac{1}{2}$ turns open, $\pm\frac{1}{4}$ turn
Slow Running Jet .... $1 - 1\frac{1}{2}$ turns open

L.O. Engine Tractors

Main Jet .... $1\frac{3}{4}$ turns open, $\pm\frac{1}{4}$ turn
Slow Running Jet .... $1 - 1\frac{1}{2}$ turns open

Carburettor Engine Tractors will be found to be fitted with one of the following carburettors :

C. 1488

Identification :— Stamped C. 1488

Data

Choke Tube dia. .... 18 mm.
Main Jet .... 225 cc.
Air Jet .... 1·2 mm.
S.R. Jet 70
Needle Seating .... 2·0 mm.
Fuel Level .... 17 m/m. at 18" head (measured from top face of carburettor bowl).

C. 1488

Identification :— Stamped C. 1488 M.
Choke Tube dia. .... 18 m/m. (recessed)
Main Jet .... 225 cc.
Air Jet .... 1·4 mm.
S.R. Jet 55
Needle Seating .... 2·0 mm.
Fuel Level .... 17 m/m at 18" head (measured from top face of carburettor bowl).

General Description

The 28G carburettor is a dustproof vertical unit of robust design and construction, capable of high angle operation.

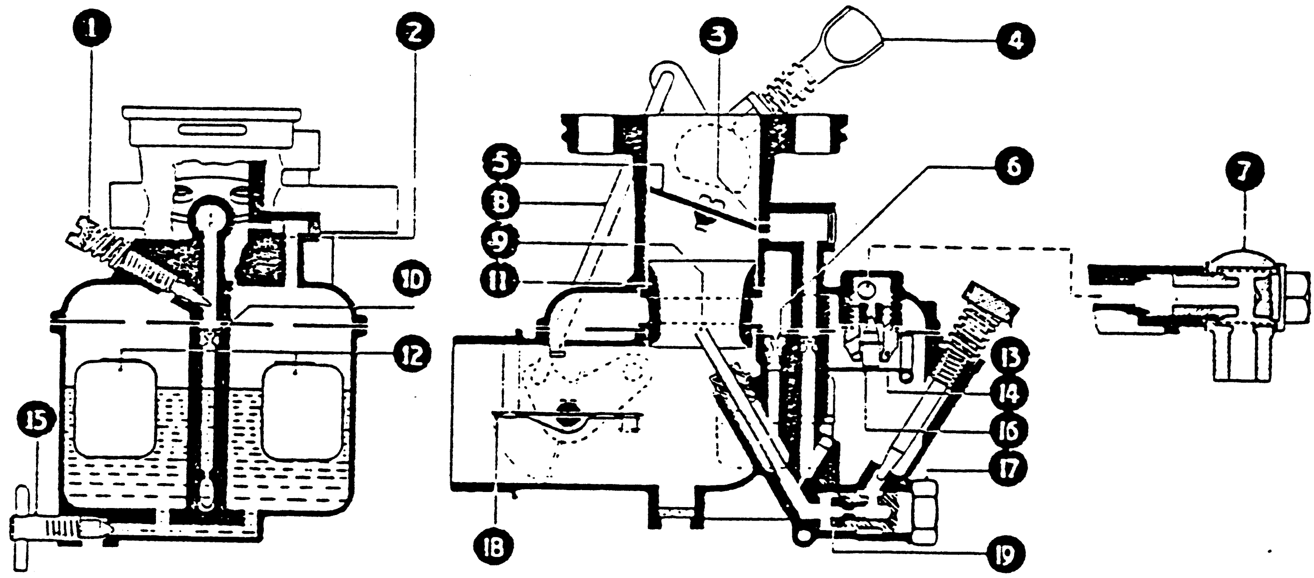


FIG. 29. CROSS SECTION OF CARBURETTOR.

Principle of Operation (Fig. 29)

Fuel enters the carburettor at the banjo union (7) and the float chamber through the needle and seating assembly (14). It will be observed that the float chamber is of special construction, embodying a dual float (12) system, so that as the fuel rises in the chamber the floats will be lifted until, at the predetermined fuel level, they will lift the needle on to its seating and thus prevent the entry of more fuel.

From the float chamber the fuel passes around the adjusting needle (13), through the main jet (19), and rises in the main discharge tube (9), slow running jet (10) passage, and the main air bleed (6) passage, to the predetermined level.

Starting from Cold

By pulling out the choke control the strangler (18) is turned on its spindle, and closes off the air intake of the carburettor. In so doing the inter-connection mechanism automatically opens the throttle (5) to a degree found most suitable for starting purposes. When the engine is rotated a very rich mixture passes to the engine to provide the necessary fuel for starting purposes. Once the engine fires, the extra depression on the engine side of the strangler causes the blade in the strangler, to open and close rapidly against the engine pulsations. This ensures that the engine will continue to run at a good speed without stalling itself due to lack of air. As soon as normal working temperature has been reached the strangler should be released and the fuel will then be obtained from the slow running system with the throttle back to the normal idling position.

Idling

Fuel is drawn from the well beneath the idling jet (10), is measured on passing through the jet and enters the bore of the carburettor through the drilling (3) on the engine side of the throttle. Progressive opening up from idling is ensured by the provision of a second feed hole, slightly below the first in the idling outlet near the throttle edge.

Main Carburettor

Once the throttle is opened, fuel in the channel beneath the air bleed (6) will have been taken in to the engine, and the main air bleed is now effective over the whole speed range. Fuel passing from the float chamber is measured on going through the main jet (19) and will then enter the bore of the carburettor from the main discharge tube (9). At this point the fuel is taken up by the air from the intake of the carburettor and the mixture proceeds to the engine.

ADJUSTMENTS

Slow Running Adjustment

This should be carried out when the engine is hot, the minimum running speed being set at 145 to 165 P.T.O. r.p.m. (40 to 450 engine r.p.m.) by adjustment of the throttle stop screw (4) and the mixture regulating screw (1) to ensure that the engine speed and fuel mixture is correct to obtain steadiness when idling.

Turning the regulating screw (1) in a clockwise direction provides a richer mixture for idling and vice versa. The screw should be turned until a slight hunting (i.e. richness) occurs, and then turned back slowly approximately 1 to 1½ turns until the engine runs evenly. If the screw is turned back too far the engine will stall.

The throttle stop screw (4) is turned inwards to increase and outwards to decrease idling speed.

Main Jet

The combination of choke tube, main jet and air jet should be as specified, and therefore it should not be necessary to alter any of these parts when dealing with ordinary maintenance.

Main Jet Setting

Turn needle (13) gently clockwise until seated and then unscrew requisite number of turns (see above).

The main jet setting given above is approximate only for normal work as fuels tend to vary in different countries, ¼ turn more or less is permissible for rich or weak mixture respectively or to suit fuel variations.

The use of a setting weaker than recommended is a false economy, and may result in burnt exhasut valves.

General Maintenance

As with all carburettors, the keynote of reliable and efficient service is absolute internal cleanliness. It is recommended that the float chamber drain tap (15) should be opened occasionally when the tractor is in use, in order to clear away any foreign matter collecting at the bottom of the float chamber.

To Remove Carburettor

1. Turn off petrol and disconnect petrol supply pipe banjo union (E) from carburettor.
2. Remove knob and locknut from choke control rod (F) at bulkhead.
3. Disconnect throttle control tie rod (G) from governor lever by removing pin from fork.
4. Disconnect rubber hose (H) between carburettor air intake and air cleaner pipe
5. Remove the two nuts (J) and lock-washers from the studs in the carburettor flange. Lift clear carburettor assembly with control rods and remove flange gasket.
6. Disconnect choke control rod and throttle control tie-rod from carburettor by removal of cotter pins.

To Fit Carburettor

Before fitting the carburettor to the manifold, the choke control rod (F) and the throttle control tie-rod (G) should, if necessary, be disconnected from their respective housings in the bulkhead and governor lever. This will facilitate the attachment of these rods by means of cotter pins to the appropriate levers on the carburettor.

1. Offer the carburettor, with gasket, to the manifold flange, locating the choke control rod in the bulkhead.
2. Fit lockwashers and nuts (J) and tighten nuts evenly on studs in manifold flange.
3. Replace locknut and knob on choke control rod, and pin and cotter in fork attachment to governor lever.
4. Attach hose (H), ensure that no air is admitted at the joints between the air cleaner pipe and the carburettor.
5. Attach petrol supply pipe with banjo connection (L).
6. Before attempting to start the engine subsequent to refitting the carburettor, it is a good practice to check the throttle control, and inter-connection linkage to make quite sure that the correct amount of travel is obtained.

FUEL SYSTEM

FAULT TABLE

CARBURETTER ENGINES

(File at rear of Section E)

Heavy petrol consumption, bad starting and running can often be wrongly attributed to the carburetter when the real cause lies in lack of engine tune.

A remedy for engine " surge " will be found under " Governor Control," Section F.

FAULT	ATTENTION REQUIRED
Will not Start.	
Fuel Supply Restricted	Ensure that fuel is turned ON and that float needle valve is not sticking. Examine filter screens, strainers and filler cap vent for blockage. Examine sediment bowl for air-lock.
Choke Plate Not Closing Fully.	Inspect and adjust as instructed.
TE-A-20 only—Incorrect adjustment of Interconnecting Linkage between throttle and choke.	Inspect and adjust as instructed.
Too rich a mixture due either to use of choke when engine is hot, or " pumping " throttle hand lever when operating starter.	Push choke control fully home. Open throttle hand lever to its limits and operate starter. After first few revolutions of the engine, excess fuel will be cleared. Reset controls and engine should start.
Difficult Starting—Poor Idling.	
Incorrect setting of either or both of the idle adjust screws.	Re-adjust as instructed.
Dirt below idle jet.	Remove jet and clean by blowing out.
Air leak due to loose carburetter bowl.	Tighten bolts. Renew gasket if defective.
Air leak at induction manifold, carburetter unions, throttle spindle bushes or hose connections to air cleaner.	Tighten nuts, renew seals, gaskets, or hoses as necessary.
Sticking float needle.	See " Fuel Supply Restricted."
Sticking strangler flap.	Free strangler by loosening air hose clip at carburetter bowl air inlet port. Take care that perfect air seal is maintained.
Poor Response From Engine on Opening Throttle.	
Non-Standard main jet.	Fit correct main jet.
Incorrect main jet adjustment.	Adjust according to instructions.
Choke plate not opening fully when dash control is released.	Inspect and adjust linkage.
Jets not screwed down tightly.	Check jets for tightness.
Fuel level in float chamber too low.	Re-adjust float setting as instructed.
Air cleaner oil bath over-filled or cleaner element dirty.	Wash out air cleaner and refill oil bath with clean oil to correct level.

FUEL SYSTEM FAULT TABLE

CARBURETTOR ENGINES *(Continued)*

FAULT	ATTENTION REQUIRED
Leakage and Flooding.	
Grit on float needle seating.	Caused by damaged filter screens in carburetter or fuel sediment bowl. Inspect, clean and remove screens where necessary. Remove needle and clean seating by blowing out. When re-assembling ensure that all washers are perfect and tightened adequately.
Fuel level in float chamber too high.	Re-adjust setting as instructed.
Leakage float.	Replace.
Leakage through packing of main jet adjustment.	Tighten packing nut. If leakage persists replace packing or adjuster assembly as necessary.
Sticking strangler flap.	See " Difficult Starting — Poor Idling."

FUEL SYSTEM

AS FITTED DIESEL ENGINE TRACTORS
TYPE TEF 20

FUEL INJECTION EQUIPMENT

WARNING :

Special Diesel Precautions.

NEVER bend the high pressure fuel pipes that feed the injectors from the injection pump. **ALWAYS** slacken both union nuts and remove the pipes completely when carrying out any servicing operations to the Fuel Injection Equipment.

NEVER leave any uncoupled fuel connection exposed to the atmosphere. The ingress of foreign matter, smaller than it is possible to see with the naked eye, can ruin both injection pump and injectors within a few seconds running. **ALWAYS** cover injection pump delivery valve outlets with either the brass caps available from any C.A.V. Agent, masking tape, or other suitable protective material.

NEVER handle the Fuel Injection Equipment on the engine with unprotected hands. Diesel fuel is very prone to cause dermatitis so always use a barrier cream on the hands before working on any parts of the fuel system.

WHEN cleaning, setting or testing Fuel Injection Equipment use Shell Fusis "A" Oil and not Diesel Fuel Oil.

NEVER ALLOW THE SPRAY FROM AN INJECTOR NOZZLE UNDER TEST TO PENETRATE THE SKIN BY PLACING A HAND IN FRONT OF THE JET. ALWAYS ENSURE THAT THERE IS A SUITABLE RECEPTACLE FOR THE NOZZLE TO "FIRE" INTO.

ALWAYS use scrupulously clean filtered fuel (or test) oil with the engine and also for fuel injection equipment under test on the bench.

NEVER attempt to run the engine with any part of the governing system such as the venturi assembly, the vacuum pipe or its unions, loose or missing altogether. Under these conditions the engine, when started, will rev. up out of control, and, if not stopped immediately will rapidly rise to speeds well above its safe maximum r.p.m.

Similarly loose joints or damaged gaskets and leaks in the engine breathing system can also unbalance thepneumatic governor.

ALWAYS use fully detergent lubricating oils selected from the brands recommended in the Tractor Instruction Book.

FUEL CIRCUIT.

The main fuel tank which is situated over the engine, feeds the auxiliary tank, located in front of the bulkhead at the L.H. side. The auxiliary tank provides a constant head of fuel, even when the tractor is tilted, and also acts as a settling vessel from which sludge and water can easily be drained.

In gravity fed systems, the fuel is piped through two filters, connected in parallel, to the injection pump. In pressure fed systems introduced at Tractor Serial No. 383711, the fuel is piped to a mechanically operated, diaphragm type feed pump, wherein it passes through a gauze filter and is then delivered at a light pressure through two filters, connected in series, to the injection pump. The injection pump forces the fuel through high pressure pipes to the injectors. Leak-off pipes return any fuel leakage at the injectors to the main fuel tank.

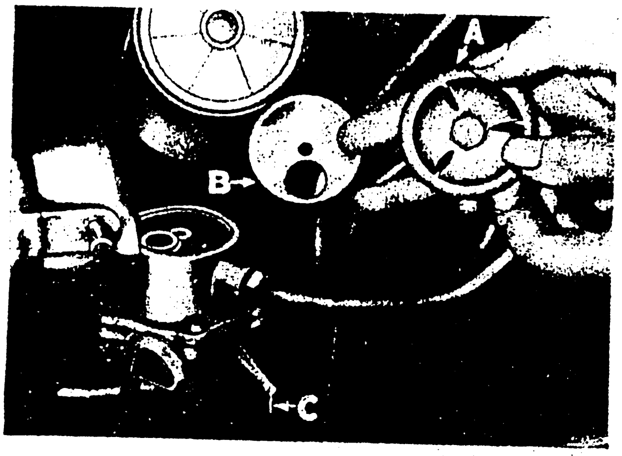


FIG. 101

Included in the pressure fed systems is a circulation connection fitted in the head of the secondary fuel filter, with a pipe leading to No. 4 injector leak-off pipe. This provides a permanent leak — within the capacity of the feed pump — back to the main fuel tank when the tractor is operating.

By this means, the fuel is kept in constant circulation, preventing the formation of stagnant air pockets and assisting de-aeration by automatically bleeding away any air which may find its way into the fuel system.

AIR CIRCUIT.

Air is drawn through a centrifugal air pre-cleaner, and an oil bath air cleaner, before passing through the venturi into the induction manifold.

The vacuum tube from the pneumatic governor is connected to the throat of the venturi, where a butterfly valve, controlled by the throttle mechanism, is mounted. Through this vacuum tube rarying degrees of depression in the venturi are communicated to the diaphragm of the pneumatic governor. The movement of the governor diaphragm operates the control rack of the injection pump, regulating the supply of fuel in accordance with the requirements of the engine. An excess fuel device is incorporated to provide additional fuel for easy starting.

AIR BREATHER CIRCUIT.

The inlet manifold is connected to the chamber enclosed by the rocker cover by an air breather pipe. Through this pipe, warm oil saturated air is drawn from the rocker cover chamber, where it is replaced by air drawn through the push rod passages from the crankcase and crankcase vent.

FIG. 102

COLD STARTING EQUIPMENT.

A Kigass pump is mounted on the instrument panel and provided with a separate fuel tank. The Kigass atomiser is situated in the inlet manifold where the spray impinges on a heater coil, which is heated electrically when the pre-heater control switch on the instrument panel is pulled out. This provides a warm fuel vapour to assist starting.

Decompression Mechanism. which provides for the decompression of three, or of all four cylinders, is provided for ease of starting.

INJECTION PUMP DRIVE

The Fuel Injection Pump on engines up to No. S.A. 5221.E. is driven by a rigid drive shaft and splined coupling incorporating a master spline (Fig. 103). The drive shaft has internal teeth at the rear end, which mesh directly with the splined coupling keyed on the pump camshaft. The pump drive is therefore rigid for either direction of rotation.

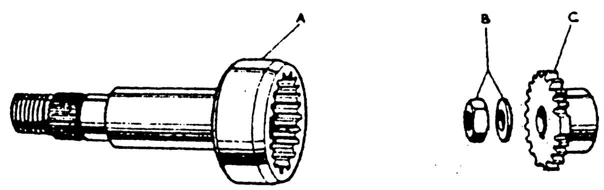


FIG. 103
DRIVE SHAFT WITH RIGID TYPE COUPLING.

The Fuel Injection Pump on engines from No. S.A. 5222.E. is driven by a uni-directional drive coupling (Fig. 104). If the engine "back-fires" the injection pump will not run back with it, since the pump merely disengages and remains stationary even though the engine may "bounce" one or two complete revolutions in reverse.

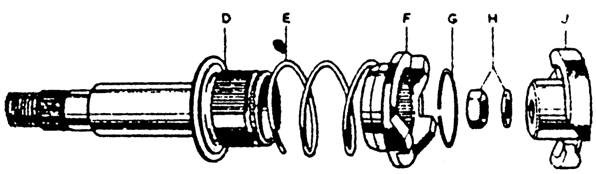


FIG. 104
DRIVE SHAFT WITH UNI-DIRECTIONAL CLUTCH.

This device is necessary to protect the engine with the pneumatic type of governor used, and care must be taken to ensure that it is working properly before it is re-assembled. If the engine did "bounce" back off a compression stroke and started to run backwards and the drive failed to "de-clutch," the intake manifold would of course become the exhaust and the governor diaphragm would receive a pressure above that of the atmosphere instead of below it. This rise in pressure would force the pump control rod into its maximum fuel position and rev. up the engine to well beyond its safe maximum speed, for "no-load" conditions, with the grave possibility of ultimate complete destruction. This will be understood more clearly if reference is made to Section "Pneumatic Governor," Section F.

The device itself, though very important, is exceedingly simple in construction, as may be seen by reference to Fig. 104. The drive consists of a short drive shaft running in a flanged bush mounted in the cylinder block and pressure lubricated from the front main bearing housing. The forward end is serrated to engage the vernier coupling bush which couples it to its driving sprocket, and the rear end is externally splined incorporating a master spline. These splines carry a three-jaw, internally splined driving dog which is spring loaded to hold it rearwards towards its limit stop, which is a circlip in an annular groove cut on the rear end of the male splines.

A similar driven female plate is keyed to the fuel injection pump camshaft, and the jaws are so arranged that the two plates will only "clutch-in" with each other in one position. The non-drive sides of these jaws are so ramped that the moment the drive shaft starts to rotate in the reverse direction, the ramped dogs ride out of their recesses in the female plate, and push the driving plate forward along its splines against the pressure of its return spring. When the drive shaft starts to rotate in its normal direction of rotation again, the drive plate rides over its female member until it reaches the one position where all three dogs can engage simultaneously with their mating recesses. It is then pushed into drive engagement again by its loading spring, thus automatically obtaining the correct pump timing.

Before re-assembling this uni-directional driven coupling, therefore, it is imperative to ensure that there are no burrs or damage on either the male or the female splines and that the two members slide perfectly freely.

when lubricated, with and without the spring in position. After the retaining circlip has been refitted ensure that it locates properly in its recess and is not strained at all, and that the driving dog returns from it, against the return spring pressure, quite easily and with no tendency to stick.

C.A.V. FUEL INJECTION PUMP

The 'A' size fuel injection pump employed on this engine is of the BPE, or enclosed camshaft type, and has four pumping units, as is shown diagrammatically in Fig. 105. The pump's function is to accurately meter and deliver to the combustion chamber fuel at a very high pressure and in quantities which are varied in direct proportion to the load conditions of the engine.

The pump is an accurately constructed and adjusted mechanism, and under no circumstances must it be dismantled or adjusted except by authorised, skilled and trained personnel, who have the appropriate testing and servicing equipment at their disposal for re-phasing and calibrating the pump.

(a) **"Phasing."**

The "phasing" of the pump may be defined as being the internal timing of the pump, that is, its adjustment so that each element commences to deliver fuel — i.e., reaches its "spill cut-off" point — exactly 90° on the pump camshaft after the previous element in the "firing" sequence.

(b) **"Calibration."**

After "phasing" has been correctly effected the pump is "calibrated," that is to say, each element is further adjusted so that at the various control rod settings all four elements deliver exactly equivalent volumes of fuel oil which agree with the volumes specified for the engine in use.

(c) **Maintenance.**

Once every 120 working hours, **when the engine is cold,** open the drain tap (Fig. 105) and run off the excess fuel oil which will, during this period, have drained down from the element chamber, via the tappets, into the camshaft housing. When fuel oil has ceased to flow, close the drain tap again. Top up injector cam box to level cock if necessary, use correct grade engine oil.

(d) **Injection Pump Internal Filter.**

This filter is built in a filter chest behind the element housing in the Fuel Injection Pump itself, and access can only be gained to it after the pump has been removed from the engine. However, no maintenance is required to this filter in between fuel injection pump major overhauls when these elements will be automatically renewed.

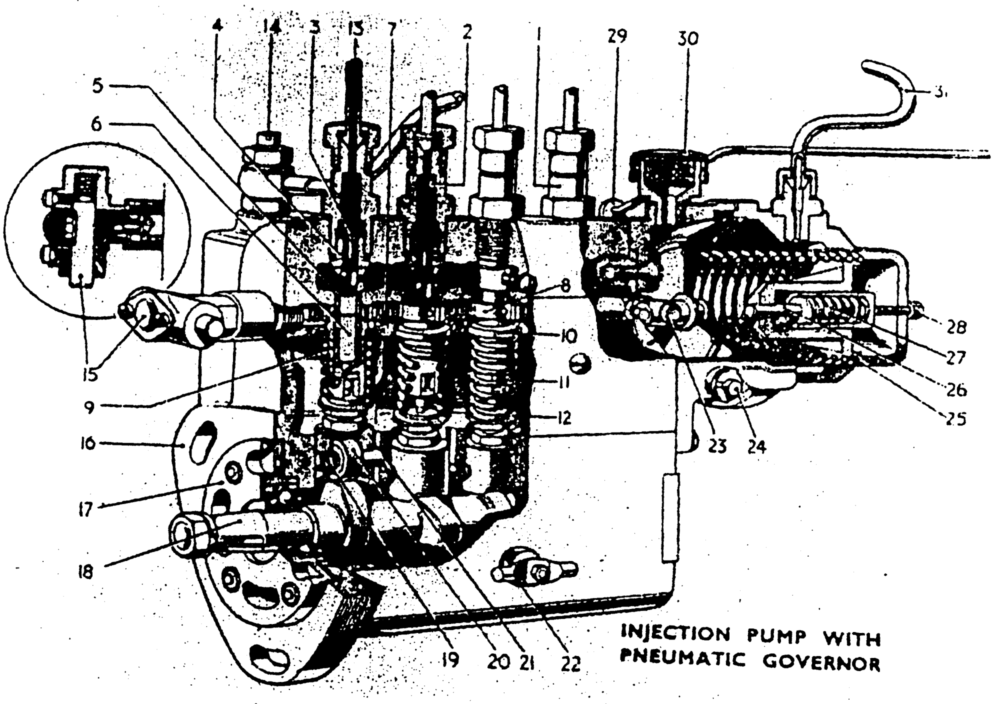


FIG. 105

Ref. No.	Description
1	Delivery valve holder.
2	Delivery valve spring.
3	Delivery valve. } Delivery valve complete.
4	Delivery valve seat. } Delivery valve complete.
5	Pump barrel. } Pumping element.
6	Pump plunger. } Pumping element.
7	Control rod.
8	Control quadrant.
9	Regulating sleeve.
10	Upper spring plate.
11	Plunger spring.
12	Lower spring plate.
13	High pressure fuel delivery pipe.
14	Air vent—fuel inlet union.
15	Excess fuel device.
16	Pump mounting flange.

Ref. No.	Description
17	Ball bearing end plate.
18	Camshaft.
19	Tappet roller pin.
20	Tappet roller.
21	Tappet.
22	Excess oil drain tap.
23	Control rod—governor coupling pin.
24	Fuel cut-off lever shaft.
25	Governor main spring.
26	Idling damper plunger } Idling stop damper.
27	Idling damper spring. } Idling stop damper.
28	Idling damper adjusting screw.
29	Fuel cut-off lever.
30	Governor breather.
31	Vacuum pipe.

FUEL INJECTION PUMP MODIFICATIONS

This section covers the modifications which have been made to the fuel injection pump and give the engine numbers to which each type was fitted in production.

Fuel Injection Pump Part No. 300342 — C.A.V. Type.

BPE 4A60Q120S6200EL complete with governor type BEP/MN 80A120X (Fitted up to engine No. SA1421E).

Interchangeability

Uni-directional pump drive cannot be substituted for rigid pump drive unless appropriate front cover (as shown in Fig. 109 6B) is fitted by Messrs. C.A.V. Ltd.

Pumps Part No. 300781 and 300972 may be used to replace this pump, provided that a new fuel pipe assembly is fitted as follows :

Fuel Pipe Assembly — Rigid Half Part No. 103855

Fuel Pipe Assembly — Flexible Half Part No. 102279

Clip Part No. 500811
Bracket Part No. 103561

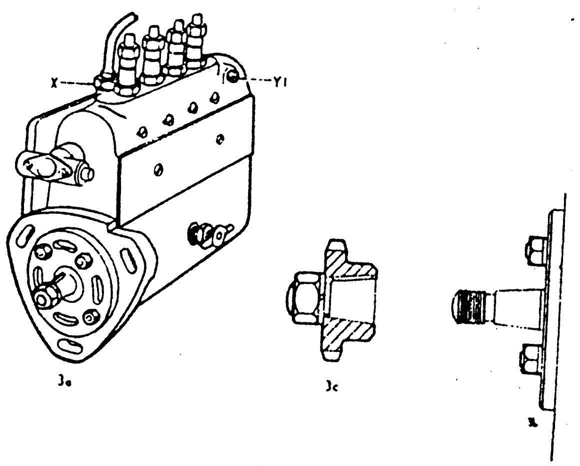


FIG. 106.
INJECTOR PUMP PART NO. 300 342.

Fuel Injection Pump Part No. 300781 — C.A.V. Type.

BPE 4A60Q 120S6200EL. complete with governor type BEP/AMN 80A 102X (Fitted to engine Nos. SA.1422E — SA.4625E inclusive).

Interchangeability.

Uni-directional clutch cannot be substituted for rigid pump drive unless appropriate front cover (as shown in Fig. 108 5B) is fitted by Messrs. C.A.V. Ltd.

Pump Part No. 300972 may be used to replace this pump.

Fuel Injection Pump Part No. 300972 — C.A.V. Type.

BPE 4A60Q 120S6292EL. complete with governor type BEP/AMN 80A 102X (Fitted to engine Nos. SA4626E — SA5156E).

Drive shaft Part No. 201277
Spring Part No. 104649
Coupling Part No. 201276
Retainer Ring Part No. 104612
Drive Coupling Part No. 104611
Nut and washer as supplied with pump.

The drain tap of this pump has a left-hand thread, an when screwed anti-clockwise to drain the pump the tap screws in.

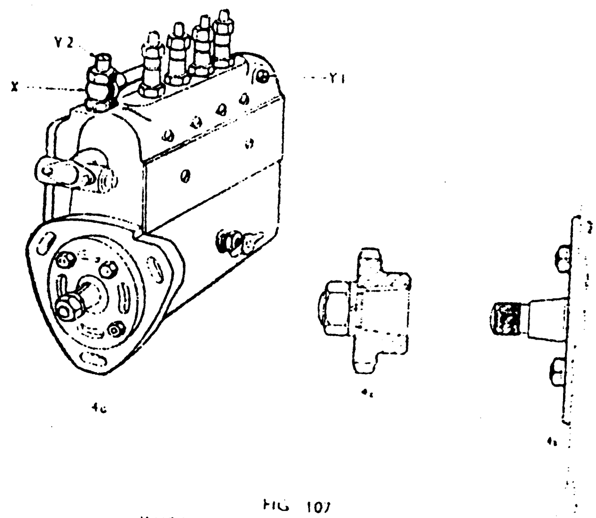


FIG. 107
INJECTOR PUMP PART NO. 300 781

Fuel Injection Pump Part No. 300964 - C.A.V. Type.

BPE 4A60Q 320/3S6293EL complete with governor type BEP/AMN.80A110 (Fitted to engine No. SA. 5157E).

Interchangeability.

This Pump Part No. 300964 was issued as an alternative to Part No. 300972 as a temporary measure to facilitate production. It is not, however, completely interchangeable with previous models.

Fuel Injection Pump Part No. 301562 - C.A.V. Type.

BPE4A60S120S 6341EL complete with governor type BEP/AMN80A 102X (Fitted to engine No. SA.58880E and future.

These pumps are identical with pumps Part No. 300972 with the exception of the cambox drain plug.

INJECTION PUMP TIMING

The spill cut-off point is the instant at which the flow of fuel through the pump spill, port is cut off by the pump plunger on its injection stroke. The pump and the engine should be synchronised so that spill cut-off occurs when the piston is in a position 32° before T.D.C. on its compression stroke.

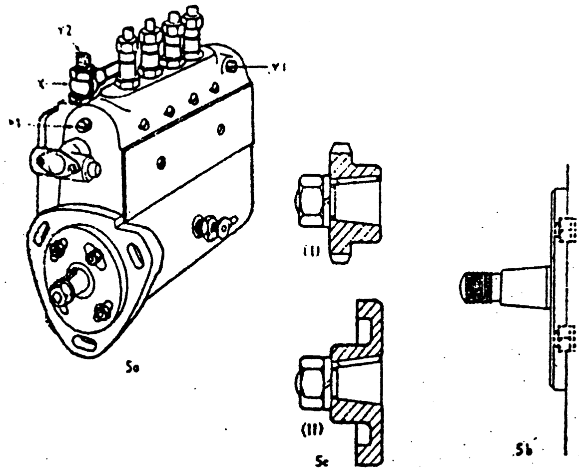


FIG. 108.
INJECTOR PUMP PART NO. 300 972.

Aligning the timing hole in the near side of the cylinder block with a corresponding hole in the flywheel by means of a ¼″ (6·3 mm.) diameter tommy bar, will locate No. 1. piston in the position of 30° before T.D.C.

Injection pump timing is set by co-ordinating No. 1 cylinder and No. 1 pump element and if the injection pump is correctly phased the remainder of the elements will conform for their respective cylinders.

It has been found that the spill timing setting for optimum performance is 32°±1° (crankshaft) up to Engine No. SA 109123E ; 26° before T.D.C. on subquent engines.

The timing holes in the flywheel and crank-case will locate the crankshaft at 30° before T.D.C., and this setting should be used as a datum point only. After setting spill timing at this point it is necessary to swivel the pump on its mounting studs anti-clockwise, (viewed from the front end) .034″ (·863 mm.) —measured on the side of the pump mounting flange adjacent to the existing timing marks— in order to obtain spill point 32° before T.D.C. At this spill timing the .25″ (6·35 mm.) diameter hole in the fly-

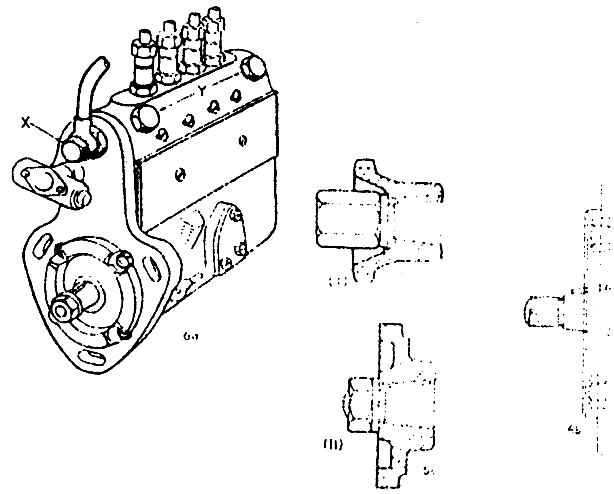


FIG. 109.
INJECTOR PART NO. 300 964

wheel will, therefore, barely be visible, since 1° pump 2 crankshaft .034″ on pump mounting flange and .208 (5·28 mm.) on the flywheel timing hole centres.

A timing disc will be required to enable 26° B.T.D.C. to be obtained from the datum point 30° B.T.D.C.

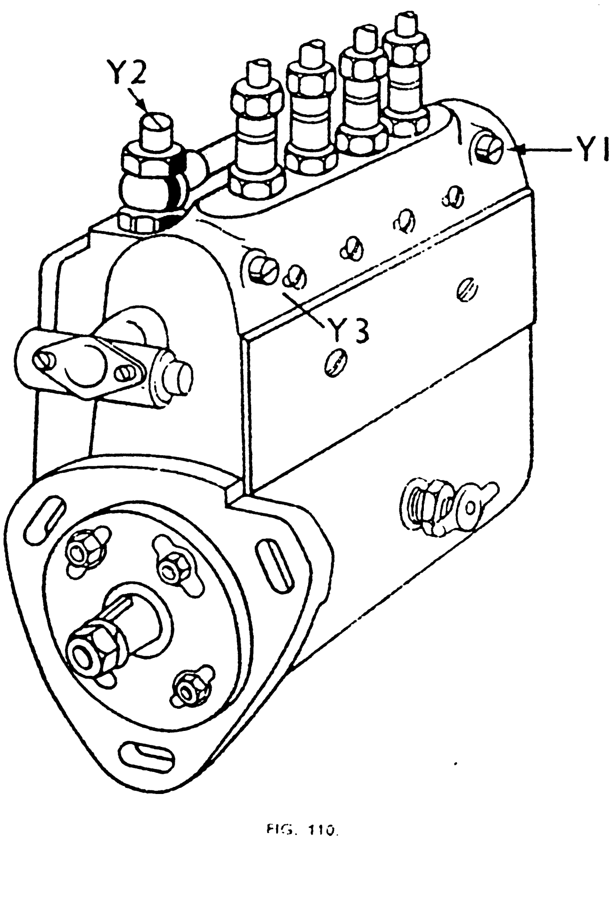


FIG. 110.

EXPLANATION OF PUMP TYPE FORMULA — BPE4A60S120S6341E.L.

B	British made.
P	Fuel Injection Pump.
E	Enclosed camshaft type.
4	Number of elements.
A	Plunger stroke (7 mm.)
60	Plunger diameter (in tenths of a mm.)
S	Design change letter.
1	Camshaft notch at No. 1. end (front as fitted), no fuel lift pump flange on housing.
2	Governor fitted at No. 2. end. (rear as fitted).
0	No injection advance device fitted.
S.6341	Symbol number of pump (variable).
EL	Excess fuel device fitted — of special type.

SPILL TIMING THE FUEL INJECTION PUMP ON THE ENGINE.

The pump is timed by the "Spill Port" method, and it is engaged with its timing sprocket so that spill cut-off occurs 32° before T.D.C. (or 26° B.T.D.C. after engine No. 109124 E).

Remove the fuel delivery high pressure pipe to No. 1. injector and unscrew the delivery valve holder above No. 1. element. Remove the valve spring, withdraw the anti-dribble valve itself and then replace the delivery valve holder and couple to this union a swan-necked pipe. Place the delivery valve and its spring in a clean place — preferably in a suitable container under Fusis Oil.

Remove the inspection cover from the injection pump and if the engine is out of the tractor attach some form of gravity feed supply tank (which incorporates a fuel tap), such as that shown in Fig. 111, to the fuel inlet connection on the pump filter chamber. If the engine is still in the tractor the ordinary fuel system can be used by building up a pressure by hand operation of the fuel lift pump priming lever. Turn on the fuel (or operate the pump, as the case may be) and open the bleed screw on the inlet union until air ceases to escape, then do likewise with the two bleed screws on the side of the pump, starting with the forward one.

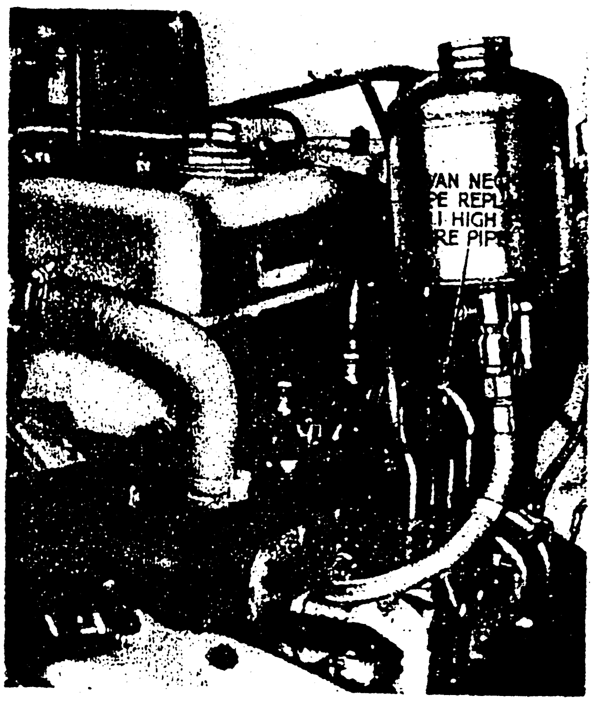


FIG. 111

With the timing inspection cover removed, and the vernier coupling withdrawn, fit the special turning handle F.T.B. 32 on to the fuel pump drive shaft, as shown in Fig. 112 and rotate the pump (first ensuring that the drive is fully engaged) until it can be seen that the tappet of No. 1 element is beginning to rise on its delivery stroke. With the pump at rest, the governor main spring will hold the control rod forward in the normal maximum fuel position, i.e., with the four plungers in the centre of their arc of rotation ; check that the pump is in fact in this condition and is not being held at "idling" or "stop" position by the fuel cut-off lever. This can be ascertained quite easily, with the inspection cover removed, by feeling for the position of the control quadrants with the fingers. An alternative method of ensuring this is by merely depressing the "Excess Fuel Button" if so desired.

Continue to rotate the pump slowly until the flow of fuel which will now be running from the swan-necked pipe, begins to diminish to a series of drips ; continue to rotate the pump very slowly and stop at exactly the point where fuel just ceases to drip from the pipe.

The pump has now reached the "spill cut-off" position for No. 1. element, that is, the plunger in this element has risen sufficiently to just close the spill port and inlet port which are drilled in the barrel. This point is the theoretical point of commencement of the injection cycle for No. 1 cylinder.

With the crankshaft already set to the correct spill cut-off point, namely 32° (or 26°) B.T.D.C. on No. 1 cylinder's compression stroke, it is now merely necessary to insert the internally and externally serrated vernier drive coupling by rotating it in one serration at a time until it will just slip in without causing any relative movement between the pump drive shaft and its sprocket wheel. Maintain a thumb pressure on the periphery of the pump sprocket at a point farthest away from the camshaft sprocket, to overcome any "tipping" tendency due to the tension of the chain.

Before fitting the two lock nuts check the timing of the injection pump by turning the engine forward nearly two complete revolutions and then advance it slowly for the remaining distance until the precise moment when the "spill cut-off" occurs. Note the crankshaft displacement from T.D.C. and ensure that this is in fact 32° (or 26°). If there is an error and it is greater than $1\frac{1}{2}$°, then the procedure must be repeated and the vernier coupling re-positioned. An error smaller than $1\frac{1}{2}$° can be corrected by slackening the three pump attachment nuts and advancing or retarding the pump itself.

If no further adjustment to the pump timing is required the two lock nuts should be fitted to the drive shaft and the inspection plate (or timing cover — whichever has been removed) replaced.

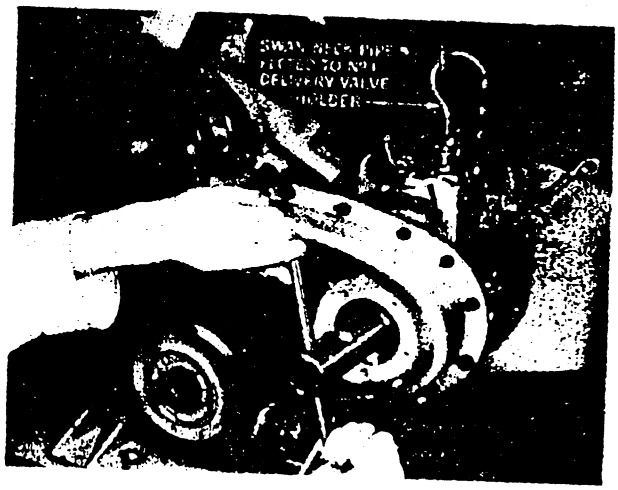


FIG. 112

FUEL FILTERS

To prevent harmful abrasives finding their way into the vital working parts of the injector pump or injectors and causing excessive wear, primary and secondary fuel filters are incorporated in the fuel system.

VOKES FILTERS.

On tractors prior to TEF.336105, the filters are connected in parallel, and have a washable element.

SERVICING.

The elements of these filters should be removed and washed in clean fuel oil every 240 working hours. Care must be taken not to damage the formation of the element fins. All parts of the filter should be washed in paraffin and allowed to dry thoroughly before re-assembly. It is important that the element assembly should be renewed at least once a year.

PUROLATOR FILTERS.
(Connected in parallel).

At tractor TEF.336105, Purolator filters incorporating an unwashable plastic impregnated element were introduced. These filters are connected in parallel on tractors with gravity fuel feed system.

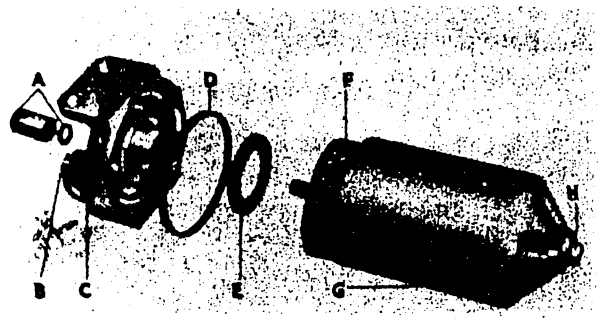


FIG. 113.

SERVICING.

The elements of these filters are not washable and should be renewed every 720 working hours. At the same time the sump and head of the filter should be cleaned. Ensure that all seals are in good condition before refitting.

PUROLATOR FILTERS.
(Connected in series).

At tractor TEF.383711, the fuel feed pump was introduced and the filters were connected in series. The nut on the secondary filter was replaced by a drilled plug, with a pipe leading to No. 4 leak-off pipe, providing a permanent leak back to the main fuel tank and assisting de-aeration by bleeding away any air which may find its way into the system.

SERVICING.

The primary fuel filter, mounted towards the rear of the engine, should be serviced at intervals of 480 working hours. The element must be changed and the sump and head of the filter cleaned.

The secondary fuel filter, mounted towards the front of the engine, will not require attention at intervals of less than 1,000 hours and is sealed for this reason.

FUEL FEED PUMP

After passing through the fuel valve and sediment bowl assembly, the fuel is piped to the mechanically operated, diaphragm type feed pump. The pump is mounted on the L.H. side of the cylinder block and is driven by the engine camshaft. It delivers the fuel under light pressure through the fuel filter to the injection pump. A hand lever is provided on the pump to enable the fuel system to be primed manually during de-aeration. (See page 114).

Details of Operation.

As the engine camshaft (G) revolves, the eccentric (H) lifts the pump rocker arm (D) pivoted at (E) which pulls the rod (F) together with the diaphragm (A) downward against spring pressure (C) thus creating a vacuum in the pump chamber (M). Fuel is drawn from the tank and enters at (J) into sediment chamber (K) through filter gauge (L), suction valve (N) into the pump chamber (M).

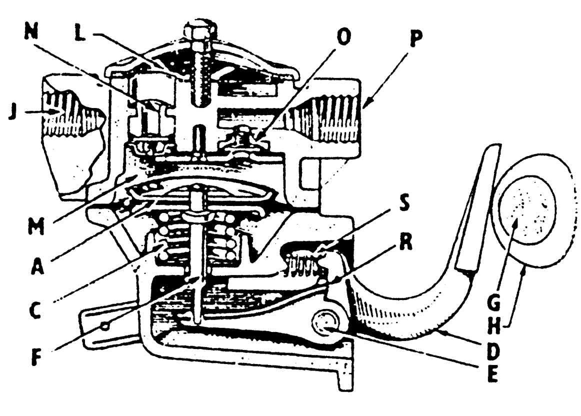


FIG. 114

On the return stroke the spring pressure (C) pushes the diaphragm (A) upwards, forcing fuel from chamber (M) through the delivery valve (O) and opening (P) to the primary and secondary fuel filters and the injection pump.

Delivery of fuel is automatically regulated according to engine requirements as when flow is small, spring (C) can only give a correspondingly reduced movement to the pump diaphragm.

The rocker arm (D) operates the connecting link by making contact at (R) and this construction allows idling movement of the rocker arm when there is little or no movement of the diaphragm. Spring (S) keeps the rocker arm (D) in constant contact with the eccentric (H) to eliminate noise.

Cleaning Filter.

The filter should be examined every week and cleaned if necessary. Under conditions of dust laden atmosphere this interval should be reduced as conditions dictate. Access to the filter is gained by removing the dome cover, after unscrewing the retaining screw, when the filter gauze itself may be lifted off its seating. Clean filter gauze with air jet. The cork gasket under the filter cover should be renewed if broken or if it has hardened. When refitting the cover, make certain that the fibre washer is replaced under the head of the screw. Tighten the filter cover retaining screw just sufficiently to make a tight joint. Check pump engine mounting set screws and fuel pipe unions for tightness.

Servicing.

Should a fault be suspected.

First check that there is sufficient fuel in the tank and see that all joints and pipes are perfectly air tight, as any leak will cause the lift pump to deliver insufficient fuel.

Uncouple the pipe from the outlet union and operate the hand priming lever. Fuel free of bubbles should spurt from the union at each stroke of the priming lever. A weak or irregular supply of fuel at the injector pump, provided it is not due to inadequate fuel supply, air locks or kinked pipes, indicates a faulty lift pump.

Removing from engine.

First, the pipe unions should be disconnected, the two set screws fixing the fuel pump at the engine should be unscrewed, after which the fuel pump will come away readily.

Inspection of Parts.

First, all parts must be thoroughly cleaned to ascertain their condition. Wash all parts in the locality of the valves in a clean paraffin bath, separate from that employed for the other and dirtier components.

Diaphragm and pull rod assemblies should be replaced unless in entirely sound condition without any signs of cracks or hardening of the diaphragm layers.

TESTING OF FUEL PUMP.

The best method is by using an AC bench test stand, on which the suction side of the pump is piped to a tin of paraffin at floor level and the outlet side of the pump connected to a stop tap and pressure gauge.

First, flush the pump through to wet the valve and seats, and then completely empty it again by continuing to operate the rocker arm by hand with the suction pipe clear of the paraffin. Again operate pump. Not more than 20 strokes should be necessary to secure delivery of paraffin from the pump outlet.

With the same apparatus a second test can be made by working the pump with the tap on the delivery side closed, pressure then being recorded on the gauge. After ceasing to work the pump it should take several seconds for this pressure to return to zero, thus denoting that the valves are seating properly. Also, while there is pressure, the outer edge of the diaphragm—visible between the two clamping flanges—

should be carefully examined for leakage and the retaining screws tightened if necessary.

When working the pump by hand a somwhat longer stroke is obtained and the pressure developed is apt to be higher than when fitted to the engine.

When the above apparatus is not available the fuel pump should be tested, using a pan of clean paraffin, as follows :—

First, flush the pump by immersing it in the paraffin and working the rocker arm half a dozen times, then empty the pump by continuing to operate it while held above the bath. Then with the pump clear of the paraffin bath place a finger over the inlet union (marked "in") and work the rocker arm several times. Upon removing the finger a distinct suction noise should be heard, denoting that the pump had developed a reasonable degree of suction.

Afterwards the finger should be placed over the outlet union, and after press- ing the rocker arm inwards the ai drawn into the pump chamber shoulc be held under compression for two oi three seconds ; this should also be don with the pump immersed in paraffi and the clamping flanges of the dia phragm watched for any signs of ai leakage.

REFITTING TO ENGINE.
Reverse the procedure outlined for remova from the engine. Ensure that the rocke arm is correctly positioned against the can

TO CHANGE FUEL INJECTION PUMP

If an engine has a fault somewhere in the fuel injection equipment, and after careful diag- nosis it has been decided that the Injection Pump is responsible, it may be changed quite simply, as described below, without disturbing its timing.

(a) **Removal of Pump.**

1. Completely remove high pressure fuel pipes and governor vacuum pipe, but only release the pump end of the flexible fuel feed pipe and the two control cables.

2. Scribe a line on the crankcase (if it is not already marked) exactly opposite the scribed line on the pump mount- ing flange, as shown in Fig. 115. If there are other scribed lines on the block these must be obliterated..

3. Remove the three attachment nuts together with their spring and plain washers and withdraw the pump. The pump attachment nut between this unit and the engine will require a socket wrench with universal exten- sion and a $\frac{9}{16}$" A/F socket.

All pumps supplied direct from a C.A.\ Agent, should have been correctly phase and calibrated within the limits specified fc this engine, and will also have the Exce: Fuel Device correctly set and sealed an will also be scribed with a " spill cut-off timing mark.

The breaking of this seal or the one on tl venturi maximum speed stop by ai

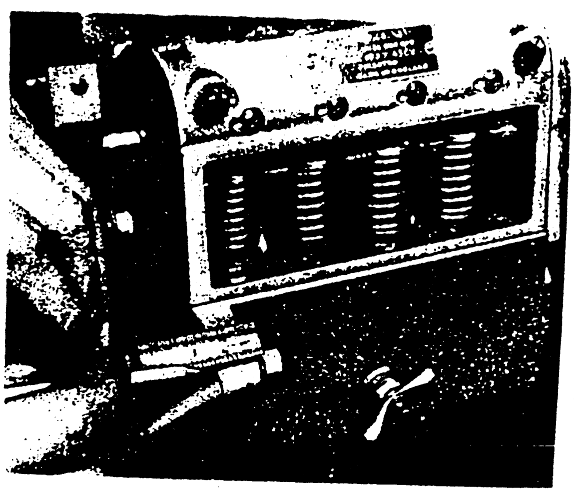


FIG. 115.

unathorised person renders the guarantee on the engine and the fuel injection equipment null and void. It is therefore essential to ensure that all pumps obtained are correctly set and sealed before being accepted — this can be confirmed by referring the pump to a C.A.V. Agent — and that they carry the scribed timing mark for installation to the engine. Although this scribed line can be put on by the repairer provided he is in possession of the required marker plate. The procedure for doing this operation is described later on in the Section.

(b) Spill Timing the Injection Pump.

For this purpose the MARKER PLATE supplied by Messrs. C.A.V. Ltd., under part No. ET816 must be used. It is attached to No. 1 end of the pump camshaft by a spring washer and nut and located by the original camshaft key, after removing the coupling flange as shown in Fig. 116.

With a gravity feed tank attached, the delivery valve removed from No. 1 element, a swan-necked pipe fitted and the inspection cover removed, the pump is rotated in its normal direction for several revolutions. Then as the tappet for No. 1. element commences to rise again continue rotating very slowly and carefully until the flow from the pipe just ceases.

If the pump has been correctly phased it will now be possible to push the plunger of

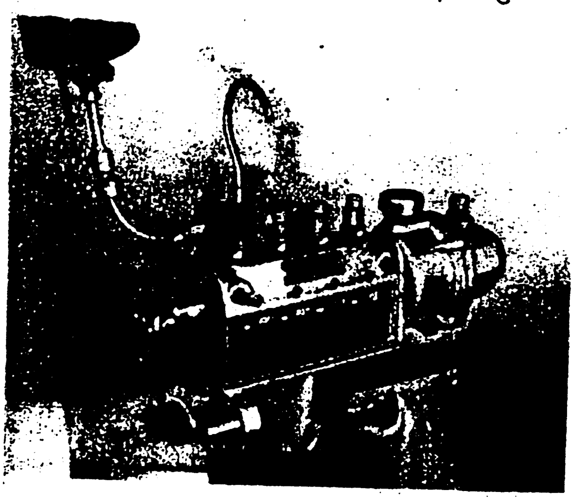


FIG. 116.

the tool in and it will pass through the attachment slot as shown in Fig. 116.

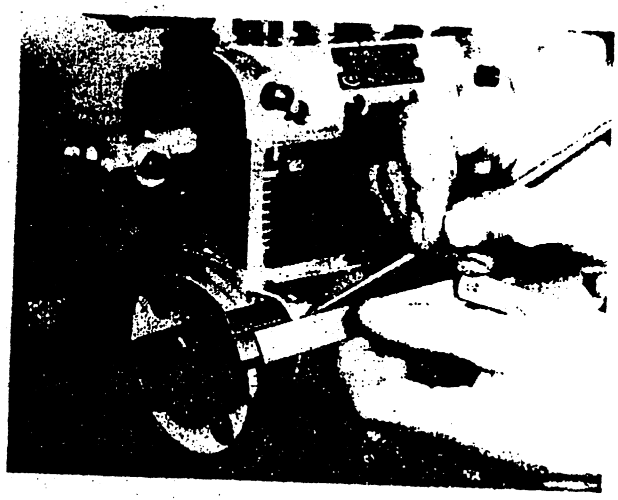


FIG. 117

If this is correct, ensure that the camshaft does not move, and then scribe a line on the pump flange exactly in line with the master line on the marker plate, as shown in Fig. 117. This, then is the mark which is used to re-position the pump on the engine and automatically sets the pump timing back to its original setting. The marker plate, gravity feed tank and swan-necked pipe should be removed and the camshaft coupling flange and No. 1 delivery valve refitted.

(c) Refitting the Pump.

Mount the pump horizontally in the protected jaws of a vice and remove the inspection cover. Open the oil drain tap and slowly fill the cam box with ordinary engine oil via the two drain holes in the base of the element chamber, as shown in Fig. 118, until oil starts to run out of the drain tap. Let the oil find its own level and when it has ceased to drip, close the tap but do not replace the inspection cover until the pump has been reinstalled.

1. Position a new paper washer over the three pump attachment studs and offer up the pump.

2. Push the pump into engagement and fit the three attachment plain washers, spring washers and nuts.

3. Before fully tightening adjust the pump until the spill timing line on the pump flange is again **exactly** opposite that on the crankcase.

Important.

This operation is best carried out by rotating the engine until the drive engages with the coupling flange of the pump.

4. Fit the venturi vacuum pipe, couple up the two control cables and ensure that they are both adjusted and functioning properly and attach the flexible fuel feed hose and turn the fuel tap "on."

When refitting the stop control rod ensure that the stop control lever rests on the pump casing when the operating knob on the instrument panel is pushed right home.

5. Replace all the high pressure pipes and tighten the union nuts finger tight. Then fully tighten the lower ones on the pump delivery valves, unscrew the upper ones half a turn and air bleed the system.

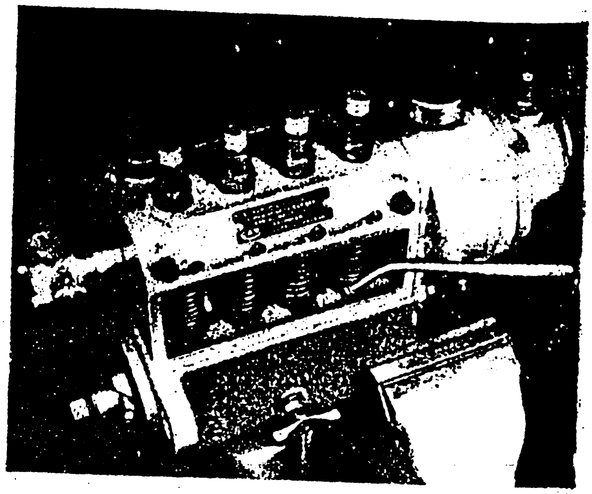


FIG. 118.

INJECTORS

THE INJECTORS. See (Fig. 119).

The injectors employed on this engine are of the "closed" type, so called because the nozzle (2) is closed by a needle valve (3) under the influence of a spring (6) after each injection stroke.

The injector consists of two main parts, the nozzle and valve assembly (shown enlarged in Fig. 120) and the nozzle holder. The nozzle valve (3) takes the form of a double cone ended plunger, accurately lapped into the nozzle body (2) to the closest possible fit at which it will work freely. The actual clearance is approximately 1 micron (i.e., .001 mm., which is equivalent, in statute measurement, to approx. .0004"). The outer end of the nozzle valve is reduced in diameter in two stages to produce a stem upon which a valve face is formed whilst the inner end is provided with a locating peg to carry one end of the valve spindle (5).

Fuel received at the inlet union (12) is delivered through the nozzle holder (11) by a drilled duct to the annular gallery formed in the pressure joint face at the inner end of the nozzle body. From this gallery three further vertical drillings carry the pressurised fuel oil into a second annular gallery or reservoir just above the valve seat. The nozzle valve is raised from its seat in the nozzle body hydraulically by the pressure of the fuel oil once this has reached the 120 atmosphere "break-away" pressure to which the injectors are set. This pressure, being produced by the upward rising plunger in the injection pump once it has shut off the spill ports, is transmitted direct to the reservoir in the lower part of the nozzle. Thus precisely the same volume of fuel displaced into the pipe line by the pump plunger is injected from the lower reservoir into the cylinder in the form of a finely atomised spray through the hole in the lower end of nozzle body. Formed on the lower part of the valve is a small cone shaped pintle

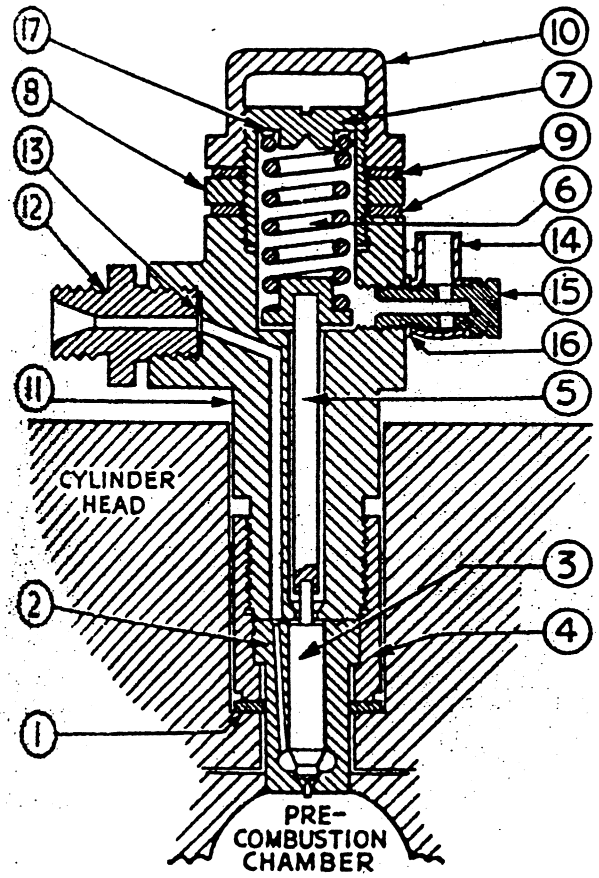


FIG. 119.

INJECTOR NOTATION (Fig. 109).

Ref. No.	Description.
1.	Copper sealing washer
	Pintle nozzle
2.	Nozzle body
3.	Nozzle valve
	Nozzle Holder
4.	Nozzle cap nut
5.	Valve spindle & cap
6.	Valve spring
7.	Spring adjuster screw
8.	Adjuster screw locknut
9.	Copper sealing washers
10.	Protecting cap
11.	Nozzle holder body
12.	Fuel inlet union
13.	Copper joint washer
14.	Leak-off union
15.	Leak-off union screw
16.	Copper sealing washers
17.	Skid washer

which projects through the discharge hole in the base of the nozzle. The function of this pintle is to control the angle of divergence of the spray to 4° and to assist in atomisation by discharging a hollow cone of highly pressurised fuel mist into the pre-combustion chamber in a form in which it can more easily absorb heat and readily ignite with the compressed air to enable it to burn completely without either smell or smoke.

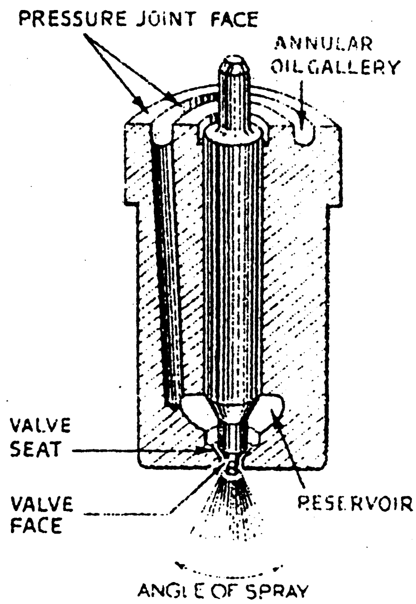


FIG. 120

The slight leakage of fuel oil which passes up the nozzle between the nozzle valve shaft and its bore from the lower reservoir is sufficient to lubricate the nozzle and it is then lead away by the " leak-off " union (14) back to the fuel tank.

SERVICING THE INJECTORS.

Under normal operating conditions it should not be necessary to remove and overhaul (i.e., strip, clean and reset) the injectors more than once every 720 hours. However, if an injector is suspect it can always be withdrawn and tested without dismantling.

The nearer the ideal conditions of good combustion, with adequate cooling and scrupulously clean fuel are realised, the less attention the nozzles will need, and consequently the longer will be their efficient working life.

(a) Faults in Service.

The first symptons of injector trouble may usually be recognised by one or more of the following complaints :—

1. Increased cylinder knock.
2. Engine overheating.
3. Loss of power.
4. Excess of black exhaust smoke.
5. Increased fuel consumption.

Do not immediately assume, however, that the nozzles are necessarily the cause of the troubles. Other faults which will produce similar symptons to the above are such features as incorrect valve timing, faulty valve seats, incorrect pump timing, dirty or damaged fuel filters, unsuitable or poor quality fuel filtration, incorrect fuel, water in the fuel, defective engine lubrication, " hot " bearings, or incorrect " normal maximum " fuel pump setting and so on.

Assuming, therefore, that everything else has been checked and is in order and the injectors are still suspect, the particular injectors causing trouble can often be detected by setting the engine to a fairly fast idling speed with the throttle control lever and then releasing the high pressure pipe union nut on each injector in turn, and listening to the idling performance of each of the other cylinders.

A faulty injector can also sometimes be detected by feeling each high pressure pipe in turn with the engine idling. A distinct " kick " on the pipe will be felt with a good injector — If one of the pipes feels " softer " than the rest check this injector first.

(b) To remove an Injector.

1. Unscrew the unions at **both** ends of the high pressure feed pipe and remove the pipe completely.

2. Unscrew the union screw underneath the injector and release the " back-leak " fuel pipe, taking care not to lose the two copper washers, one on either side of the brass union itself.

3. Unscrew the two injector retaining nuts evenly about a quarter of a turn at a time until all the tension has been released, to avoid distorting the injector.

Note : If all the injectors are being removed for routine cleaning, merely remove all eight attachment nuts and washers evenly, and withdraw all injectors as a battery, i.e.. still attached to the four branch fuel back leak pipe. Then detach each injector individually on the bench.

(c) To Test a Suspect Injector with a Nozzle Setting Outfit (Fig. 121).

Fill the fuel tank of the nozzle setting outfit with approximately $1\frac{1}{2}$ pints (·852 litres) of Shell Fusis 'A' Oil. Before operating the outfit, bleed off all the air by opening the bleed screw situated at the rear and just above the pumping element and close it about three seconds after the escaping fuel has ceased to show signs of air bubbles.

Attach the injector to be examined to the pressure pipe and leave the union nut slack. With the pressure gauge isolator valve (2) closed, operate the outfit to expel all air from the pipe line until fuel is seen to escape from the loose union nut. Then tighten the union nut and continue pumping until the injector commences to spray.

WARNING : Great care must be taken to ensure that the spray from injector is firing into a suitable container and away from the operator. Although fusis oil is not so liable to cause " dermatitis " as diesel fuel oil, the spray from an injector is neverthertless quite capable of penetrating the skin and having done so, could easily enter the blood-stream of the unwary or careless operator.

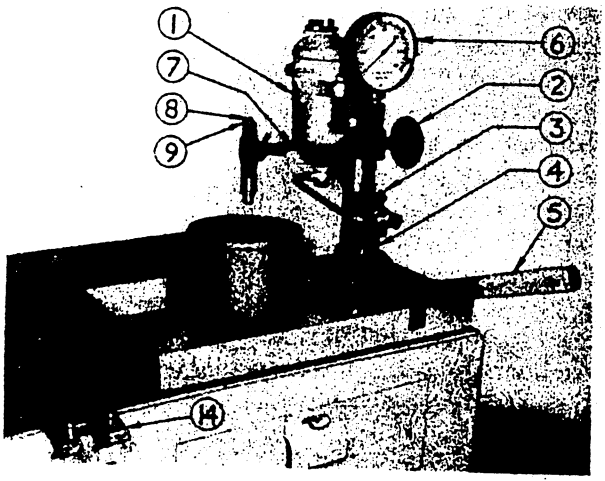


FIG. 121.

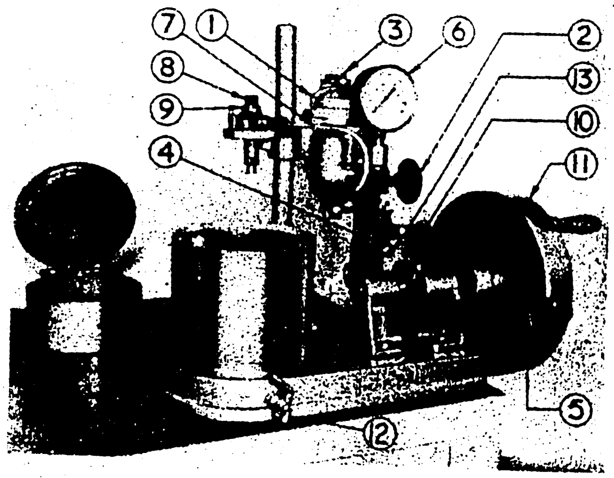


FIG. 122.

NOTATION FOR FIGS. 121 and 122.

Ref. No.	Description
1.	Fuel container and filter unit.
2.	Pressure gauge isolator valve.
3.	Air vent screw.
4.	Injection element.
5.	Hand pumping lever.
6.	Pressure gauge.
7.	High pressure feed pipe.
8.	Injection pressure adjusting screw.
9.	Locknut for adjusting screw.
10.	Pumping eccentric.
11.	Hand wheel.
12.	Fuel drain cock.
13.	Fuel (volume) delivery control rod.
14.	Bench Plate ET.812.
15.	Safety container ET.142.

Next open the isolator valve and whilst operating the pump handle slowly note the "break-away" pressure of the injector under test. This should just reach 120 atmospheres on the dial, before the valve in the nozzle lifts and allows the spray to escape. If this is satisfactory, shut off the isolator valve and rotate the flywheel, Fig. 122 (or operate the pump handle in the case of ET.122PA. — Fig. 121), at approximately 100 r.p.m. and study the formation of the spray. With this type of pintle nozzle the spray should be finely atomised, true to, and equally distributed around the axis of the nozzle, and free from course or solid streaks, which would indicate the presence of foreign matter or damage to the valve seating, and the angle of divergence of the spray should be 4°.

To ensure that the valve seat is not leaking, wipe the face of the injector nozzle dry, and pump up the pressure to 10 atmospheres under the break-away pressure i.e., to 110 atmospheres).

The flat nozzle face must remain substantially dry and there must be no tendency for blobs of fuel to collect or drip. A slight dampness can be tolerated.

If these tests prove satisfactory, and the injector has not yet reached its "major overhaul" period, it may be refitted to the engine with reasonable confidence in its performance.

(d) To Test a Suspect Injector with no Equipment.

This is not an operation which is to be recommended as a certain amount of guess work and uncertainty are involved, but in the event of an injector failing when the tractor is in the field, provided a spare, clean and correctly set injector is available for such replacement purposes, the following procedure may be employed to determine if an injector is at fault.

Ascertain by the method described under " Faults in Service " (a) which injector is suspect, then remove it as described under " To Remove an Injector " (b).

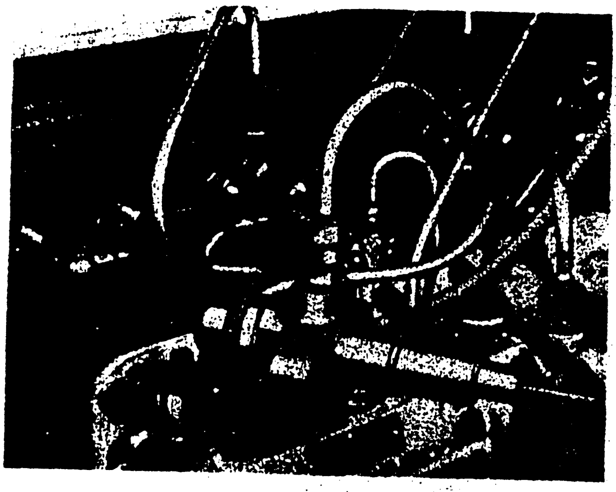


FIG. 123.

If it is not possible to isolate any one injector as suspect, then start with No. 1 and remove and test each in turn. With the injector withdrawn, the high pressure pipe will, of course, be entirely removed. Reposition the pipe so as to allow space for the injector to be re-attached the opposite way round, " firing " away from the cylinder head, as shown in Fig. 123.

It may be necessary to use one of the other injector pipes to allow the suspect injector to be suitably positioned, or alternatively, a special length of " spare " high pressure pipe shaped for the purpose.

Next, slacken the unions of the injector feed pipe of the other injectors to prevent fuel oil being sprayed into the cylinders. Using the Decompression lever, fully decompress all cylinders by moving the lever upwards as far as it will go. Operate the electric starter motor, turn the engine over and observe the spray.

If any of the faults described in the previous section are present, that is, if the spray is noticeably " wet " or " streaky " or obviously deflected to one side, or if the nozzle dribbles and the face of the injector is unduly wet after being operated a few times, or atomisation is poor, then it should be replaced by a spare injector. If, however, this injector proves satisfactory, repeat the test operation with each of the remaining three injectors in turn.

After locating the troublesome injector, fit the " spare " one ; the faulty one should be wrapped in clean grease proof paper or rag and placed in the tool kit for the earliest possible attention at the Service Depot. No attempt should be made to dismantle the injector and clean the nozzle " on the spot " as without proper cleaning tools and nozzle setting outfits this is impossible.

TO OVERHAUL AN INJECTOR

(a) To dismantle an injector after withdrawal from the cylinder head place it on a mounted nozzle bench plate (ET.812) and remove.

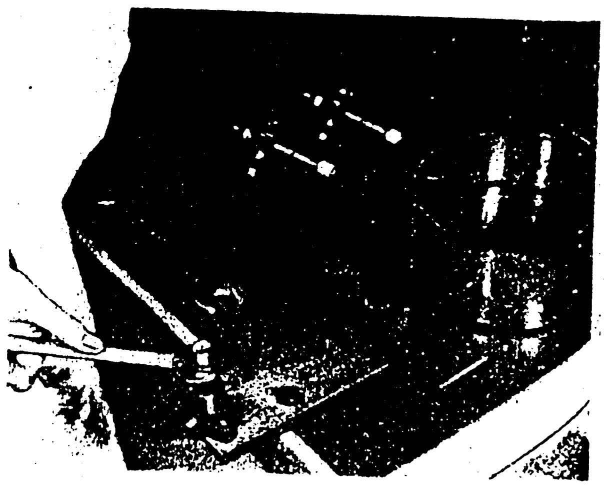


FIG. 124

1. Protecting cap (10) with 1" A/F spanner.

2. Locknut (8) also 1" A/F spanner, together with the two copper sealing washers.

3. Unscrew spring adjuster screw (7) and withdraw the valve spring (6),

taking care not to lose the small skid washer which rests on top of the spring.

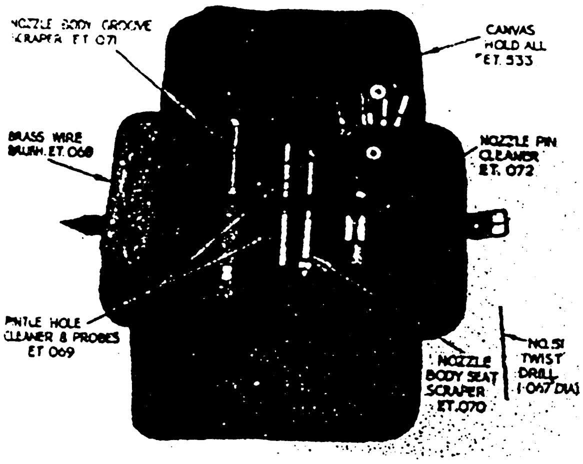


FIG 125

4. Insert the nozzle holder and tip out the valve spindle (5) then unscrew the nozzle cap nut (4) with $\frac{3}{4}$" A/F open ended spanner.

5. Remove nozzle body (2) complete with nozzle valve (3) and place in the safety container (partly filled with Fusis oil) together with the nozzle holder.

Note : It should not be necessary to remove the fuel inlet union (12) under normal circumstances, but if this is necessary because of leakage, a $\frac{5}{16}$" Whitworth ring spanner should be used and a new copper joint washer (13) must be refitted.

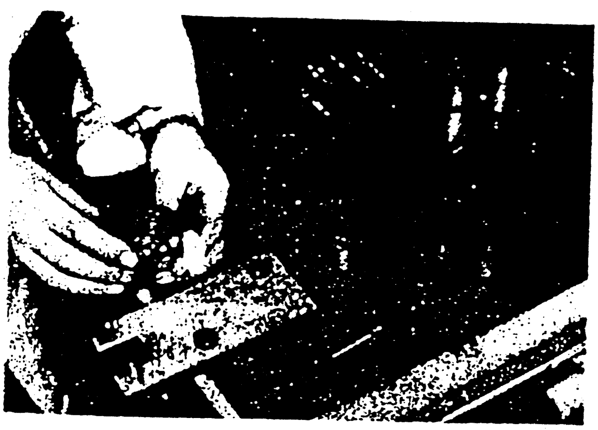


FIG. 126.

(b) **To Clean a Dismantled Injector.**

The most suitable bench for nozzle maintenance is one that is zinc or linoleum covered, absolutely free from dust, dirt, filings, grease, or acids, where no other work is done and where the use of cotton waste and fluffy rags is strictly forbidden. It should be provided with a small vice (the jaws being protected with soft copper or aluminium shields) at one end, a nozzle bench plate (ET.812) mounted at the other end and a dust proof drawer for holding nozzle cleaning tools.

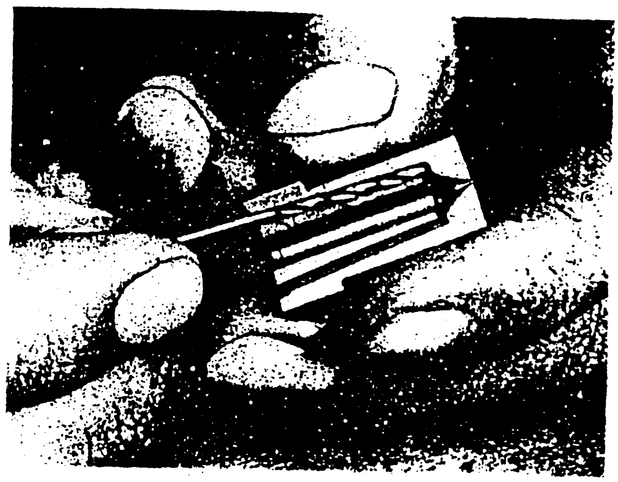


FIG. 127.

For the pintle injectors fitted to this engine which are of the "S" type, the cleaning kit ET.140 shown in Fig. 125, will be required. This kit consists of a canvas hold-all (ET.533) and contains the following tools :—

1. ET.068 Brass wire brush.
2. ET.069 Pintle hole cleaner with probes.
3. ET.070 Nozzle body seat scraper.
4. ET.071 Nozzle body groove scraper.
5. ET.072 Nozzle valve head cleaner.

(c) **Cleaning Procedure.**

1. Examine the nozzle for carbon and whether the valve lifts out freely. Brush all carbon from the outside of the nozzle with the brass wire brush (E.T.068), see Fig. 126.

Place the nozzle body and valves in the Fusis oil container to soak and soften the internal carbon.

Note : The nozzle should be free from all signs of damage and it is important that it is not "blued" due to overheating. All polished surfaces should be relatively bright without scratches or dull patches. It is essential that the joint faces of the nozzle holder and the nozzle body area are absolutely clean and free from any blemish as these faces must register together and form a high pressure joint without the assistance of any form of gasket or washer.

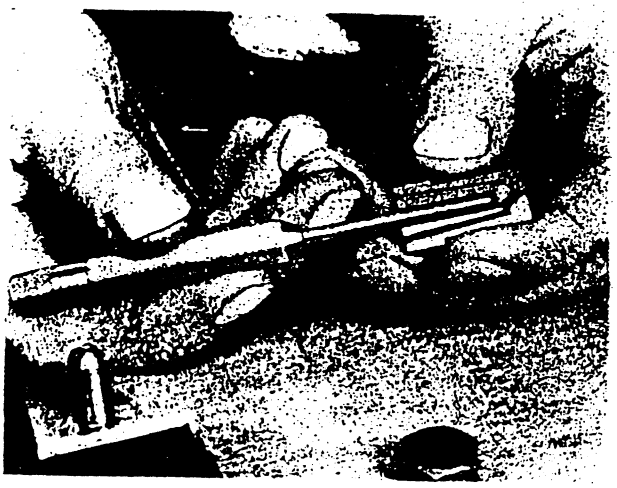


FIG 128.

2. Clean out the three drillings that feed the lower resevoir in the nozzle body either with a piece of wire or a No. 51 twist drill (0.66" dia.), see Fig. 127. These bores are rarely choked and the insertion of the drill or wire by hand will be sufficient. If, however, they do contain a heavy carbon deposit, it is advisable to use a $\frac{1}{16}$" diameter drill, also by hand, first.

3. Insert the special groove scraper (ET.071) until its nose locates in the fuel resevoir, as shown in Fig. 128. Press hard against the side of the cavity and rotate the nozzle to clear all carbon deposits from this area.

4. With the nozzle body seat scrape (ET.070) clean all carbon from thi valve seatings by pressing the toc on to the seat and rotating the nozzl body by hand, see Fig. 129.

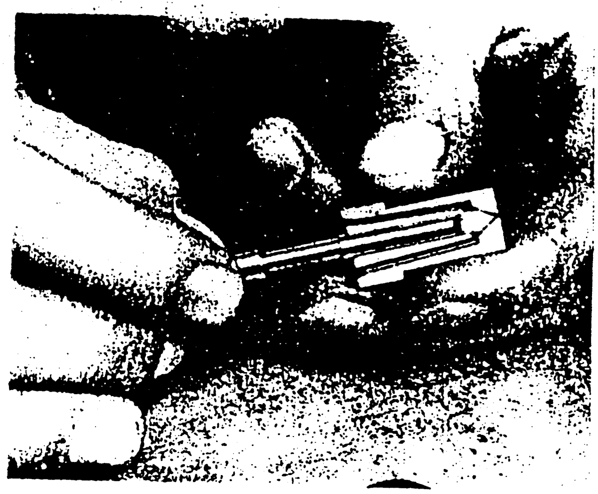


FIG 129

5. For cleaning the orifice in the face of the nozzle body use the pintle hole cleaner (ET.069) and select an appropriate size probe from those supplied with the kit and fit it into the tapered hole in the smaller end of the brass holder for the earlier injectors, or the other end for the later ones. Pass the probe down the bore of the nozzle until it protrudes through the orifice, then rotate the nozzle, using only a light pressure, until all the carbon is clear, as shown in Fig. 130.

6. To clean the pintle end of the valve itself insert the valves into the appropriate end of the nozzle pin cleaner (ET.072) and rotate until all the carbon is removed, as shown in Fig. 131. Should this not prove completely satisfactory the brass wire brush (ET.068) may also be used and any hard pieces of carbon still not dislodged may be removed with a piece of wood or brass strip.

It is important that great care is exercised with the nozzle valve, and in particular the pintle, to prevent damage to either as a slight scratch or burr may cause valve leakage or spray distortion.

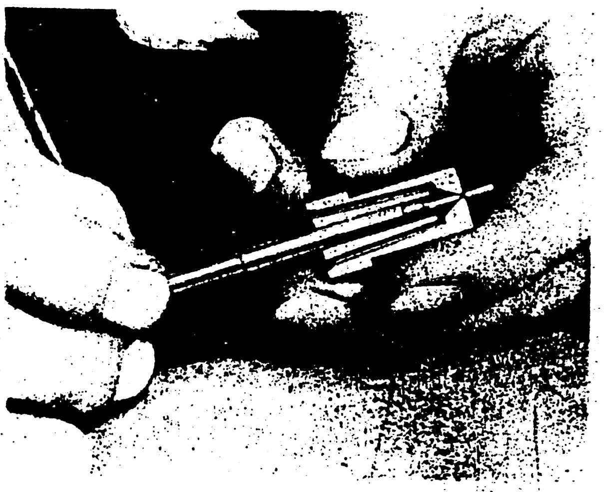


FIG 130

7. Assemble the nozzle into the flushing tool (ET.427) with the nozzle face towards the smaller thread connector, as shown in Fig. 132, which should then be coupled to the nozzle setting outfit (ET.122 PA). The flushing tool should be arranged with the open end pointing downwards to facilitate particles being washed out.

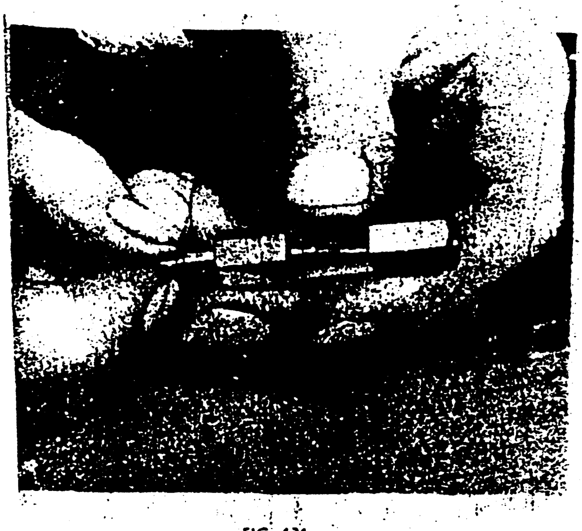


FIG. 131.

Force the oil through vigorously by operating the pump lever smartly. This is most important as it has the effect of not only thoroughly cleansing out the inside of the body reservoir and bores but also washes away loose particles of carbon that may still be present in the pintle orifice. After cleaning, both the nozzle body and the nozzle valve should be placed in the Fusis oil container.

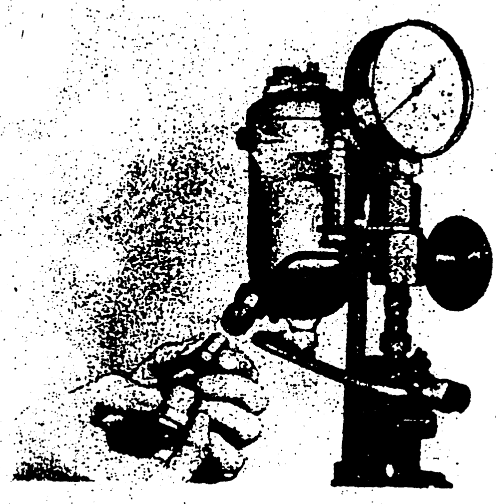


FIG. 132.

Note : If the nozzle is blued or the valve seat has a dull circumferential ring indicating wear or pitting, the complete unit should be set aside for special attention by a C.A.V. Depot or agency. Under no circumstances may an attempt be made to lap the nozzle valve and body to try and improve the valve seat, as this is a highly specialised process and any attempt to perform this will probably reduce both nozzle and valve to scrap.

(d) To Re-assemble an Injector after Cleaning.

1. Fit the nozzle valve into the nozzle body whilst still under the surface of the Fusis oil. If there is the slightest sign of tightness do not force the valve, but withdraw it and gently swill both valve and nozzle about under the Fusis oil and try again.

Lift the nozzle, with the valve fitted out of the oil and ensure that the valve is free enough to move throughout its full length under its own weight. Then replace in the oil.

FIG. 133.

2. Examine the lapped pressure face of the nozzle holder and the corresponding face of the nozzle and ensure that they are both perfectly clean and free from dirt or metallic particles. The nozzle holder itself of course, should have been thoroughly cleaned and washed out in petrol, or Fusis oil, before re-assembly. Dip the lapped joint face of the nozzle holder into the Fusis oil container, pick up the nozzle body, complete with assembled valve, and place the two joint faces together whilst under the surface of the oil then lift them both out. By employing this process particles of dirt too small to be seen by the eye will be washed away as the two joint faces come into contact. Place the nozzle holder upside down on the bench plate and fit and tighten the nozzle cap nut which will already have been cleaned.

3. Fit the valve spindle and by pressing on the pintle head of the nozzle valve with the thumb nail of one hand and pressing on the spindle with the other, as shown in Fig. 133, ensure that the valve is still perfectly free.

If it is not, the nozzle has been distorted in the tightening of the nozzle cap nut which must be undone and re-tightened without causing distortion.

4. Locate the valve spring and fit the spring adjuster screw, ensuring that the spring locates properly over its spigot on the latter, and that the skid washer (Fig. 119, Page 115) is in position. Fit one of the copper sealing washers and the adjuster screw locknut which is left finger tight at this stage.

The other copper sealing washers and the protecting cap are not fitted until after the injector has been tested and adjusted.

(e) To Test and Reset and Clean Injector.

The C.A.V. nozzle setting outfit (Tool No. ET.122PA, shown in Fig. 121, Page 117) is suitable for this purpose, but better still, the " rotary " version of this outfit shown in Fig. 122, Page 117, has greater advantages.

Couple up the injector to be set and " bleed " the unit as described under Section " To Test a Suspect Injector with a Nozzle Setting Outfit " then proceed to test as follows :—

1. **Back Leakage.**

   Open the isolator valve to bring the pressure gauge into operation and set the injector, by means of the adjuster screw to " break " at between 160 to 170 atmospheres. Operate this pump handle two or three times and carefully check that the break-away pressure is between these limits, then pump up the pressure again to just below the break-away setting so that the injector does not actually " fire." Hold the lever and allow the pressure to fall naturally, timing the drop of the gauge needle from 150 to 100 atmospheres. Using

Shell Fusis "A" oil, with a room temperature at between 50° and 70°F. this pressure drop should take not less than 6 seconds for a nozzle in good condition, and should not take more than 45 seconds, which would mean that the valve is receiving insufficient lubrication.

When carrying out this test, observe that no leakage occurs at the lapped pressure faces of the nozzle holder and nozzle. If leakage at this point is suspected, do not over-tighten the cap nut in an effort to stop such leakage.

The correct procedure is to remove the nozzle cap nut, re-examine the pressure joint faces for signs of dirt or surface imperfections and again re-assemble under the surface of Fusis oil and retest. If the pressure drop time is still below the minimum and there are no leaks at the nozzle joint face, then excessive leakage past the lapped position of the valve must be suspected and a replacement nozzle and valve assembly should be installed.

This may be confirmed if excessive oil issues from the "leak-off" union after several operations of the pump handle, assuming that the valve seat itself is not at fault. See next paragraph.

2. **Forward Leak.**

Now set the nozzle to the correct "breaking" pressure of 120 atmospheres by pumping the lever slowly and noting the pressure recorded before the gauge needle "kicks" as the valve opens. This should be accurately adjusted by movement of the spring adjuster screw and when the correct "break-away" pressure has been achieved, lock the adjuster by tightening the adjuster screw locknut.

To check the "forward leak," that is, ensuring that the valve seat is not leaking, wipe the face of the nozzle dry and build up a pressure which is 10 atmospheres below the break-away pressure, and maintain it by very slow downwards movement of the pump lever. The nozzle face must remain substantially dry, there must be no tendency for blobs of fuel to collect or drip.

A slight dampness can be ignored.

3. **Spray Test.**

Use the rotary type nozzle setting outfit and isolate the gauge by shutting the valve and rotate the flywheel at between 85 and 90 r.p.m. by hand and observe the spray, if outfit ET.122PA is being used, operate handlever smartly at a speed of 90 — 100 strokes per minute.

The following points should be checked :—

(*a*) Deflection.

The spray should be true to the axis of the injector and spread equally, as the spray advances, either side of the axis.

(*b*) Penetration.

The spray should penetrate the same distance into the surrounding atmosphere on each stroke.

(*c*) Form.

The spray should be finely atomised covering an included angle of 4° as it leaves the nozzle. There must be no coarse or solid streaks of un-atomised fuel in each discharge.

If all is in order and the injector has passed all the tests satisfactorily, remove it from the test outfit and place it back in the bench plate to refit the second copper washer and the cap nut.

When the injector is re-installed on the engine, a new copper washer (1) should be fitted and care must be taken to ensure that its two attachment nuts (each of which carries a spring washer) are tightened evenly.

EXPLANATION OF INJECTOR TYPE FORMULA.

(a) The Nozzle Holder, BKB 50S 622.

B — British made.
KB — Nozzle holder.
50 — Barrel length in mm.
S — Barrel dia. (25 mm.)
622 — Individual feature number.

(b) The Nozzle, BDN 4S 1.

B — British made.
DN — Nozzle, pintle type.
4 — Angle of spray.
S — Size letter.
1 — Individual feature number.

DIESEL FUEL SYSTEM FAULT TABLE

FAULT	ATTENTION
A. Engine will not Start.	
1 Air supply restricted.	1 Clean air filter, pre-cleaner and bowl. Refill to level mark with clean oil.
2 Fuel supply inadequate.	2 Examine and rectify as necessary : (a) Fuel pipes for obstructions and kinking. (b) Fuel lift pump and pipe connections. (c) Fuel filters for choking by dirt or water. De-aerate the fuel system.
3 Injection pump or injector not functioning correctly.	3 De-aerate the fuel system. Check control rack for sticking shut. Service injectors. Renew pump if necessary.
4 Spill timing incorrect.	4 Check and adjust as necessary.
5 Kigass cold starting equipment not functioning correctly.	5 Check spray and atomiser. Check that heater plug is operative.
B. Loss of Power.	
1 Unsuitable fuel.	1 Use only fuels recommended in the instruction Book.
2 Exhaust ports or pipe restricted.	2 Clean out as necessary. Enlarge ports, see Section C, Fig. 122.
3 Decompression mechanism incorrectly adjusted.	3 Adjust in accordance with instruction in Section C, Page C 109.

Additionally, apart from paragraph 5 covering the Kigass starting equipment, any of the faults listed in Table A may be responsible for loss of engine power, and any of the faults listed here in Table B may contribute towards the engine failing to start.

DIESEL FUEL SYSTEM FAULT TABLE—CONTINUED

FAULT	ATTENTION
C. Excessive Black Smoke.	
1 Air supply restricted.	1 See table A (1).
2 Excessive fuel injected.	2 Maximum fuel stops out of adjustment. Fuel pump incorrectly calibrated.
3 Injectors not functioning correctly.	3 Service Injectors.
4 Spill timing incorrect.	4 Check and adjust as necessary.
5 Poor compression.	5 See Table B (3).
6 Fuel syphoning from Kigass tank.	6 Screw in Kigass pump operating knob.
8 Unsuitable fuel.	8 See table B (1).
D. Overheating.	
1 Spill timing too far advanced.	1 Check and retard as necessary.
2 Injectors not functioning correctly.	2 Service Injectors.
3 Exhaust ports or pipe choked.	3 Clean out as necessary.

GOVERNOR CONTROL

GOVERNOR CONTROL.

Function of the Governor—Fig. I.

One of the most consistent demands made on the engine of a modern, all-purpose tractor is the ability to operate at constant speed under varying load conditions. It is thus necessary for the engine to provide an immediate, automatically controlled response in power output to compensate for any increase or reduction in loading.

This is obtained through the action of a simple mechanical governor, driven by the camshaft and connected through a linkage system :

(*a*) directly, to the carburetter throttle plate.

(*b*) indirectly, through a coil spring, to a hand control lever mounted on the steering housing.

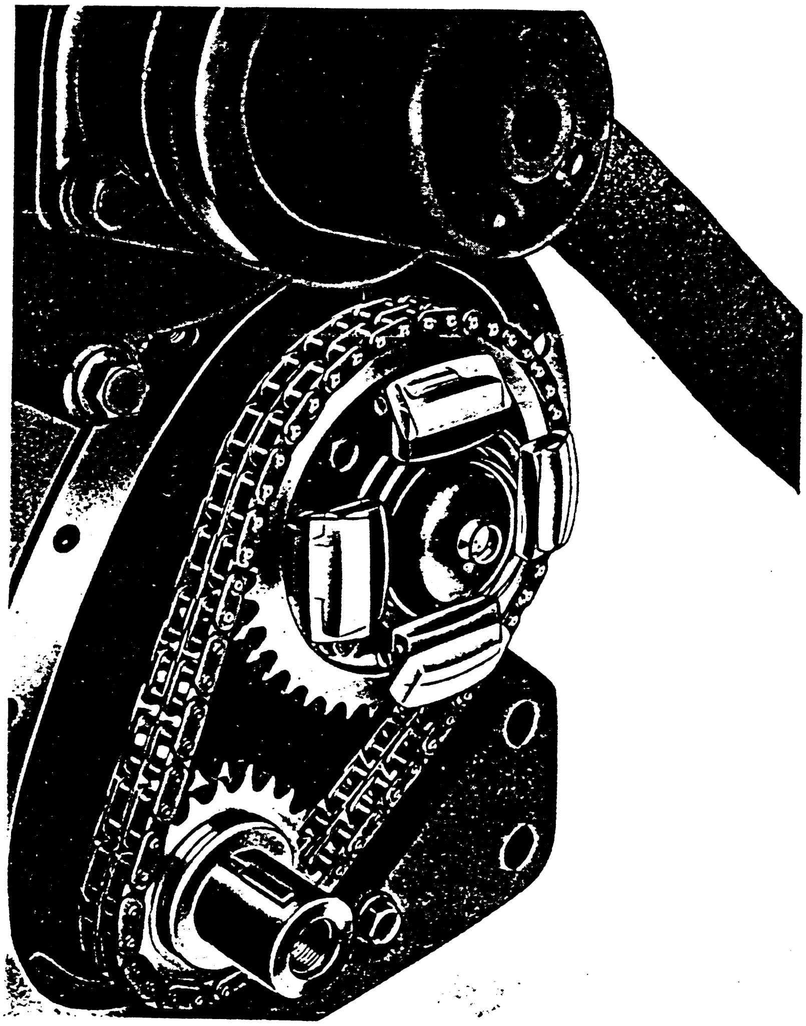


FIG. I

Action of Governor—Fig. 2.

Fig. 2, shows a diagrammatic view of the governor, from which it can be seen that as the assembly revolves, centrifugal force causes the bobweights (1) to fly out developing a secondary horizontal force acting on the governor lever (3) through the governor cup (2). This force is always proportional to the governor speed, which in turn is proportional to the engine speed :

governor speed = camshaft speed
= half engine speed.

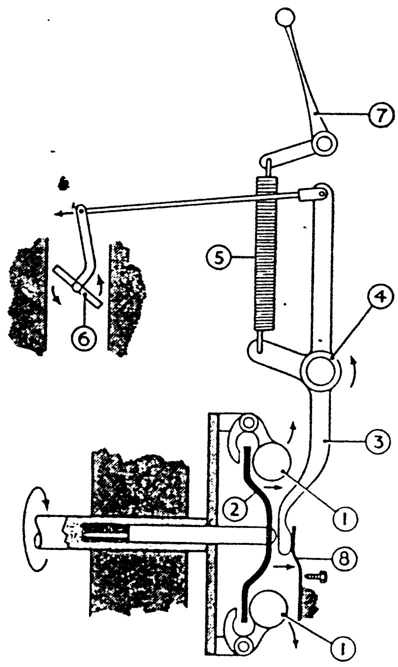


FIG. 2

Before the force developed by the governor is able to pivot lever (3) anti-clockwise about spindle (4), decreasing the opening of throttle (6), it must stretch spring (5), the tension of which is also dependent, on the position of hand control lever (7).
The further clockwise the setting of the hand lever, the greater will be the spring tension and governor force, (proportional to engine speed) necessary to overcome this tension.

Thus, the amount of throttle opening resulting from any position of the hand control lever depends upon the balance between the governor force and the spring tension.

Prevention of Engine "Surge"—Action of Bumper Spring.

Under conditions of light load, with comparitively small throttle opening, any alteration in throttle setting, whether brought about by the action of the governor, or manually, as will be later explained, will tend to cause a relatively large change in engine r.p.m. with consequent reaction by the governor weights or governor spring. The bumper spring (8) arrests the tendency for over-correction on the part of the governor spring by damping out any sudden forward movement of the governor plate. Correct adjustment of the bumper spring tension prevents consequent engine "surge."

Setting Engine Speed.

Let us now consider the sequence of operation of the governor mechanism and linkage when, with the engine running slowly, the hand lever is opened fairly wide:-

1. Carburetter throttle is opened wide.
2. Governor spring is stretched.
3. Engine speed increases.
4. Forward acting force developed by the governor weights on the cup increases.
5. The cup moves forward, further stretching the spring, slightly closing the throttle and stabilising the engine speed.

Within the governed speed range, the rate of change of governor force is always in excess of the rate of change of spring tension. Therefore, the governor force continues to stretch the spring until the resultant decrease of throttle opening reduces engine speed. As the governor force has a greater rate of decrease than that of the slightly weaker spring force, a state of balance will be quickly brought about, maintaining a certain throttle opening for that particular hand lever position and engine loading.
This action can be observed if, from idling, the engine speed is increased in steps throughout the hand lever range. With each increase in engine speed, the action of the governor will cause a counteracting anti-clockwise movement of the governor lever, tending to close the throttle.

Maintaining engine speed—Increased Loading.

Assuming that a state of balance has been obtained between the governor force and spring tension, an increased engine load will bring about the following action :

1. Decrease in engine speed.
2. Reduction in forward force developed by the governor on the lever, which immediately becomes insufficient to balance the spring tension.
3. Slight contraction of the spring, which has the effect of slightly opening the throttle.

Note :—The only way of relieving this excess spring tension without opening the throttle would have been to alter the hand lever position.

4. As soon as the throttle has opened, the engine speed is allowed to build up until the forward force developed by the governor has increased sufficiently to extend the spring and increase its tension until a state of balance has been obtained for the unaltered setting of the hand control lever.
5. This process is continuous during the whole time the engine is subjected to increasing load, i.e., the reduced force developed by the governor is constantly tending to allow the spring to contract, opening the throttle immediately the engine speed begins to decrease.

Maintaining Engine Speed—Reduced Loading.

Assuming that a state of balance exists between the governor force and the spring tension, a reduced engine load will have the following effect :-

1. Increase in engine speed.
2. Increase in forward force developed by the governor on the lever, which is immediately able to extend the spring, increasing its tension and slightly closing the throttle.
3. As soon as the throttle has begun to close, the engine speed decreases until the forward force developed by the governor is sufficiently reduced to allow the spring to contract to its original tension for the unaltered hand control lever setting.
4. This process is continuous during the whole time the engine is being subjected to reduced load.
   i.e. The extra force developed by the governor is constantly tending to stretch the spring and close the throttle immediately the engine speed begins to increase.

Limitations to Governor operation.

The governor has been designed to have maximum efficiency throughout the speed range of 1,000-2,000 r.p.m. at which the engine is most commonly operated.
At low engine speed the friction and backlash in the linkage is sufficient to counteract the small governor force developed. Consequently, to ensure efficient governing, it is best to select a gear which will enable the tractor to operate, on full throttle at about 1,500 r.p.m.

DISMANTLING INSTRUCTIONS

To Remove Throttle Hand Lever.

1. Disconnect link rod between arm of hand lever (1) and throttle rod plate at ball connection to arm.
2. Raise hood and pivot forward.
3. Remove battery by sliding to left and slightly tipping.

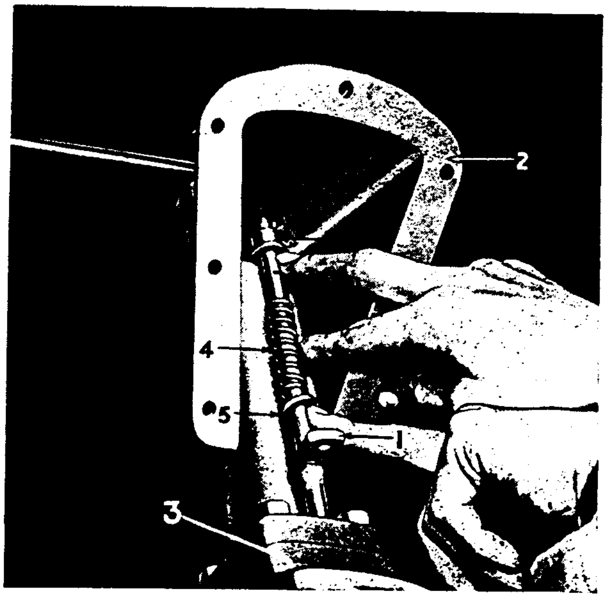


FIG. 3

4. Remove nuts and lockwashers from the seven rib neck carriage bolts securing instrument panel to upper steering housing (2). Tap out bolts, using a hide-faced hammer.
5. Remove the four set screws with lockwashers securing base of upper steering housing to lower housing (3). Lift clear, if necessary turning steering wheel to disengage pinion from steering sectors.
6. Remove cotter pin from hand lever to release spring (4) and washer (5).
7. Tap out bush (6) from steering housing and withdraw hand lever through bush bore.

To Replace Throttle Hand Lever—

1. Ensure that the lever assembly is complete with bush, spring and washer, and that the cotter pin has been removed.
2. Insert lever through bush bore and locate lower end in hole in steering housing.
3. Tap bush in position in housing.
4. Insert cotter pin below washer to locate spring.
5. Align front wheels in straight-ahead position with front drag link ball over bolt securing radius rod to front axle beam.
6. Replace upper steering housing assembly, turning steering wheel slighty as necessary to engage pinion with sectors. Tighten the four securing set screws on to their lock washers.
7. Replace the seven rib neck carriage bolts and tighten their nuts on to lockwashers to secure upper steering housing to instrument panel. Note that the battery earth strap is secured by the nut of one of the carriage bolts.
8. Turn plate at end of throttle rod, Fig. 4, as far as possible anti-clockwise to the closed throttle position.
9. Press down the threaded shank of throttle link rod ball joint and screw into the hole in hand lever arm.

Note :—On tractors of early manufacture it may merely be necessary to press home the spring ball joint cup.

10. Replace battery.

To Remove Throttle Rod Assembly—Fig. 4.

1. Disconnect throttle link rod (2) at throttle rod plate (3).
2. Loosen throttle rod clamp (6). It is usually necessary to remove the battery for access to the clamp nut.
3. Slacken nuts on U-bolt (7) at forward end of throttle rod.
4. Withdraw rod to rear, removing clamp (6), spring (5) and steel washer behind spring.
5. Remove friction disc (4).

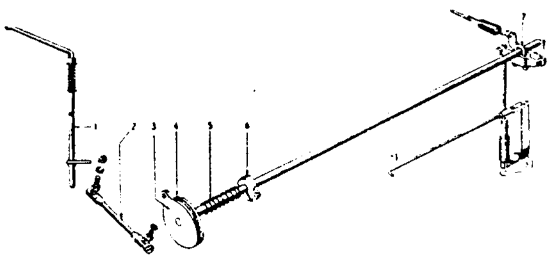


FIG. 4

To Replace Throttle Rod Assembly—Fig. 4.

1. Mount friction disc (4) on rod behind plate and insert rod through hole in bulkhead, mounting steel washer (4), spring (5) and clamp (6).
2. Locate forward end of rod in hole in fuel tank support bracket of thermostat housing. Mount governor lever U-bolt (7), but do not tighten nuts.
3. Re-attach throttle link-rod at ball joint of throttle rod plate.
4. Compress spring on to washer by pushing back clamp. Tighten clamp nut ensuring that it will not foul battery case when hand lever (1) is in closed throttle position.
5. For details of necessary procedure prior to tightening U-bolt nuts. (see " Governor Setting and Adjustment).

To Remove and Dismantle Governor—Fig. 5.

The following procedure is recommended for access to the governor mechanism :—

1. Remove timing cover—see section C.
2. Slide out governor cup and shaft assembly (1) which is an easy running fit in its bore in the camshaft.
3. Remove governor weight anchor plate assembly, which is secured to the camshaft timing sprocket (2) by four set screws (3) with lock washers.

Note :—In the case of a Continental engine, the plate is attached to the camshaft timing gear.

4. After removal of the plate, each governor weight (4) can be released by pulling its pivot pin (5) which is located by a cotter pin (6) in lugs on plate.

To Remove Governor Shaft.

After removal of timing cover, the governor shaft is detachable as follows :—

1. Remove wired taper set screw (7) locating governor rocker arm (8) to shaft (9).
2. Remove from timing cover the set screw (6) with lock washer locating grooved shaft end. Note bumper adjusting screw (11).

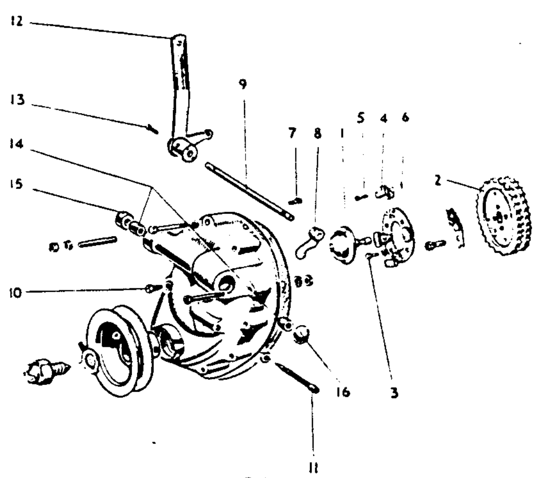


FIG. 5

3. Withdraw shaft with lever (12).

Note :—In the case of the Continental engine, the shaft and lever form a welded assembly with the rocker riveted to the shaft. To remove this assembly, it is necessary to file off the rivet head. No further dismantling is possible.

4. Remove the taper set screw (13) which is wired to the shaft boss of governor lever (12) and withdraw shaft.

   It will be seen that the shaft is supported by two needle roller races (14), located in the cover casing. At the lever end, oil is retained and dust excluded by a pressed-in seal (15) and at the outer end by a core plug (16). To remove the bearings and seals, it will be necessary to use a shouldered bar of the same diameter as the governor shaft, with a detachable collar of the same diameter as the bearing cage.

5. Insert bar, fit collar, and tap out outer bearing and core plug.

6. Insert bar through outer bearing, locating hole and fit collar. Tap out inner bearing and oil seal.

To Replace Governor Shaft.

Having located shaft in governor lever boss, located, tightened and wired taper set screw, proceed as follows :—

1. Tap in bearings and oil seals from outside.

2. Insert shaft and mount rocker arm.

3. Tighten outer set screw on to lock washer.
   Note that the shank of this screw is shorter than the one which locates the rocker arm.

4. Locate, tighten and wire tapered set screw securing rocket arm to shaft.

Reassembly.

The procedure for reassembly after inspection of the governor is a reversal of the procedure for dismantling. However, the following points should be noted.

1. Fit a new timing cover gasket.

2. (TE-A20 only). Ensure that the oil deflector is correctly located on the crankshaft before refitting timing cover.
   Should the stud have screwed out when removing timing cover, notice that this should be replaced directly below water pump.

3. Notice that the fan can be mounted in one position only, but ensure that it is positioned with the blades to the rear of the central mounting plate.

4. When replacing front axle support, the heads of the four large bolts should be to the front but those of the two small bolts to the rear.

GOVERNOR ADJUSTMENTS

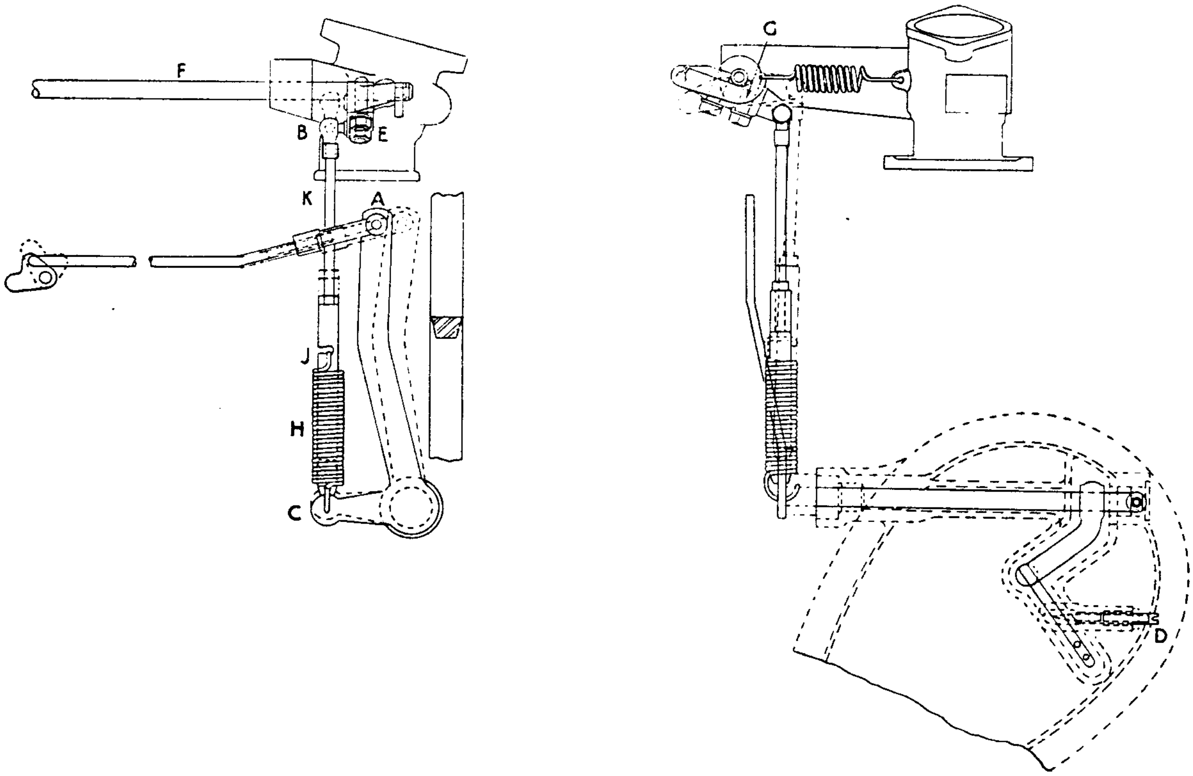


FIG. 6

Efficient governing is dependent, to a large extent, on the accuracy and care with which governor adjustment is carried out. It is strongly recommended that the following instructions are adhered to :—

1. Thoroughly warm up engine. Disconnect fork end (A) of throttle tie rod from governor lever by removal of clevis. Set idling stop and mixture control screw to give a steady idling speed of 400-450 r.p.m. as described in Section E. This speed can be checked by means of a tachometer applied to the rear end of P.T.O. shaft as shown in Fig. 7.

   400-450 r.p.m. (Engine) = 145-165 r.p.m. (P.T.O. Shaft).

2. Switch off engine and swing dynamo clear.

3. Disconnect assembly comprising vertical rod, plunger, and governor spring at ball joint (B) and spring hook (C).

4. Slacken bumper screw (D) and re-adjust until internal bumper spring can just be felt.

5. With the carburetter idle adjustment screw on its stop, adjust screwed fork end (A) of throttle tie rod so that, on holding back governor lever, the clevis pin can be inserted when light contact is felt between governor rocker arm and bumper spring.

6. Shorten rod by screwing back fork end one full turn.

7. Slacken nuts on U-bolt E, and turn it on throttle rod F until spring hook G is just touching the rod with throttle hand lever (on steering housing) is in its idling position, i.e., about 65° from fully back against steering column.

8. Re-tighten U-bolt nuts.

9. Ensure that when the coils of governor spring H are in their relaxed position, they are not stuck with paint or rust. If necessary, slightly stretch spring to free coils.

Note :—

(*a*) Open coils in the relaxed position indicate over-stretching and the spring should be renewed.

(*b*) Springs fitted to tractors type TE-A-20 have 15 coils, while those for type TE-20 have 26 coils.

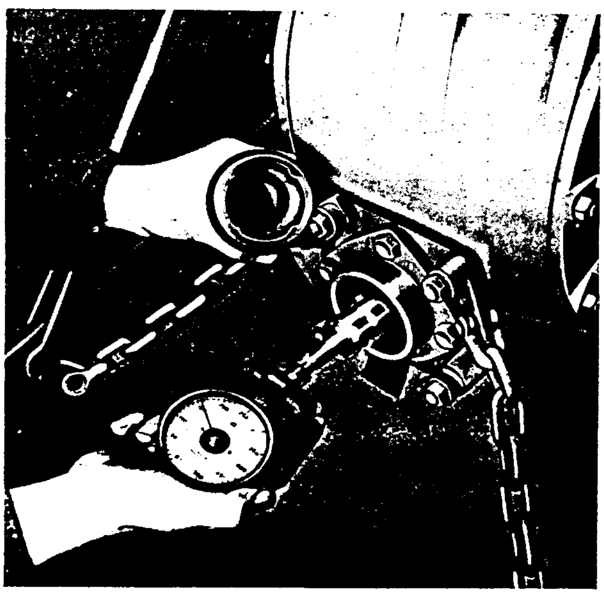


FIG. 7

10. Clean off paint or rust from hooks of governor spring H and from governor lever and plunger at C and J.

11. Locate hooks of governor spring H in eyes of governor lever and plunger at C and J.

12. Holding back the governor lever in the closed throttle position, apply a very slight upward pull to vertical rod K and measure the clearance between plunger and lever at C, this should be .005"—.010" (.127—.254 mm).

Note :—Extreme care should be exercised when carrying out instruction 12 on Tractors type TE-20, as the governor spring has no initial wound-in load. Springs for tractors type TE-A-20 have an initial wound-in load, so this operation is less critical.

13. If the measured clearance between lever and plunger is outside recommended limits the spring length should be adjusted by "setting" the hooks.

14. With hand control lever in idle position (see Instruction 7), close carburetter throttle and adjust the setting of vertical rod K in plunger so that the rod can be connected at ball joint B with plunger butting on governor lever.

15. Replace fan belt and adjust tension by swinging dynamo before tightening mounting nuts.

16. Start engine and thoroughly warm up. Pull hand throttle lever hard back to the fully open position.
After slackening nuts, turn U-bolt E on throttle rod to adjust governor spring tension so that engine speed is 2,200 r.p.m.
2,200 r.p.m. (Engine) = 800 r.p.m. (P.T.O. Shaft)

17. Re-tighten U-bolt nuts.

18. Should engine speed fail to remain constant, giving unsteady reading on the tachometer, turn bumper screw D clockwise. When engine "surge" is overcome, tighten lock nut.

19. If hand throttle lever will not remain fully open, adjust the compression by slackening clamp nut, compressing spring, and retightening nut.
If lever still tends to "creep," shorten free length of compensating spring N by ¼" (6.35 mm).

GOVERNOR CONTROL AND THROTTLE LINKAGE

TEF - 20 TRACTORS

PRINCIPLE OF THE PNEUMATIC GOVERNOR

The rate of expansion of the gas in the engine cylinder, and consequently the engine speed, depends upon the amount of fuel injected just before each power stroke. This, in turn, is dependent upon the position of the fuel pump control rack, which is linked to and controlled by a spring loaded leather diaphragm in the pump governor located at the rear of the injector pump. One side of this diaphragm is open to atmosphere and the other is connected by a copper pipe to a venturi unit situated between the air cleaner and the induction manifold.

When the engine is stopped the diaphragm spring holds the control rack forwards in the maximum fuel position to assist starting. As soon as one of the engine pistons beings to move down its bore on the induction stroke, air is drawn into the induction manifold through the venturi, causing a drop in pressure on the sealed side of the governor diaphragm. The magnitude of this drop is controlled by the position of a butterfly valve which is linked to the tractor hand throttle lever. It will be seen that with the butterfly valve fully open the engine will be allowed to build up a high speed before the velocity of air over the stack pipe in the venturi will cause sufficient depression behind the diaphragm to pull the pump control rack back against the spring pressure sufficiently to reduce the fuel supply and engine speed.

However, when the butterfly is almost fully closed, the greatly increased air velocity over the stack pipe will immediately cause sufficient depression at a very low engine speed to move back the control rack until the spring force is balanced.

At any pre-determined throttle setting a constant engine speed is obtained as soon as the governor diaphragm spring force is balanced ; any slight speed increase compressing the spring and moving the control rack to reduce the fuel supply until a balance is once more obtained. On the other hand, the slightest reduction in engine speed reduces the depression behind the diaphragm and allows the spring force, through the control rack, slightly to increase the fuel supply.

IMPORTANT.

The engine must not under any circumstances be run unless the venturi control unit, pipe and induction manifold are in position.

SPEED SETTING.

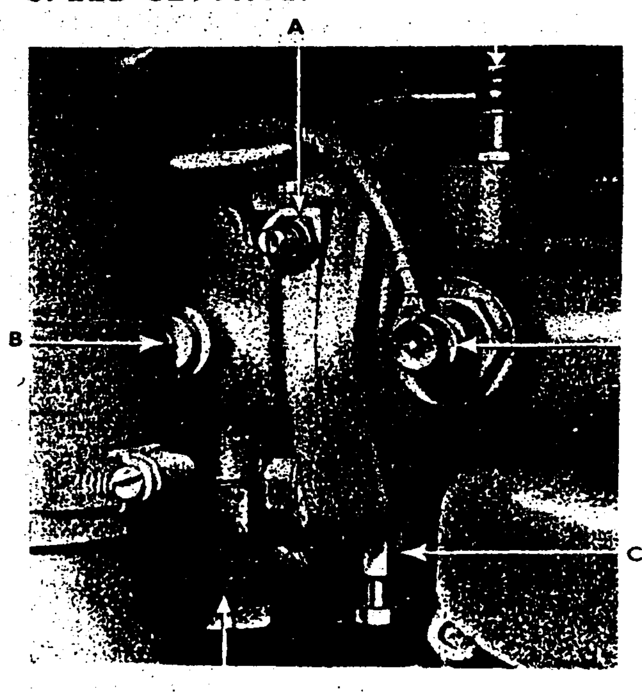


FIG. 101

KEY TO ANNOTATION

A. IDLING SPEED ADJUSTING SCREW.
B. VENTURI BUTTERFLY.
C. MAXIMUM SPEED ADJUSTING SCREW.

Maximum Speed Adjustment.

The absolute maximum speed is entirely governed by the diameter of the throat in the venturi unit and cannot be altered.

However, the size of the venturi permits a slight increase above the maximum recommended speed of 2,200 r.p.m. at no load. This setting is adjusted in production and should not require resetting, the adjusting screw, which simply limits the travel of the venturi butterfly, is therefore sealed.

On the rare occasions that adjustment becomes necessary proceed as follows :—

1. Start and warm up engine.

2. Loosen the maximum speed adjusting screw locknut — Fig. 101, fully open throttle lever and adjust the setting screw until an engine speed of 2,200 r.p.m. under no load conditions (800 r.p.m. P.T.O. speed) is obtained. Then tighten lock nut securely, taking care not to disturb the setting.

ENGINE IDLING SPEED.

Minimum Speed Adjustment.

This is governed by the horizontal screw in the venturi body. When the idling speed has been adjusted the hand lever stop beneath the instrument panel, which is incorporated to prevent strain being imparted to the linkage, must be adjusted to come into operation immediately after the idling screw stop on the venturi is effective.

Before commencing, the possibility of any defects, and particularly air leaks, disturbing the correct functioning of the governor should first be investigated. See under page F.104 SERVICING. Then proceed as follows :—

1. Start and warm up engine.

2. Fully close throttle lever and ensure that the hand lever stop is not restricting the travel in the fully closed position. If necessary loosen retaining screws and move stop well clear.

3. Slacken off the lock nut of the idling speed adjuster on the venturi body and, with the throttle fully closed, adjust the screw until an engine speed of between 440 and 495 r.p.m. (P.T.O. speed 160 and 180 r.p.m.) is obtained.

4. Tighten the lock nut on the idling screw and adjust the hand lever stop so that it is only just clear of the hand lever crank when this is in the fully closed position.

PREVENTION OF ENGINE SURGING.

Refer to Fig. 1.

At slow running speeds the governor diaphragm will be subjected to wide pressure fluctuations, which would tend to induce engine surging due to the reaction of the pump control rack to the pulsations of the diaphragm.

To provide a stable idling speed, when the control rack is drawn rearwards to the slow running position it contacts a spring loaded plunger, situated at the rear of the main spring, thereby reducing the sensitivity of the rack to the pulsations of the diaphragm.

The plunger spring is loaded by a cam, which is connected to the throttle control lever and is brought into operation when the lever is moved to the closed position.

To increase the load on the plunger spring in order to stabilize the idling performance, the idling control link rod should be shortened. Adjustment of this rod is made easy by only the front end of the rod being screwed while the other end is captive but free to turn.

Increasing the spring load will tend to increase the idling speed.

Minimum Speed Adjustment in conjunction with the Governor Anti-Surge Device.

Ensure that the Air Cleaner is serviced to instructions and that there are no air leaks on the inlet side, i.e. manifold, rubber hose, vacuum pipe, venturi, governor housing and diaphragm which will affect the governing characteristics. See page F.104 SERVICING.

Proceed as follows :—

1. Injector Pump cut-off control in the start position.

2. Check for control rod freedom and ensure that the cam on the governor anti-surge spindle does not restrict the full opening of the throttle at the venturi by fouling inside the governor casing of the Injector Pump.

3. Move the hand lever stop beneath the instrument panel well clear of the arm of the hand lever.

4. Loosen lock nut on venturi body and turn idling speed adjusting screw until butterfly is fully closed in the venturi body — see Fig. 102.

5. Disconnect the idling control link from the governor anti-surge device lever by either removing the rod complete with ball end or by unscrewing the rod from the ball socket. This will then enable the governor anti-surge lever to fall towards the driving end of the Injector Pump.

6. Move the hand control lever to approximately ¼ open, start engine and allow it to warm to operating temperature.

7. Close the hand throttle and at the same time adjust the idling speed on the venturi body to approximately 160 p.t.o. r.p.m. (440 engine r.p.m.) Engine will probably be surging at this setting but this can be ignored at this stage.

8. Move the anti-surge lever — by hand — on the fuel pump casing clockwise, i.e. rearwards — until the cam can be felt to be in contact with the anti-surge plunger inside the governor housing — to damp out any surge and it is permissible for the idling speed to be increased to 180 p.t.o. r.p.m. (495 engine r.p.m.) to suit this setting. In order to get this adjustment it may be found in some cases that the idling control link rod is too short and, therefore, it will be necessary for the rod to be lengthened by cutting and welding in an extension piece. It is important when adjusting the idling control link rod that too much load must not be exerted on the plunger control spring.

The function of the pneumatic governor is to maintain constant engine speed irrespective of load conditions on the tractor.

This is essential with any Tractor Implement combination, for it would be impractical for an operator to continuously change the throttle setting to compensate for frequent load variations.

Precautions to be taken against Fuel leaking into the Governor.

Fuel entering the Governor housing from the pump body will prevent efficient Governor operation ; therefore, it is advisable to give close attention to the following points :—

1. Always holding the pump in an upright position to prevent fuel filling the space on the atmospheric side of the diaphragm.

2. Ensure that the three set screws retaining the Governor housing to the pump body are tight enough to prevent the ingress of fuel through the screw holes.

3. The setscrew and washer locating the fuel pump rack must be checked for tightness otherwise leakage will take place from the fuel gallery into the main pump body and eventually into the Governor housing.

4. The delivery valve holders must be tight otherwise fuel will leak past and fill the Governor housing.

5. Drain off excess fuel from the fuel pump at the specified intervals to prevent a fuel build-up in the fuel pump with subsequent possibility of flooding Governor Housing.

SERVICING

The governor diaphragm, being made of specially prepared leather, should give lasting service.

A fuel oil mist hole connects the front end of the governor housing with the pump tappet chamber, by this means the diaphragm is kept supple and no additional lubrication is required.

To Test the Governor for Leaks.

Air leaks will, naturally, have an adverse effect on the operation of the pneumatic governor and in the event of a leak being suspected the following procedure should be adopted :—

1. Remove vacuum pipe.
2. Pull back fuel cut-off control and seal the diaphragm housing by placing a finger over the pipe union in the governor housing.
3. Release the fuel cut-off control, which should then remain stationary, any movement indicating leakage either at the diaphragm or at the housing union or between the housing and cover.

   Carefully check that all these parts are in order and if the leak still persists, the diaphragm is at fault and must be renewed by a C.A.V. agent.

Governor Vacuum Pipe.

The governor vacuum pipe can be tested for leaks in exactly the same way by connecting the pipe to the diaphragm housing a applying a finger to the venturi end of t pipe

Throttle Linkage.

Ensure that slackness does not occur in a of the linkage joints between the thro lever and the governor.

It is important to note that, to suit instal tion, there is a bend in the rear end the throttle control link rod — whi must always be set in the correct positio with the ball connections central at 90 their sockets, otherwise wear will aggravated and governor adjustme adversely affected

Any adjustment to this rod will, therefor entail lengthening or shortening by one more complete turns and not by fractions a turn

Two grease nipples — are provided f the cross-shaft and these must recei attention regularly ever 120 working hour

Air Cleaner.

An air cleaner restricted or partially choke either through lack of maintenance, over filling the bowl or using too heavy an o grade will have the effect of increasing th vacuum on the governor diaphragm thereb reducing the maximum speed of the engi or restricting the air and making combu tion less effective. Never run the engi without the air cleaner in position.

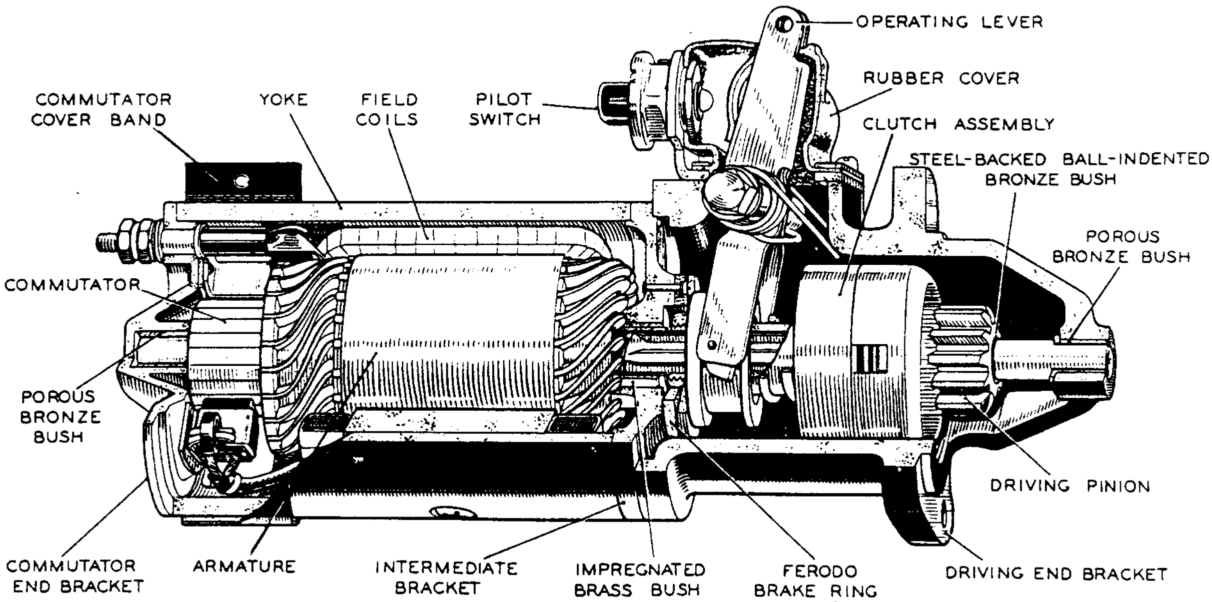
The FERGUSON SYSTEM
TRADE MARK

Ferguson

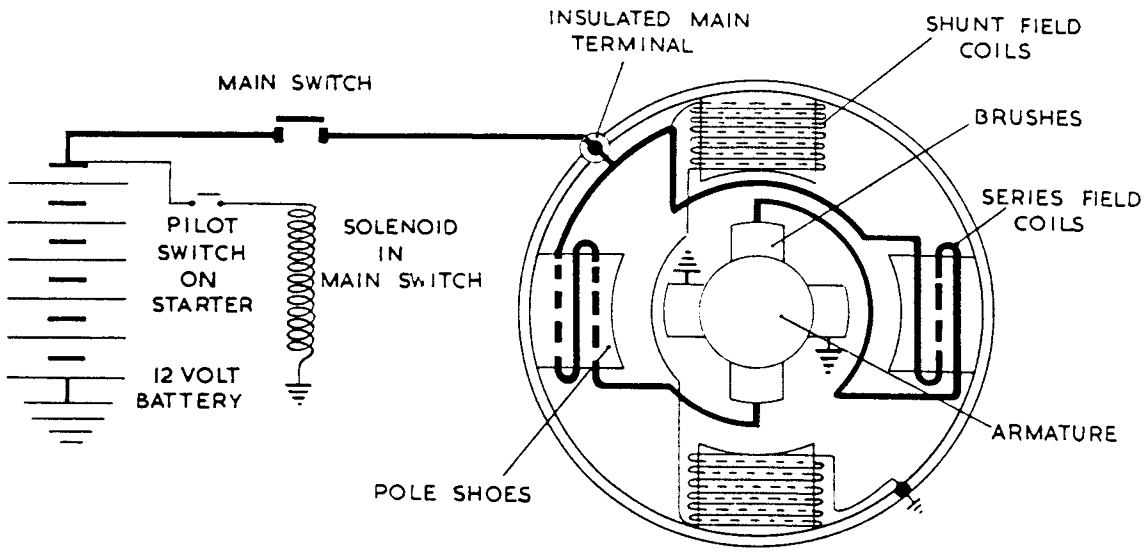
SERVICE MANUAL

Section G

ELECTRICAL SYSTEM



CONSTRUCTION OF THE FERGUSON PRE-ENGAGED STARTING MOTOR

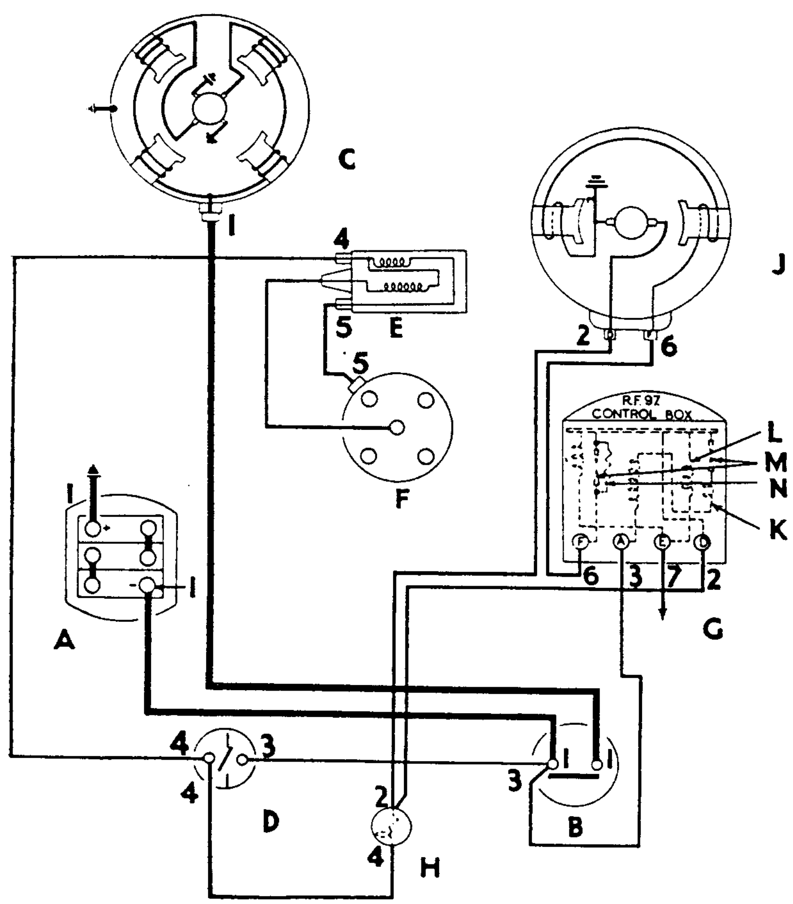


STARTER CIRCUIT FOR FERGUSON TRACTOR USING M45G 26071 STARTING MOTOR

ELECTRICAL SYSTEM

The instructions given for the servicing of electrical equipment have not been over-elaborated, being confined to the procedure for normal day-to-day maintenance. Repairs or overhauls which exceed the scope of these notes should be referred to the most convenient Lucas Service Depots or Agents, who will make the fullest facilities available.

TRACTOR WIRING DIAGRAM.



KEY

A—6 volt battery, positive earth.
B—starter motor switch.
C—starter motor.
D—ignition switch.
E—coil.
F—distributor.
G—control box.
H—ignition warning light.
J—dynamo.
K—cut-out series winding.
L—cut-out shunt winding.
M—contact points.
N—regulator resistance.

Key to Cable Colours.

1. H.T. thick cable.
2. Yellow.
3. Yellow and Black.
4. White.
5. White and Brown.
6. Green and Black.
7. Black.

SPECIFICATION AND TEST DATA

(6-volt Equipment, Positive Earth Return)

BATTERY

Lucas Model STXFRW13-6.

Capacity 75 amp. hours (10 hours discharge rate).

Specific gravity of electrolyte in service :—

1.280—1.300 Battery fully charged.
About 1.210 ,, about half discharged.
Below 1.150 ,, fully discharged.

These figures are given assuming an electrolyte temperature of 60°F. If the electrolyte temperature exceeds this, .002 must be added to the observed hydrometer readings for each 5 F. rise to give the true specific gravity at 60 F. Similarly .002 must be subtracted from hydrometer readings for every 5 F. below 60 F.

DYNAMO

Lucas Model C45X

Service No. 22415A Tractor Serial Nos. 1–30660
Service No. 22420B Tractor Serial Nos. 30661 onwards

Note : Two types of dynamo have been fitted owing to a change in the method of fixing. Dynamo Model C45X, Service No. 22420, is supplied as a general replacement. It can be fitted in place of Model C45X, Service No. 22415A, by reversing the position of the support bracket which is secured to the dynamo body by two bolts.

Two-pole type.
Compensated voltage control.
Clockwise rotation viewed from driving end of dynamo.
Plug-in, non-reversible terminals.

Test Data

Dynamo cold.
Cutting-in speed, 750-900 r.p.m. at 6.5 dynamo volts.
Output 17.5 amps. at 1500-1700 r.p.m. at 7 dynamo volts taken on 0.4 ohm resistance load without regulator (Resistance must be able to carry 20 amps. without overheating).
Brush tension 15-25 ozs. (400-700 gms).
Field resistance 2.5 to 3.2 ohms.

STARTER MOTOR

Lucas Model M418G.

Service No. 25505B Terminal on yoke. Tractors 1001 to 15882
,, ,, 25519A Terminal on commutator end bracket. Tractors 15883 to 43073
,, ,, 25519D Incorporating rubber type drive. Tractors 43074 onwards.

Note : Earlier tractors were fitted with Starter Motor, Model M418G, Service No. 25505, while later models are fitted with Starter Motor, Model M418G, Service No. 25519. The former have the supply terminal on the motor housing while with the latter it is located on the commutator end bracket. Starter Motor, Model M418G, Service No. 25519D, is supplied as a general replacement unit, and, when replacing the earlier model, the cable must be lengthened by fitting the extension piece in the kit supplied.

Four-pole design.

Clockwise rotation viewed from driving end.

Lucas barrel type outboard drive with 9 tooth pinion.

Test Data

Lock torque approximately 9.25 lbs. ft. (1.28 kg. metres) with 500-550 amps. at 2.5–3.0 volts.

At 1000 r.p.m. approximately 4 lbs. ft. (.55 kg. metres) with 300 amps. at 3.9 volts.

Brush tension—30–40 ozs. (.85–1.13 kg.).

Normal cranking speed 180–200 r.p.m.

STARTER MOTOR SWITCH

Lucas Model ST.18

Service No. 76407

Mechanical type, operated by the gear change lever.

DISTRIBUTOR

Lucas Model D3A4

Service No. 40084 Tractors type TE-20. See page G.17.

,, ,, 40132 Tractors type TE-A20 See page G.18.

,, ,, 40146 See page G.19.

Clockwise rotation viewed from driving end.

Contact breaker gap .010″–.012″ (.25–.30 mm.)

Firing angles 0°, 90°, 180°, 270° ± 1°.

Closed periods 45° ± 4°. Open period 45° ± 4°.

Contact breaker spring tension 20–24 ozs. (570–680 gms.) measured at contacts.

Condenser capacity 0.2 microfarad.

Test Data.

Distributors Service Nos. 40084 and 40132.

Centrifugal automatic advance commences at 200–360 (distributor) r.p.m. and can give maximum advance of 18°–20° at 1360–1480 (distributor) r.p.m., 13°–16° at 1000 (distributor) or 2000 (engine) r.p.m., 9½°–12½° at 750 (distributor) or 1500 (engine) r.p.m.

Distributor Service No. 40146.

Centrifugal automatic advance commences at 200–300 (distributor) r.p.m. and can give maximum advance of 20°–30° at 1340 (distributor) r.p.m., 15°-18° at 1000 (distributor) or 2000 (engine) r.p.m., or 11°-14° at 750 (distributor) or 1500 (engine) r.p.m.

IGNITION COIL

Lucas Model R6.

Service No. 408011.

Current consumption 1.6 amps (approx.) running.

Current consumption 4.3 amps. (approx.) stall.

SPARK PLUG

Tractors Type TE-20

Champion No. 7 Commercial (18mm.)

Gap setting .025″–.028″ (.64–.71mm.)

Tractors Type TE-A20

Champion L.10 (14mm.)

Gap setting .030″–.032″ (.56–.64mm.).

CONTROL BOX

Lucas Model RF97.

Service No. 37053.

Incorporates cut-out and voltage regulator.

Test Data.

(*a*) Cut-out Relay closing voltage—6.3–6.7 volts.

Drop-off voltage—4.5–5.0 volts.

Cut-out air gap .022″–.030″ (.55–.75mm.)

Cut-out air gap .012″–.020″ (.30–.50mm.) *with shim fitted and .018″ (.46 mm.) feeler gauge in back.*

Fixed contact gap .006″–.017″ (.15–.43 mm.) with cut-out gap closed.

(*b*) Regulator.

Setting at	10°C. (50°F.)	7.9–8.3	volts.
,, ,,	20°C. (68°F.)	7.8–8.2	,,
,, ,,	30°C. (86°F.)	7.7–8.1	,,
,, ,,	40°C. (104°F.)	7.6–8.0	,,

Charging begins at approximately 1000 dynamo r.p.m. or 625 engine r.p.m.

IGNITION WARNING LIGHT

Lucas Model WL3.

Service No. 38029.

Bulb : Lucas No. 970. 2.5 volts, 0.5 watt M.E.S.

SERVICE INSTRUCTIONS

BATTERY

The battery is a six-volt, thirteen-plate unit and has a capacity of 75 ampere hours at 10 hours discharge rate. It is located under the tractor hood as shown in Fig. 1 and is readily accessible for inspection and refilling with distilled water.

The battery is protected from damage due to vibration and physical shocks by means of rubber mounting pads fitted to the support platform and attachment points of top securing frame. Incorporated on tractors of later manufacture is a battery cover hinged to the top frame.

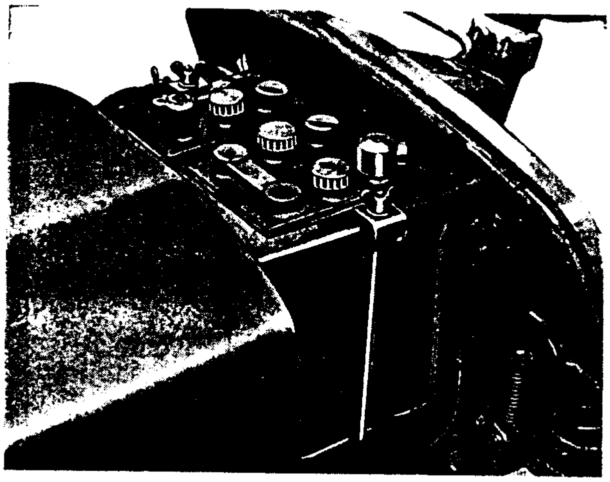


FIG 1

To remove the battery, disconnect the earth strap and the positive lead to switch, unscrew wing nuts and remove top frame assembly. Slide battery to the left.

Note : Disconnect earth strap first when removing battery and reconnect last when installing battery.

Maintenance.

About every two weeks, or more often in hot weather, take out the three filler plugs from the top of the battery and check the level of the electrolyte in each cell. Contrary to the usual procedure, sufficient distilled water should be added to bring the electrolyte just level with the top of the separators.

Note : Always use distilled water when topping up a battery. Do not use a naked light when examining the condition of the cells.

A hydrometer will be found useful for topping up, as it prevents distilled water from being spilled on the top of the battery. If any is spilled, however, wipe it away and ensure that the top of the battery is kept clean and dry. Remove any dirt from the holes in the vent plugs with a piece of wire.

Clean any corrosion from the battery terminals and smear them with petroleum jelly. Examine the connections to the terminals and make sure that they are tight.

It is advisable to check the state of charge of the battery occasionally by measuring the specific gravity of the electrolyte in each of the cells by means of a hydrometer, as shown in Fig. 2 and comparing the result obtained with the figures given in "Test Data."

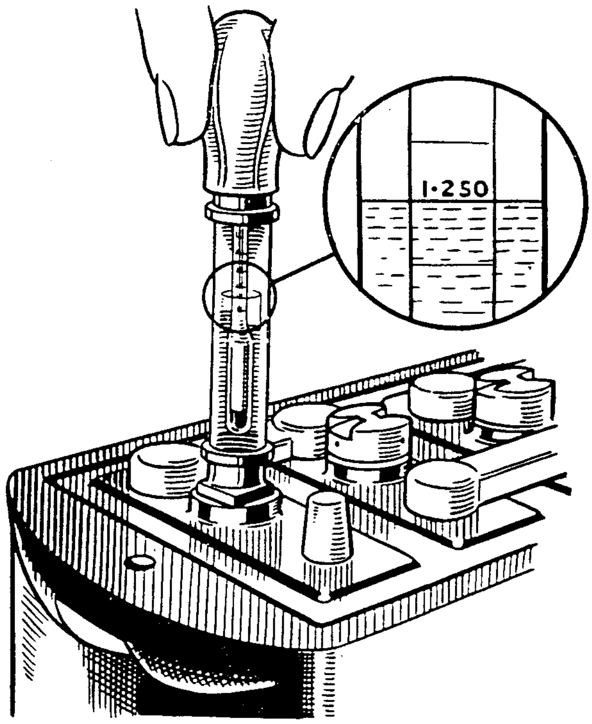


FIG. 2

When taking specific gravity readings, examine the condition of the electrolyte in the hydrometer. It should be fairly clear. If it is very dirty, it is possible that the plates are in bad condition, and the battery should be sent for overhaul. Ensure also that too much electrolyte is not drawn up into the hydrometer barrel so that the float is jammed and a false reading given.

The readings for all cells should be approximately the same. If one cell gives a reading very different from the rest, it may be that acid has been spilled or has leaked from this particular cell or there may be a short circuit between the plates. In the latter case the battery should be examined by a Lucas Service Agent.

Winter Operation

Battery capacity is greatly reduced during very cold weather as this has a retarding effect on the electro-chemical action. A fully charged battery with 100% cranking power at 80°F. drops to 65% cranking power at 32°F. and to 40% at 0°F.

Stiff engine oil adds to the load of starting. At 0°F. the engine requires $2\frac{1}{2}$ times more power to crank than at 80°F. Therefore, the importance of a fully charged battery for efficient and dependable operation is apparent.

Battery Service

Points to check in servicing batteries :—

1. Partial corrosion of cables which restricts current capacity.
2. Broken or cracked battery case which may allow electrolyte to escape.
3. Low gravity cells.
4. Sealing compound broken away from cell covers.
5. Terminal posts broken or partially broken.
6. Cell connectors broken away from cell posts or posts broken away from post strap.
7. Freezing due to partially discharged battery.

Action

1. Clean terminals for inspection with ammonia or a solution of baking soda in water.
2. Inspect battery carrier for looseness and bad or broken battery fasteners. Vibration and heavy jarring blows shorten battery life.
3. Check charging rate and adjust to specifications. High water consumption is one indication of too high a charging rate. (See Regulator Test Data, page G3).
4. Open battery cells only as a last resort in checking for trouble.

Storage

Never leave the battery in a discharged condition for any length of time. Have it fully charged and every fortnight give it a short refreshing charge to prevent any tendency for the plates to become permanently sulphated.

Batteries should be stored in as cool a place as possible to minimise self-discharge. All stored batteries must be fully re-charged before use.

New Batteries

To prepare a new battery, supplied dry, for service, proceed as follows :—

(*a*) **Preparation of Electrolyte**

The specific gravity of the electrolyte necessary to fill the new battery, and the specific gravity at the end of the charge, should be as follows :—

TEMPERATURE RANGE	*CORRECTED TO 60°F.*	
	S.G. of Filling Acid	S.G. at end of Charge
Ordinarily below 80°F. (27°C.)	1.350	1.280–1.300
Between 80°F.–100°F. (27°C.–38°C.)	1.320	1.250–1.270
Over 100°F. (38°C.)	1.300	1.220–1.240

The electrolyte is prepared by mixing distilled water and concentrated sulphuric acid of 1.835 S.G. The mixing must be carried out in a lead-lined tank or a suitable glass or earthenware vessel. Steel or iron containers must NOT be used. The acid must be added slowly to the water, while the mixture is stirred with a glass rod. NEVER ADD THE WATER TO THE ACID, as the resulting chemical reaction may have dangerous consequences. To produce electrolyte of the correct specific gravity as stated above, use proportions of acid and distilled water recommended overleaf.

To obtain Specific Gravity (corrected to 60 F.)	Add 1 part by volume of 1.835 S.G. acid to distilled water by volume as below.
1.350	1.8 parts
1.320	2.3 ,,
1.300	2.5 ,,

Heat is produced by the mixture of acid and water, and it should, therefore, be allowed to cool before pouring it into the battery, otherwise the plates, separators and moulded container may be damaged.

(*b*) Filling and Soaking

The temperature of the acid, battery and charging room should be above 32°F.

Carefully break the seals in the filling holes and half-fill each cell in the battery with dilute sulphuric acid solution of the appropriate specific gravity (according to temperature). The quantity of electrolyte to half-fill each cell is ¾ pint (.426 litre).

The mixing of the electrolyte with the water contained in the separators, and the chemical action of the dilute acid upon the plates, especially the negative groups, results in the generation of heat. The battery should, therefore, be allowed to stand for at least six hours before further electrolyte is added, thereby allowing the heat generated by the first filling to be mainly dissipated and avoiding an excessive temperature rise which might cause damage to plates and container.

After the lapse of this period, add enough dilute acid to fill each cell to the top edge of the separators and allow to stand for a further two hours before commencing the charge.

(c) Duration and Rate of Initial Charge

Charge at a constant current of 5 amps. until voltage and temperature-corrected specific gravity readings show no increase over five successive hourly readings. This period is dependent upon the length of time the battery has been stored since manufacture, and will be from forty to eighty hours, but usually not more than sixty.

Throughout the charge, the acid must be kept level with the tops of separators in each cell by the addition of acid solution of the same specific gravity as the original filling-in acid.

If, during charge, the temperature of the acid in any cell of the battery reaches the maximum permissible temperature of 120 F., the charge must be interrupted and the battery temperature allowed to fall at least 10 F. before charging is resumed.

At the end of the first charge, i.e. when specific gravity and voltage measurements remain substantially constant, carefully check the specific gravity in each cell to ensure that it lies within the limits specified. If any cell requires adjustment, the electrolyte above the separators must be siphoned off, and replaced with either acid of the strength used for the original filling-in, or distilled water, according to whether the specific gravity is too low or too high respectively. After such adjustment, the gassing charge should be continued for one or two hours to ensure adequate mixing of the electrolyte. Re-check, if necessary, repeating the procedure until the desired result is obtained.

DYNAMO

The dynamo is a 6-volt, shunt-wound, two-brush type with compensated voltage control, its output being automatically controlled by a regulator unit which is housed with the cut-out in the control box

It is completely sealed against the entrance of dust and moisture.

After each 120 hours running, the dynamo bearings should be lubricated as instructed in " Lubrication" (Page G9).

Inspect the driving belt and adjust, if necessary to take up any undue slackness, by swinging the dynamo on its mountings at A and B, Fig. 3. Care should be taken to avoid over-tightening the belt and to ensure correct alignment, otherwise undue strain will be thrown on to the dynamo bearings.

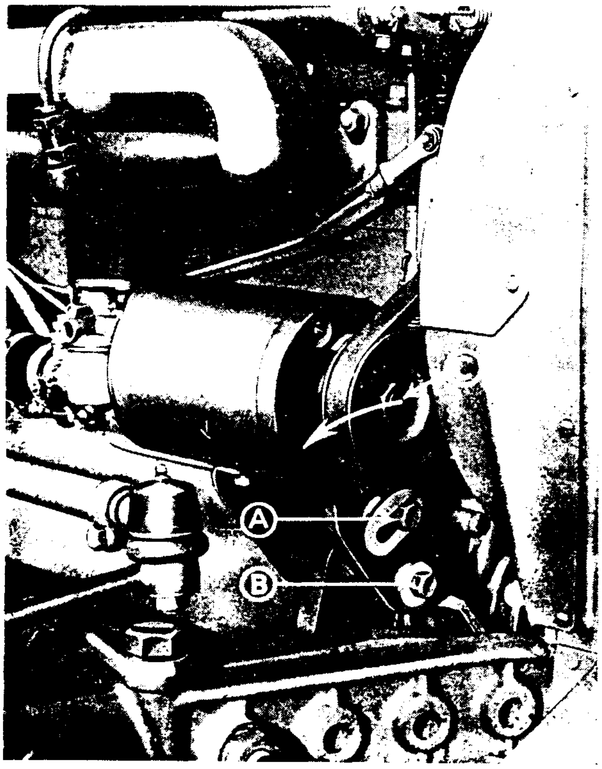


FIG. 3

It is important that the pulley fixing nut (C) is locked solid and checked periodically.

The dynamo requires no other attention during normal service.

Testing in Position

1. Take out the plug-in connectors and join the sockets by a short length of wire.
2. Connect a voltmeter (0-10 volts) between the two sockets and dynamo housing.
3. Increase the engine speed gradually and note the voltmeter reading ; this should reach 6 volts at a comparatively low speed. Do not run the engine at a speed above 1200 r.p.m. If no reading is given or if it is low or erratic, the dynamo must be removed for examination by swinging inwards, removing fan belt from dynamo pulley, and removing mounting bolt A and B.

To Dismantle

1. Remove the driving pulley, which may be very tight. In this case it should be tapped off or withdrawn by means of an extractor.

   Note : The latest type of end bracket is not an integral welding, and the support bracket must be removed by unscrewing three setscrews before the withdrawal of the through bolts (15), which are illustrated in Fig. 6.

2. Unscrew the two through bolts and pull off the commutator end bracket.

The driving-end bracket complete with armature can now be withdrawn from the dynamo housing.

If it is necessary to remove the armature from the driving-end bracket, it can be done by means of a hand press.

Note : There are no connections to be uncoupled between the dynamo housing and the commutator end bracket.

Armature

1. Examine the commutator, and if burned or blackened, clean with a petrol-moistened rag, or, in bad cases, by carefully polishing with very fine glass paper.

A B

FIG. 4

2. If necessary, undercut the mica insulation to a depth of 1/32" (18mm) with a hacksaw blade ground down to the thickness of the mica. Fig. 4 (A) shows mica cut correctly, (B) incorrectly.
3. Check the armature by means of a growler and a volt drop test, and test

the insulation by connecting a test lamp at mains voltage between the commutator segments and the shaft. If the lamp lights, the commutator should be replaced.

Brushgear

1. Check the brushes for wear and freeness in their holders. If they are worn so that they do not make good contact on the commutator or if the brush flexibles are exposed on the running faces, take out the screws securing the eyelets on the end of the brush flexibles and remove the brushes.

   Fit new brushes into holders and secure eyelets on the ends of the brush leads in the original positions. Brushes are pre-formed, and do not require bedding in.

2. Check the tension of the brush springs with a suitable spring scale. Replace if pressure is outside the limits of 15-25 ozs. (400-700 gms.).

Field Coils

1. Test the resistance of the field coils by means of an ohm meter. It should be between 2.5 and 3.2 ohms.

   If an ohm meter is not available, connect a 6 volt battery, with an ammeter in series, between the field terminal and the dynamo housing. The ammeter reading should be approximately 2 amps. If the ohm meter reading is less than 2.5 ohms, or if the ammeter reading is more than 2.5 amps, the field coils have an internal short circuit and should be replaced. If no reading is registered, the field coils are open circuited and must be replaced.

2. To test for earthed field coils, unsolder the end of the field winding from the earth terminal of the dynamo housing and, with a test lamp connected from supply mains, check between field terminal and dynamo housing. If the lamp lights, field coils are earthed, and must be replaced.

3. When replacing field coils (17) Fig. 6, an expander should be used so as to press the pole shoes into position. A few taps on the outside of the dynamo housing with a copper faced mallet will assist the expander to seat the pole shoes. When the pole shoes are finally home, fully tighten the fixing screws and caulk to lock them in position.

Bearings

Bearings which are worn to such an extent that they will allow excessive side movement or end float of the armature shaft must be replaced.

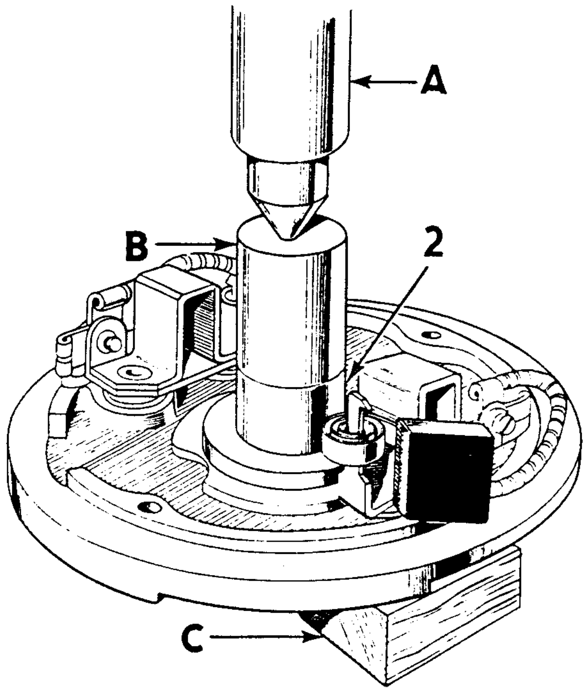


FIG. 5

Commutator End Bearing

To remove and replace the bearing bush at the commutator end, proceed as follows :

1. Remove protective cap (1) Fig. 6, at the outside end of the bracket.

2. Press the bearing bush out of the bracket by means of a hand press A, Fig. 5.

3. Press the new bearing bush (2) into the end bracket using a shouldered mandrel B of the same diameter as the shaft

which is to fit the bearing.

The end bracket should be mounted on wood blocks C for this operation.

Note : Before fitting a new porous bronze bearing bush, it should be immersed for 24 hours in clean thin engine oil.

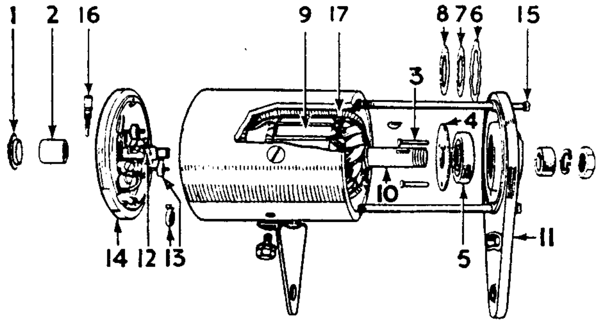


FIG. 6

Driving-End Bearing

The ball bearing at the driving end is replaced as follows :—

1. Knock out the three rivets (3), Fig. 6, which secure the bearing retaining plate (4) to the end bracket and remove the plate.

2. Press the bearing (5) out of the end bracket and remove the corrugated washer (6), felt washer (7) and oil retaining washer (8).

3. Before fitting the replacement bearing ensure that it is clean, and pack it with high melting point (H.M.P.) grease.

4. Place the oil retaining washer, felt washer and corrugated washer in the bearing housing in the end bracket.

5. Locate the bearing in the housing and press it into position by means of a hand press.

6. Fit the bearing retaining plate. Insert three new rivets from the outside of the end bracket and open the rivets by means of a punch to secure the plate rigidly in position.

To re-assemble Dynamo

1. If the armature (9) has been removed from the driving-end bracket, first press the armature shaft (10) into the bearing in the end bracket and then fit the armature in position in the dynamo housing and locate the driving-end bracket (11) on the dowel.

2. Raise the brushes (12) in their holders and wedge in this position by locating the springs (13) on the sides of the brushes as shown in Fig. 7.

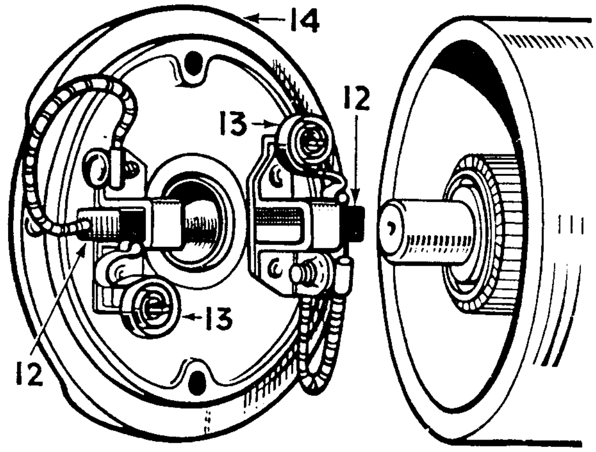


FIG. 7

3. Fit the commutator end bracket (14) until the brushes are just started on the commutator and then raise the springs to release the brushes, ensuring that the ends of the springs return to locate centrally on the tops of the brushes.

4. The end bracket can now be pushed into position and the through bolts (15) inserted and tightened.

Lubrication

Before refitting the dynamo to the tractor, unscrew the lubricator (16), Fig. 6, on the end of the dynamo, lift out the felt pad and spring, and half fill the lubricator with H.M.P. grease.

Replace the spring and felt pad, and screw the lubricator in position.

STARTER MOTOR

Normal Service

If the starter motor pinion will not mesh correctly or becomes jammed in mesh with the flywheel, it may be that the starter drive requires cleaning. The control nut (14), Fig. 10, should move freely on the screwed sleeve; if there is any dirt or foreign matter on the sleeve, it must be washed with paraffin. Do not lubricate.

For this purpose, it will be necessary to remove the driving-end bracket from the starter motor housing (see "Dismantling Instruction.")

It can usually be freed by turning the armature by means of a spanner applied to the shaft extension at the commutator end which is accessible by removing the cap.

To remove the starter motor from the engine, first disconnect the cable from the positive battery terminal and starter motor terminal. Danger of causing short circuits will thus be avoided.

Wear on the starter gear ring of the flywheel can be considerably reduced by ensuring correct engagement between its teeth and those of the starter motor pinion. The dimension between the front edge of the starter gear ring (X) on flywheel and the starter mounting bracket face (Y) should be 1.281″ (32.54 mm.) as shown in Fig. 8.

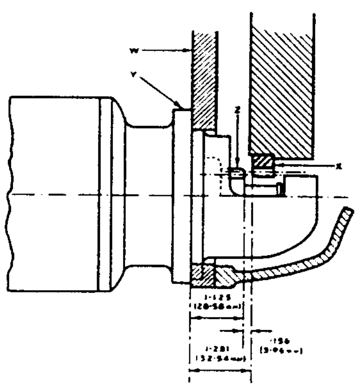


FIG. 8

On certain of the earlier tractors, full engagement between starter ring (X) and pinion (Z) may be slightly greater or less than the amount shown in Fig. 9.

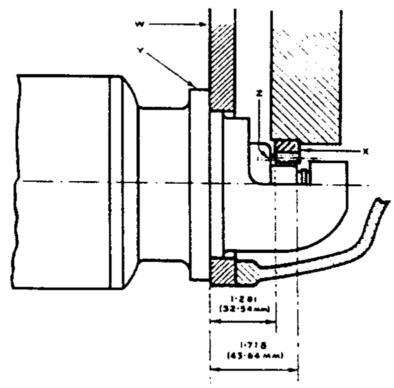


FIG. 9

Over-engagement.

Service by fitting packing washers, Part No. 2047, between starter bracket (Y) and mounting flange (W) as required for correct engagement.

Under-engagement

Service by facing up starter bracket flange as required for correct engagement.

Note: Engine Serial Nos. S67029E onwards—The position of the starter gear ring locating flange on the flywheel has been altered to reduce starter pinion clearance shown in Fig. 8, by $\frac{1}{16}$″ (1.6 mm.)

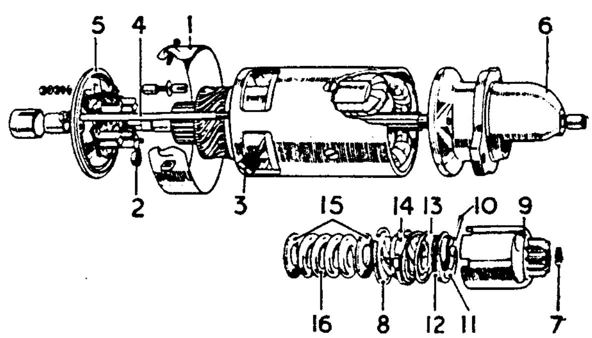


FIG 10

Dismantling the Starter Motor

1. Take off the cover band (1) Fig. 10, at the commutator end, hold back the brush springs (2) and remove the brushes (3) from their holders.

2. Unscrew and withdraw the two through bolts (4) and remove the commutator end bracket (5).
3. Remove the driving end bracket (6) from the starter motor housing.

Note : Starter motors, Lucas Service No. 25519 (See specification).

The connection from the battery on the above starter motors is made to a terminal on the commutator end bracket. When dismantling, it will be necessary to take the nuts off this terminal bolt before the commutator end bracket can be removed from the starter motor housing.

Starter Drive

1. Secure the armature by gripping the shaft extension and removing the locating ring (7), Fig. 10, from the end of the shaft.

2. Remove the retaining ring (8) and withdraw the barrel-and-pinion assembly (9).

3. Take out the peg (10) securing the locating nut. Remove the locating nut (11), which has a LEFT HAND THREAD, friction washers (12) and retaining spring (13).

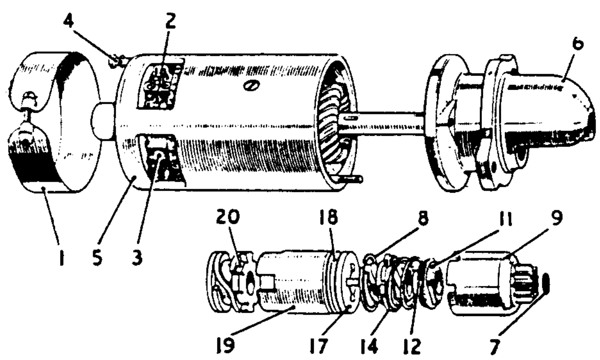


FIG 11

Note : On the latest models (Fig. 11), the locating nut is secured by caulking the keyway provided in the shaft, therefore no peg (10) is fitted. When re-assembling, it will be necessary to fit a new locating nut.

4a. Spring type drive only (Fig. 10)—Slide the sleeve and control nut (14) off the splined shaft. Remove the buffer washers (15) and main spring (16).

Note : The instructions 4b and 4c apply only to the rubber-type drive incorporated on the latest type of starter motor, as illustrated in Fig. 11.

4b. Slide the sleeve and control nut (14) off the shaft. Remove the sleeve coupling (17) and friction washer (18).
The rubber coupling (19) can now be removed from the armature shaft.

4c. Remove transmission plate and cushioning spring assembly (20) from the key in the armature shaft. Re-assemble by reversing the above procedure.

Armature

Examine the commutator, and if burned or blackened, clean with a petrol moistened rag, or in bad cases by carefully polishing with very fine glass paper.

Note : The mica on the starter commutator **must not be undercut.**

Brushes

Check the brushes for wear and freeness in their holders. If they are worn so that they do not make good contact on the commutator, or if the brush flexibles are

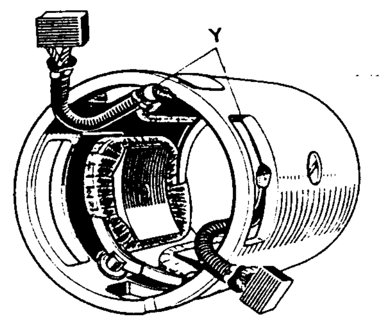


FIG. 12

exposed on the running faces, they must be replaced. Two of the brushes are connected to tappings (Y) on the field coils (Fig. 12), and the other two are connected to terminal eyelets (X) on the brush boxes (see Fig. 13).

The flexible connectors must be removed by unsoldering, and the connectors of the new brushes secured in their places by soldering. The brushes are pre-formed so that bedding to the commutator is unnecessary.

Check the pressure of the brush springs with a suitable spring scale. Replace brushes if the pressure is outside the limits of 30-40 ozs. (.8—1.13 kg.).

Field Coils

The field coils can be tested for an open circuit by connecting a 6 volt battery and test lamp to the tapping points at which the brushes are connected. If the lamp does not light, there is an open circuit in the wiring of the field coils.

Lighting of the lamp does not necessarily mean that the field coils are in order, as it is possible that one of them may be earthed to a pole shoe or to the starter motor housing. This may be checked by removing one of the test leads from the brush connector and holding it onto a clean part of the starter housing.

Should the lamp light it is indicated that the field coils are earthed and must be replaced.

When replacing field coils, the procedure as detailed in the dynamo section should be followed.

Bearings (Fig. 13)

Bearings which are worn so that they will allow excessive side play or end float of the armature shaft must be replaced. To replace the bearing bush proceed as follows :—

1. Press the bearing bush out of the end bracket by means of a hand press (A).
2. Press the new bearing bush (B) into the end bracket using a shouldered mandrel (D) of the same diameter as the shaft which is to fit in the bearing.

   The end bracket should be mounted on wood blocks (C) for this operation.

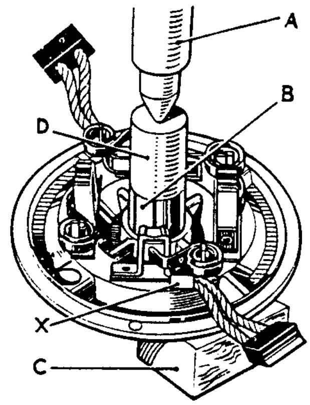


FIG. 13

Note : Before fitting a new porous bronze bearing bush, it should be immersed for 24 hours in clean thin engine oil.

Re-Assembly

The re-assembly of the starter motor is a reversal of the dismantling procedure.

FLYWHEEL STARTER GEAR RING

Tractors Type TE-20

The flywheel, which is balanced as an assembly with the crankshaft, is secured in such a manner that it cannot be re-located if starter ring teeth become worn. When teeth reach this condition, the gear ring should be removed and replaced as instructed below.

To remove starter gear ring

1. Drill a 5/16" (7.94 mm.) hole as near as possible to the inside edge of the ring.
2. Cut through the remaining outer section with a hacksaw and the ring will spring away.

To fit starter gear ring

1. Clean the outer spigot of flywheel.
2. Lay gear ring on a flat surface and heat uniformly to a temperature of 560°-570°F.

3. Drop gear ring on to flywheel flange and slowly rotate while cooling until held firm by contraction. Interference fit—.024"/.015". (.61-38 mm.).

Tractors Type TE-A-20

Detachable starter gear rings are not fitted to flywheel of engines S.I.E. to S.1099E. However, if ring teeth have become worn, the flywheel can be removed from the crankshaft, turned through 90° and re-located with unworn teeth presented to the starter pinion at rest position.

Further servicing can be carried out on flywheels of engines S.1100E onwards as they are fitted with detachable shrunk-on starter gear rings.

To remove starter gear ring

Use the same method as described for TE-20.

To fit starter gear ring

TO BE

ISSUED LATER

TO BE

ISSUED LATER

DISTRIBUTOR

Routine maintenance—Every 100 hours running

Lubrication (See Fig. 16).

Remove the distributor cap, rotor arm (1) and dust excluding plate (2).

Cam

Lightly smear the cam (10) with a very small amount of clean engine oil.

Cam bearing and distributor shaft.

Add two or three drops of thin machine oil to the top of the spindle (21) from which the rotor arm has been removed. DO NOT REMOVE THE SCREW WHICH IS EXPOSED TO VIEW. The screw is drilled to allow the oil to pass into the cam bearing.

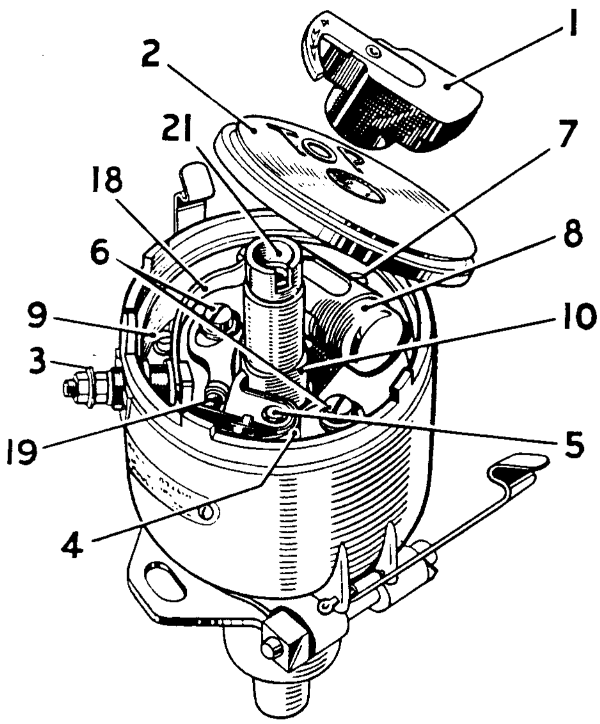


FIG. 16

Automatic Timing Control

Add a few drops of thin machine oil through the hole in the contact breaker base through which the cam passes. As there is only a small clearance between the cam and the contact breaker base, great care must be taken not to allow any oil to get on to the contact breaker points.

Contact Breaker Pivot

Place a small amount of clean engine oil on the pivot (5) on which the contact breaker works. Do not allow any oil to get on or near the contact points. Be careful to replace the dust excluding plate and rotor arm correctly.

Cleaning

Wipe the inside and outside of the distributor cap with a soft dry cloth, paying particular attention to the spaces between the metal electrodes. Ensure that the small carbon brush on the inside of the moulding, moves freely in its holder.

Examine the contact breaker, and if the contact points are burned or blackened, clean them with a fine carborundum stone or very fine emery cloth, afterwards wiping away any trace of dirt or metal dust with a petrol moistened cloth. Cleaning of the contact points is made easier if the contact breaker lever carrying the moving point is removed. To do this, slacken the nuts on the terminal post and lift off the spring, which is slotted to facilitate removal. After cleaning, check the contact breaker setting.

Contact Breaker Adjustment

Turn the engine by hand until the contact points (19) are seen to be fully opened, and check the gap with a gauge having a thickness of .010″-.012″. (.25-.30 mm.). If the gap is correct, the gauge should be a sliding fit, but if the gap varies from the gauge thickness, the setting must be adjusted as follows:

1. Keep the engine crankshaft in the position giving maximum contact opening and slacken the two screws (6), Fig. 16, securing the fixed contact plate.

2. Adjust the position of the plate until the gap is set to the thickness of the gauge and tighten the two locking screws.

3. Re-check the gap for other positions of the engine giving maximum contact opening.

Dismantling

1. Spring back the securing clips and remove the moulded cap.

2. Lift the rotor (1), Fig. 17, off the top of the spindle. If it is a tight fit, it should be gently levered off.

3. Remove the dust excluding plate (2).

4. Slacken the nuts (3) on the terminal post and lift off the end of the contact

breaker spring (4). The contact breaker lever can now be lifted off its pivot (5), Fig. 16. Take out the two screws (6), complete with spring washers and flat steel washers, which secure the plate carrying the fixed contact point, and remove the plate.

5. Remove the screw (7) securing the condenser clip, lift the slotted terminal connection off the post and remove the condenser (8).

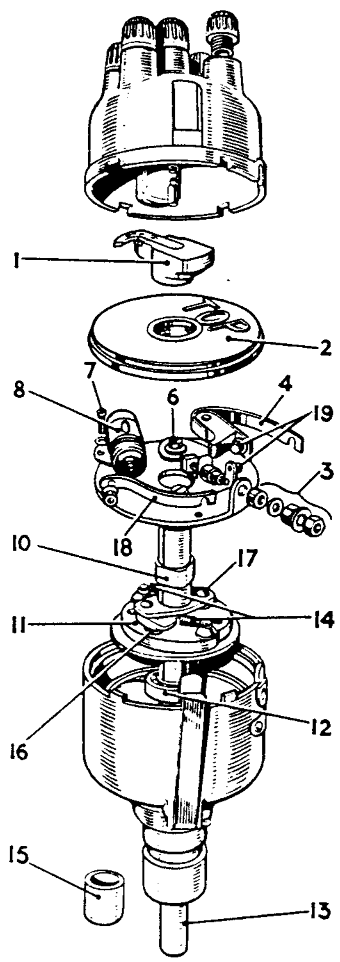


FIG. 17

6. Remove the locking nut (3) and insulating bush from the terminal post on the outside of the distributor body. The terminal post complete with insulating bush and locating tag can now be removed from the inside.

7. After the removal of the two screws (9), Fig. 16, and spring washers fitted at the edge of the contact breaker base, the latter can be removed from the body of the distributor.

8. *TRACTOR TYPE TE-20 ONLY. Remove the driving gear which is pinned to the shaft (See Fig. 18).*

9. The cam (10), Fig. 17, automatic timing control assembly (11), and shaft assembly complete with ball bearing (12) can be removed from the distributor body by gently tapping the distributor shaft (13) at the driving end.

10. Further dismantling of the automatic advance mechanism can be carried out by removing the cam. The cam securing screw is accessible from inside the top of the cam spindle.

Before dismantling, carefully note the position in which the various components are fitted so that they can be replaced correctly. Note that the springs (14) of the automatic advance mechanism are not equally strong and that the eyelet of the stronger spring is elongated.

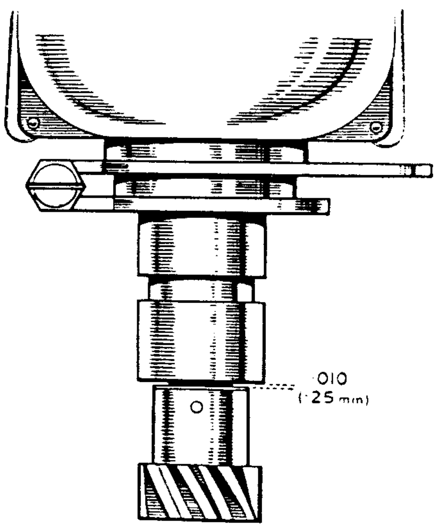


FIG. 18

Replacement of Driving Gear and Distributor Shaft TE-20 only, Fig. 18.

If it becomes necessary to replace the

distributor shaft or driving gear, the pin holding the latter to the shaft must be driven out and gear removed, or the shaft pushed up through the gear and distributor body. Check the bearing and bushing, and replace if necessary.

To reassemble, the replacement shaft is pushed down through the distributor body, and, after placing a fibre washer on the shaft, the replacement gear is pressed on until there is an end play of .010" (.25 mm.) Drill through the gear and shaft, and pin together.

REPLACEMENT OF BEARINGS

Bearing Bush—Distributor Body

1. Remove the bearing bush (15), Fig. 17, from the lower end of the body by using a hand press and a rod of suitable diameter.

2. Invert the distributor body and press the new bearing bush into the lower end of the distributor shank, using a hand press and a shouldered mandrel of the same diameter as the distributor shaft.

   Note : Before the new bush is fitted it should be allowed to stand for 24 hours immersed in clean thin engine oil.

3. After fitting, the bush must not be opened out, as this would tend to impair its porosity and so prevent effective lubrication.

Ball Bearing—Distributor Shaft

The ball bearing (12) on the distributor shaft (13) can be removed by means of an extractor. The new bearing can be fitted by means of a sleeve which locates over the distributor shaft and bears on the inner journal of the bearing.

Re-assembly

Note : Before re-assembling, lubricate with thin engine oil the distributor shaft (13), automatic advance mechanism (11) and the portion of the shaft on which the cam fits. The ball bearing (12) on the distributor shaft must be packed with H. M. P. grease.

1. Assemble the automatic timing control taking care that the parts are fitted in their original positions and that the control springs are not stretched.

   Two holes are provided in each toggle (16) and the springs must be fitted to the inner hole in each case. Ensure that the elongated eyelet of the stronger spring can slide freely on its peg.

   Place the cam on its spindle and locate the two pegs on the cam foot (17) in the holes in the toggle levers.

   Secure the cam by replacing and tightening the fixing screw.

2. Place the shaft assembly in position in the distributor body and gently tap the distributor shaft, at the cam end, until the ball bearing is correctly seated.

3. *TRACTORS TYPE TE-20 ONLY. Replace the driving gear and pin in position (See " Replacement of Driving Gear " Fig. 18).*

4. Place the contact breaker base in position on the distributor body and secure by replacing the two fixing screws (9), Fig. 16, together with spring washers.

5. Replace terminal bolt, locating tag, and insulating bush through the hole in the contact plate and the corresponding hole in the distributor body and secure in this position by fitting the insulating bush and nut (3) on the outside of the distributor body.

6. Position the plate carrying the fixed contact point on the contact breaker base and secure it in position by means of the two screws (6), first placing a spring washer and flat steel washer under the head of each screw.

7. Locate the slotted head of the condenser strip (18) under the head of the terminal bolt and secure the condenser in position by means of its screw.

8. Place the insulating washer over the contact breaker pivot pin (5), Fig. 16, and position the contact breaker lever on the pin. Locate the slotted end of the contact breaker spring (4) between the head of the terminal screw and condenser strip and tighten the nut to lock the spring in position. Adjust the contact breaker setting to give a gap of .010″ to .012″ (.25-.30 mm.) when fully opened.

Note : If it becomes necessary to renew the contact points (19), fit a replacement set comprising fixed and moving points.

9. Replace the dust excluding plate (2) and place the rotor (1) on top of the spindle, locating the register correctly and pushing the rotor fully home.

10. Fit the distributor cap and secure by means of the spring clips.

IGNITION TIMING

incorporating fitting distributor

Tractors type TE-20

Engines fitted with Lucas Distributor type D3A4 Lucas Service No. 40084.

The timing must be such that the distributor contact points are just opening when No. 1 piston is at T.D.C. of firing stroke, otherwise there is danger of a back-fire and consequent damage to the starter. A convenient method of setting the timing is as follows :—

1. Adjust contact points—see "Contact Breaker Adjustment." There should be a gap of .010″ to .012″ (.25-.30 mm.) when fully open.

2. Locate No. 1 piston at T.D.C. of firing stroke.

   (*a*) remove No. 2, 3 and 4 spark plugs.

   (*b*) turn crankshaft with starting handle until compression of No. 1 cylinder is beginning to be felt.

   (c) tractors of early manufacture have a vee mark on the inner rim of the fan belt drive pulley and corresponding cast markings on the timing cover. Continue to turn the crankshaft until the vee aligns with the mark D.C., indicating that No. 1 piston is at T.D.C. of firing stroke.

Note : Angular markings on flywheel fitted to tractors of later manufacture can be observed through a hole in the engine mounting flange and the position of No. 1 piston can be determined by the alignment of the appropriate marking with a small slot in the observation hole.

3. Turn rotor, which is keyed to distributor shaft to the position of No. 1 segment in distributor cap so that the contact points are just beginning to open.

4. Secure the distributor, with gasket, on its mounting studs so that the drive gear engages with the gear on the camshaft. The position of the rotor arm on the distributor should be approximately 10 o'clock.

5. Slacken the clamp securing the distributor body and re-check the opening of the contact points by turning the body until the correct position of opening is obtained.

6. Tighten body clamp, replace dust cover, rotor arm, distributor cap, sparking plugs and electrical connections.

Tractors type TE-A-20

Note :—

I graduation of distributor timing plate = 2° distributor = 4° crankshaft.

Engines Serial No. S1E to S8995E, fitted with Lucas distributor Model D3A4 Lucas Service No. 40132.

The flywheels fitted to these engines have holes drilled in the face and located in such a way that they can align with a small hole in the engine mounting flange when No. 1 piston is at a position 10°, 100°, 190°, or 280° before T.D.C.

The timing of the distributor, however, must be such that the contact points are just opening when No. 1 piston is 6° (crankshaft) before T.D.C. of firing stroke. A convenient method of setting the timing is as follows.

1. Adjust contact points—see "Contact Breaker Adjustment." There should be a gap of .010" to .012" (.25-.30 mm.) when fully opened.

2. Locate No. 1 piston at a position 10° before T.D.C. of firing stroke.

   (*a*) Remove Nos. 2, 3 and 4 sparking plugs.

   (*b*) Turn crankshaft with starting handle until compression of No. 1 cylinder is beginning to be felt.

   (*c*) Insert 1/4" (6.35 mm.) dia. rod through the timing hole in the engine mounting flange.

   (*d*) Continue to turn the crankshaft with starting handle until rod registers with timing hole, indicating that No. 1 piston is at a position 10° before T.D.C. of firing stroke.

   (*e*) Check that the correct timing hole has been engaged by viewing through No. 4 sparking plug hole to observe piston position, i.e. 10° before T.D.C.

3. Locate distributor driving gear and oil pump drive shaft.

   (*a*) Assemble drive gear on key of oil pump drive shaft with large boss of gear uppermost.

   (*b*) Insert shaft in housing bush with slots in gear parallel with camshaft and with keyway of gear away from engine.

   (*c*) Press down and turn clockwise to engage with skew gear on camshaft

   (*d*) Remove rod from locating hole in engine mounting flange.

   (*e*) Press down on driving gear and at same time slowly turn starting handle to engage drive shaft tongue in oil pump.

4. Rotate crankshaft two complete turns and re-insert locating rod.

Note :—

(*i*) slots of drive gear should be inclined at 45° toward No. 1 sparking plug with the keyway away from engine.

(*ii*) distributor cap fits in one position only.

5. Turn rotor, which is keyed to distributor shaft, to the position of No. 1 segment on cap.

6. Mount distributor assembly complete with timing plate, and clamp-on adaptor with the terminal post away from the flat on the adaptor lower flange, but do not tighten set screws or clamp nut.

7. Mount adaptor and distributor over gasket on to studs in mounting flange so that distributor terminal post is positioned away from the engine. If it is found that adaptor does not locate correctly on studs, turn rotor arm slightly in either direction until adaptor seats. Secure with nuts on studs.

8. Turn distributor body until contact points just begin to open with rotor arm approaching the position of No. 1. segment in distributor cap.

9. Holding the distributor body in this position, turn the clamp so that the pointer is in the central position on the timing plate. Tighten clamp nut.

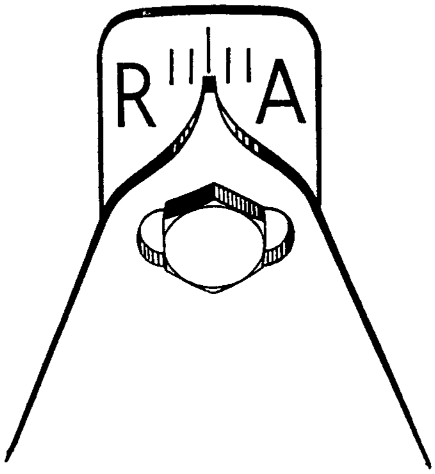


FIG. 19

10. Turn the distributor body, with clamp and indicator (Fig. 19) one graduation anti-clockwise towards R and tighten timing plate setscrews.

Engine Serial Number S8996E onwards, fitted with Lucas distributor Model D3A4, Lucas Service No. 40146.

The flywheels fitted to these engines have holes drilled in the face and located in such a way that they can align with a small hole in the engine mounting flange when No. I piston is at T.D.C. or a position 90°, 180°, or 270° before T.D.C. The timing of the distributor, however, must be such that the contact points are just opening when No. I piston is at T.D.C.

Fitting and timing of the distributor can be carried out according to instructions given for engines No. S1E to S8995E, bearing in mind the following points.

1. Correct location of timing rod gives T.D.C. for firing stroke of No. I piston.
2. If timing plate setscrews are tightened after instruction 9, instruction 10 should not be carried out.

Engine Serial Number S1E to S8996E fitted with Lucas replacement distributor Model D3A4, Lucas Service No. 40146.

Note :

Piston location given by flywheel timing holes is 10°, 100°, 190° or 280° before T.D.C. Piston location required when contact points begin to open is T.D.C. of firing stroke.

Fitting and timing of the distributor can be carried out according to instructions previously given for engines No. S1E to S8995E, bearing in mind that, when carrying out instruction 10, the distributor body should be turned $2\frac{1}{2}$ graduations of the indicator anti-clockwise towards R.

CONTROL BOX

Regulator

The function of the voltage regulator is as follows :—

1. Breaks the circuit between the battery and dynamo if the dynamo voltage falls below the battery voltage. This prevents discharge of the battery through the dynamo when the tractor is stopped or idling.
2. Controls the maximum voltage reached by the dynamo.
3. Controls the maximum current output of the dynamo.

The voltage regulator is located below the battery and is housed in a waterproof casing. It is of the temperature-compensated type which permits a higher output when cold and a reduced output when warm. This allows a quick charge immediately after starting, when a heavy drain has been placed on the battery.

The compensating device consists of a bimetal strip which, due to unequal expansion of the two metals, increases the pressure of the adjusting spring.

The regulator is actually a two-unit type consisting of cut-out unit and voltage control unit. However, the voltage control has a number of windings carrying full generated current which assist in breaking the field circuit if the current becomes excessive.

If the voltage or amperage reaches a predetermined limit, the regulator breaks the circuit to the field and cuts in a resistance. This immediately cuts down the voltage and amperage until the contact points close when the output rises until the circuit is again broken by opening contact points. These cycles occur so rapidly that the points vibrate at a high frequency and thus hold the output at a constant predetermined maximum.

The voltage regulator is thus permitted automatically to cope with the electrical loads as applied, and maintains the battery at full charge without overcharging.

Note : Three types of resistance are fitted to the control box (Fig. 20)

1. Wound type in position Z.
2. Plain carbon type in the same position.
3. Carbon type as shown in Fig. 23, item Z.

When replacing the control box cover, especially where resistance type 1 or 2 is fitted, do not tighten down too tightly. Thus distortion of the regulator frame and possible short circuiting of the resistance will be avoided.

Regulator Adjustment.

The regulator is carefully set before leaving the works to suit the normal requirements of standard equipment, and in general it should not be necessary to alter it. If, however, the battery does not keep in charged condition, or if the generator output does not fall when the battery is fully charged, it may be advisable to check the setting and, if necessary, to re-adjust.

Before any attempt is made to alter regulator settings, it should be established that the fault does not lie in the circuit associated with it.

Important points which can give a false indication of a regulator fault are :—

1. **Slipping dynamo belt.**
   Check belt and make sure it is not slipping. Adjust until fan can only just be turned by hand.
2. **Crossed dynamo connections.**
   Maybe these are crossed either at the regulator or dynamo. Examine these leads. If they are crossed, the regulator points will have burnt the moment the engine was started.
3. **Faulty battery.**
   Check battery. Test with hydrometer and check voltage of each cell. Top up if required. Clean any sulphation off lugs. Make sure top of battery is dry.
4. **Bad earth connections.**
   Check earth connections of battery and regulator.

To Check and Adjust Setting–Electrical

Note : It is important that a good quality moving coil voltmeter (0-10 volts) be used to adjust the regulator.

Owing to the terminal arrangments of the control box, it is necessary to remove the negative connector from the battery, run a temporary connection from the negative battery terminal to the " SW " terminal of the ignition coil, and, with the ignition switch in the " OFF " position, start the engine by hand. Earth one lead of the voltmeter and connect the other to the main dynamo connection at the dynamo, or to the terminal at the back of the warning light to which the yellow cables are connected.

Slowly increase the engine speed until the voltmeter needle ' flicks ' and then steadies ; this should occur at a voltmeter reading between the limits given in " Test Data " for the particular temperature of the regulator.

If the voltage at which the reading becomes steady occurs outside these limits, the regulator must be adjusted.

For this adjustment the control box must be removed from its mounting and it will be necessary first to take out the battery and to disconnect the plug-in connector to the control box, by removing the two fixing screws. After removing the control box, drill off the heads of the four rivets securing the cover to the base, using a cutter or a 1/4" (6.35 mm.) drill with a slow lead.

Reconnect the control box, and release the locknut (X) Fig. 20 holding the regulator adjustment screw. Turn the screw in a clockwise direction to raise the setting or in an anti-clockwise direction to lower the setting. Turn the screw a fraction of a turn at a time and then tighten the locknut.

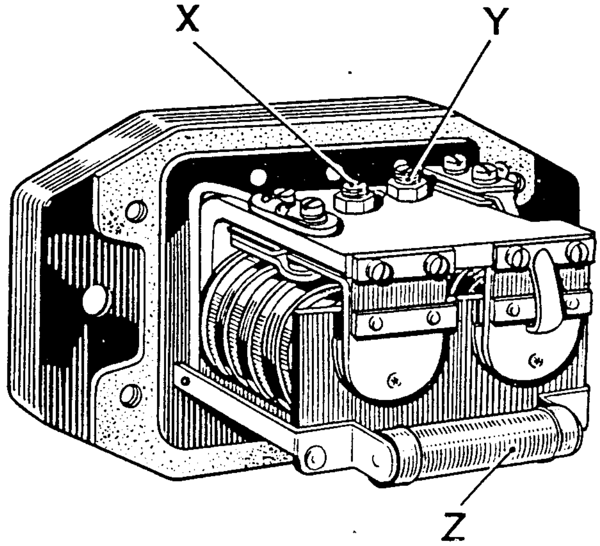


FIG. 20

When adjusting, do not run the engine up to more than half throttle because, while the generator is on open circuit, it would build up a high voltage if run at high speed, and a false voltmeter reading would be obtained.

Remove the temporary connection to "SW" terminal of ignition coil and refit negative battery terminal.

Mechanical Setting of Regulator.

The armature carrying the moving contact of the regulator is accurately set and should not be removed. If, however, it does become necessary to re-set the contacts, with ignition switched off proceed as follows, referring to Figs. 21 & 22.

1. Slacken the two armature fixing screws (E). Insert a .018" (.46 mm.) feeler gauge between the back of the armature (A) and the regulator frame (B).
2. Press the armature against the regulator frame and down on to the top of the bobbin core (C) with gauge in position. Lock the armature by tightening the two fixing screws.
3. Check the gap between the underside of the arm (not the contact) and the top of the bobbin core. This should be .022"—.030" (.55-.75 mm.) as shown in Fig. 21.

Note :
Take care that this measurement is not taken between the top of the bobbin core and the stop rivet.

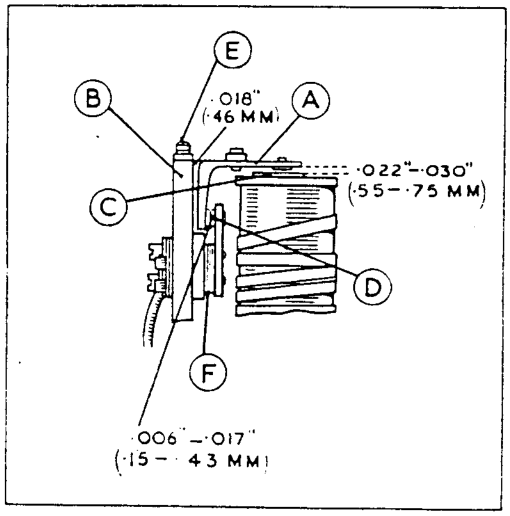


FIG. 21

On the later models, a large shim is fitted to the inner face of the armature. In this case, the gap should be .012"-.020" (.30-.50 mm.) as shown in Fig. 22.

If the gap is outside the given limits, correct by adding or removing shims (F) at the back of the fixed contact (D).

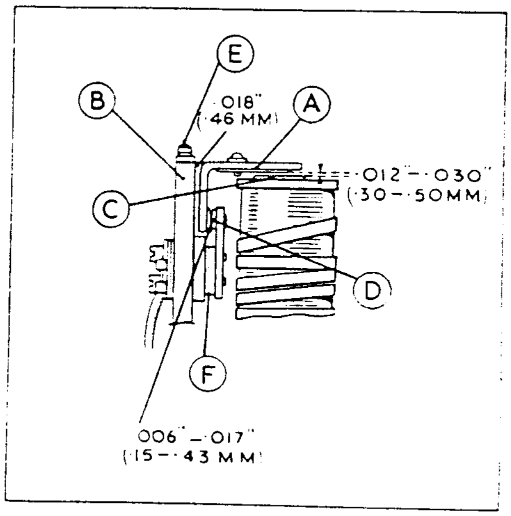


FIG. 22

4. Remove the gauge and press the armature down. The gap between the contacts should be .006"-.017" (.15-.43 mm.)

Cleaning Regulator Contacts

After long period of service it may be found necessary to clean the vibrating contacts of the regulator. These are accessible if the top screw securing the fixed contact is removed and the bottom screw slackened to permit the fixed contact to be swung outwards. The contacts can then be polished with fine emery cloth.

CUT-OUT

Adjustment.

If it is suspected that the cutting-in speed of the dynamo is too high connect a voltmeter (as described in Regulator Adjustment) and slowly raise the engine speed. When the voltmeter reading rises to about 6.3-6.7 volts the cut-out contacts should close.

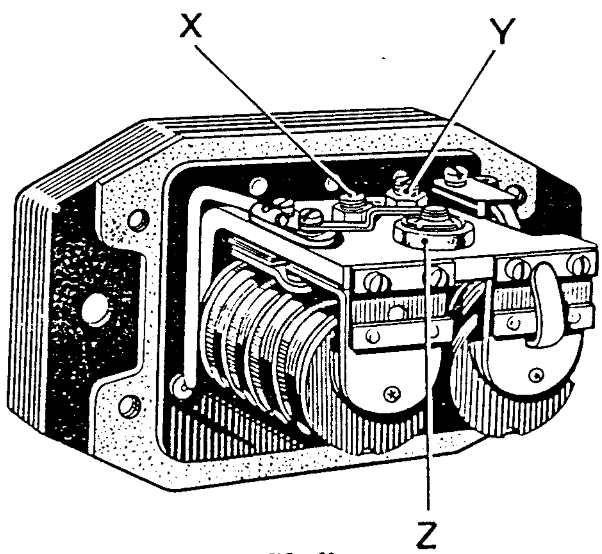


FIG. 23

If cut-out has become out of adjustment, and operates at a voltage outside these limits, it must be reset. To make the adjustment slacken the locknut and turn the adjusting screw (Y), Fig. 23, a fraction of a turn in a clockwise direction to raise the operating voltage or in an anti-clockwise direction to lower the voltage. Tighten the locknut after making the adjustment.

When the correct setting has been obtained, refit the cover so that it locates on the rubber sealing washer. Firmly secure the cover with four suitable bolts, washers and nuts.

CONDENSER

The best method of testing a condenser is by substitution. Disconnect the original condenser and connect a new one between the low tension terminal of the distributor and earth.

Should a new condenser be necessary, remove the old one as follows :—

Take out the screw from the condenser band clip.

Unscrew the terminal nut, lift off the spring washer, and remove the condenser.

When re-fitting, ensure that all nuts and screws are tight.

IGNITION COIL

The ignition coil requires no attention beyond ensuring that the terminal connections are tight and that the exterior is kept clean, particularly between the terminals.

SPARK PLUGS

Spark plugs and their gaskets should be removed periodically for inspection and service. If the gaskets are found to have flattened excessively owing to long service or because the plugs have been pulled down too tight, they should be replaced. Wash the plugs in petrol and leave them to dry.

Clean the insulators and electrodes with a wire brush or, preferably, use one of the proprietary spark plug service units.

Remove all traces of grit and carbon from the plug threads. Examine the insulators for cracks, and the electrodes for signs of excessive burning ; if damage of this nature is present, the plug should be replaced.

If it is decided that plugs are worthy of further use, it is recommended that the gap should be dressed, on both centre and side electrodes, with a small smooth file.

When re-setting gap, bend side wire only, never bend the centre electrode as this may split the insulator tip. Provided gap has been set correctly a plug can be considered fit for further use if the spark is continuous up to 100 lbs. per square inch (7.03 kilos per sq. cm.) and there is no gas leakage at the terminal.

Plug gap—see Specification and Test Data.

When installing plugs, screw down by hand as far as possible, then use spanner for tightening only. Always use a box spanner to avoid possible fracture of the insulator. Plugs should not be screwed down too tightly on to their gaskets—just sufficiently so that a good seal can be reasonably expected.

Damage to the top half of the insulator is often responsible for poor plug performance. Inspect for paint splashes, accumulation of grime and dust, cracked insulators, especially at shoulders or terminal posts, caused by a slipping spanner or overtightening of terminal.

SWITCHES AND WIRING

The starter switch is mounted on the clutch portion of the transmission housing, just forward of the steering column, in a casing of its own that is held by four bolts. The contact points are sealed against dirt and moisture, and are actuated by a plunger that projects to the inside of clutch housing. The plunger in turn is actuated by a rocker which is connected to the transmission reverse gear shifter rail by means of a strap (see Fig. 24). Reverse movement of the transmission shift rail causes the rocker to force the plunger upward against the switch and makes contact between the two points.

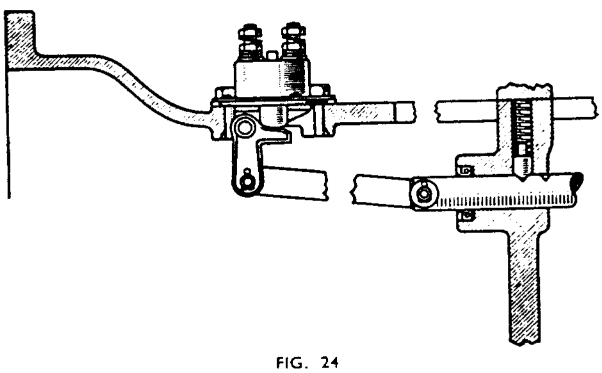


FIG. 24

The above movement is brought about by raising shift lever and moving it forward to the right, thus preventing the operation of the starter motor when a gear is engaged.

Service

1. Remove the three wires connected to switch (battery, key and starter), and the four bolts holding switch.

2. Raise and tilt the switch forward to remove pin. To prevent the connecting link from switch to rail from dropping down, secure same with a piece of wire or string. The pin can now be pulled and the switch replaced.

3. The switch case is riveted and, should inspection be desired, rivets can be cut and replaced without difficulty. The switch must be sealed against the entrance of dust, which prevents a good electrical contact.

Note : A switch of improved design, facilitating inspection of contacts by the removal of 3 set screws is incorporated on latest production tractors.

4. To adjust the starter switch move (backward or forward the slotted mounting bolts) until correct engagement or disengagement is obtained.

The wiring on the tractor is comparatively simple, but must be maintained in good condition to prevent hard starting and electrical difficulties. The battery cables are designed to carry between 200 and 400 amps. However, if the terminal contacts are not kept clean and tight, the current carrying capacity is greatly reduced and starting trouble results. It is essential to maintain good earth connections for battery, starter and dynamo.

The high-tension wiring system is of 7 mm. diameter wire with a high resistance insulating covering. If this insulation becomes broken or cracked, a current leak may occur, with the result that no spark or a reduced spark reaches the spark plug.

The method of connecting the H.T. cables, as shown in Fig. 25, is to thread the knurled moulded nut over the cable, bare the end of the cable for about 1/4" (6 mm.), thread the wire through the washer removed from the end of the original cable, and bend back the wire strands. Screw the nut into its terminal.

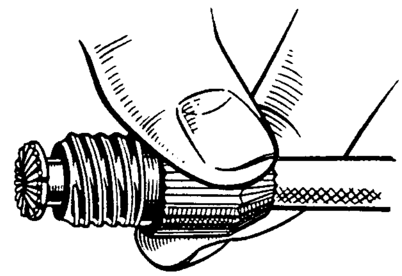


FIG. 25

It is recommended that, as opportunity occurs, the splayed-over cable strands should be soldered in position on to the washer.

The remaining low-voltage wiring system should be inspected regularly and all connections kept clean and secure. Locations where chaffing has worn the covering should be repaired before a short circuit occurs. Advantage should be taken of the wiring harness assembly which is made available as a service part.

Ignition warning light.

A burnt-out bulb will, of course, require replacement. To service the assembly (Lucas No. 38029) either :—

1. Use a bulb with a flashlight-type screw base, 2.5 volts, .14 amps.
2. Use a bulb with a flashlight-type screw base, 6-8 volts and .3 amp. When this is used, the resistance wire at the back of the socket must be short-circuited.

12-VOLT ELECTRICAL SYSTEM

(FITTED IN PRODUCTION FROM 200,001ST TRACTOR)

SPECIFICATION AND TEST DATA

(12-VOLT EQUIPMENT, POSITIVE EARTH RETURN)

BATTERIES

Petrol, V.O. and L.O. Tractors.

Lucas Model GTW.7A/1 or GTW.7A/2

Lucas Model GTZ.7A/1 or GTZ.7A/2 (Dry Charged).

Capacity 38 ampere hour at 10 hour rate.
12-volt 7 plate unit.

Diesel Tractor.

Up to Tractor Serial No. TE-F 207705 :

Two Lucas Model TMX/17/T batteries connected in series.

Capacity 120 ampere hour at 10 hour rate.
Two 6 volt 17 plate unit.

Tractor Serial No. TE-F 207706 and future :

Two Lucas Model T/TX19E or Model T/TX19T (Dry Charged) batteries connected in Series.

Capacity 115 ampere hour at 10 hour rate.
Two 6-volt 19 plate unit.

(A) TABLE OF SPECIFIC GRAVITIES AND CHARGING RATE

Battery	Plates in each cell	Ampere Hour Capacity		Volume of Electrolyte required to half fill one cell.	Initial Charging Current (amp)	Normal Recharge Current (amp)
		At 10	At 20			
GTW.7A/1, GTW.7A/2, GTZ.7A/1, GTZ.7A/2	7	38	43	⅜ pint	2.5*	4
TMX17/T	17	120	137	1¼ pints	8	13
T/TX19E, T/TX19T	19	115	131	1 pint	8*	12

* Not applicable to Dry Charged Batteries.

(B) SPECIFIC GRAVITY OF ELECTROLYTE (CORRECT TO 60°F)

Home Trade and climates normally below 80°F (27°C)		Sub Tropical climates 80° 100°F. (27° 38°C.)		Tropical climates over 100°F. (38°C.)	
Filling	Fully Charged	Filling	Fully Charged	Filling	Fully Charged
1.[illegible]50	1.280 1.300	1.320	1.250 1.270	1.300	1.220 1.240

(C) MAXIMUM PERMISSIBLE ELECTROLYTE TEMPERATURE DURING CHARGE

Climates Normally below 80°F (27°C)	Climates between 80°—100°F (27°—38°C)	Climates frequently above 100°F (38°C)
100°F (38°C)	100°F (43°C)	120°F (49°C)

DYNAMO

All types

Lucas Model C 39P/2.

Service No. 2259A.

Shunt wound two-pole two brush machine arranged to work in conjunction with compensated voltage control regulator unit.

Clockwise rotation viewed from driving end of Dynamo.

Test Data.

Normal Voltage	12
Cutting-in speed r.p.m.	1050 - 1200
At Dynamo Volts	13.0
Max. Output Amps.	11
At r.p.m.	1600 - 1700
At Dynamo Volts	13.5
• On resistance Load - ohms.	1.23
Field Resistance - ohms.	6.2
Brush Spring Tension	22.25 ozs. (634 grm)

• Resistance Load must be capable of carrying 15 amps without overheating.

STARTER MOTOR

Petrol. V.O. and L.O. Tractors.

Lucas Model M 35G.

Service No. 25038A.

Four-pole, four brush machine with an extended shaft carrying a Lucas Eclipse type engagement gear.

Clockwise rotation viewed from driving end.

Test Data.

Normal Voltage	12
Lock torque lbs./ft.	9.3 (1.285 kg./m.)
Current amps.	325 - 345
Voltage	8.1 - 7.7
Torque at 100 r.p.m. lbs./ft.	4.9 (.677 k /m.)
Current amps.	200 - 220
Voltage	8.9 - 9.3
Brush Spring Tension	15 - 25 ozs. (425-709 grm)

Diesel Tractor.

Lucas Model M 45 G.

Service No. 26071

Compound wound four-pole, four brush machine incorporating pre-engaged type driving pinion with combined back run ing and overload clutch.

Test Data.

Normal Voltage	12
Lock Torque.	22 lbs./ft. (3.04 kg./m.) at 790- 10 amperes at 6.1-5.7 volts.
Torque at 1000 r.p.m.	11.4 lbs./ft. (1.575 kg.m) at 470-490 amperes at 8.5-8.1 volts.
Brush Spring Tension	30-40 ozs. (850-1134 grms)

STARTER MOTOR SWITCH

Petrol. V.O. and L.O. Tractors.

Lucas Model ST.18.

Service No. 76418A

Mechanical type operated by gear lever.

Diesel Tractor.

Lucas Model ST.950.

Service No. 76411B.

Solenoid type, energised by electrical contact switch on Starter Motor operated by gear lever.

DISTRIBUTOR

Petrol. V.O. and L.O. Tractors.

Tractor	Distributor	Initial Timing Crankshaft degrees.	Maximum Advance Distributor degrees at Distributor r.p.m.
TE-20	D3A4 V125 40084J	T.D.C.	
TE-A (80 m/m) Original	D3A4 V139 40132E	6° B.T.D.C.	18°—20° at 1350.
TE-A (80 m/m) Later.	D3A4 V139/3 40146D	T.D.C.	20°—23° at 1340.
TE-A (85 m/m)	D3A4 V160 40243A	1° B.T.D.C.	14°—16° at 1300.
TE-D Early	D3A4 V151 40186A	6° B.T.D.C.	23°—27° at 1200.
TE-D Later	D3A4 V151 40298A	6° B.T.D.C.	9°—11° at 1100.
TE-H	D3A4 V157 40229A	1° B.T.D.C.	16°—18° at 1240.

Contact breaker gap. .014" - .016" (.36 - .42 m/m)

Contact breaker spring tension 20 - 24 ozs.

Condenser capacity .18 - .23 microfarad.

Automatic timing control commences at 200 - 300 distributor r.p.m.

IGNITION COIL

Petrol. V.O. and L.O. Tractors.

Lucas Model B.12. 45012A

Current consumption 1.05 amps. (approx.) running.

Current consumption 2.5 amps. (approx.) stall.

IGNITION WARNING LIGHT

Petrol. V.O. and L.O. Tractors.

Lucas Model VL3/L 38075A

Bulb : Lucas N.987 12 Volt - 2.2 watts.

CONTROL BOX

All types.

Lucas Model RF.97.
Model RB.107. introduced at Tractor Serial No. 381.660.

Regulator Air Gap Settings : RF.97.

Gap between frame and armature .018" (.46 m/m).

Gap between armature and core face .012" - .020" (.30 - .50 m/m).

Contact gap .006" - .017" (.15 - .44 m/m).

Regulator Air Gap Setting : RB 107.

Gap between armature and core face .015" (.38 m/m)

Cut-out RF.97.

Cut-in Voltage : 12.7 - 13.3 volts.

Drop-off Voltage : 8.5 - 11 volts.

Reverse 3.0 - 5.0 amps.

Gap Settings.

1. Air Gap between yoke and armature .008" (.20 m/m).
2. Air gap between core face and armature with .008" (.20 m m) gauge in position .011" - .016" (.28 - .41 m/m) or .016" - .020" (.41 - .51 m m) without shims.
3. The contact gap .002" - .006" (.05 - .15 m/m) with a .030" (.76 m/m) gauge between armature and core face.
4. The stop plate arm gap .030" - .034" (.76 - .86 m/m) with .008" (.20 m/m) gauge in position.

Open Circuit Setting.

10 C (50 F)	15.3 - 15.9 V
20 C (68 F)	15.0 - 15.6 V
30 C (86 F)	14.9 - 15.3 V
40 C (104 F)	14.6 - 15.0 V

Charging begins at (approx.) 1100 dynamo r.p.m. or 600 r.p.m. engine spark ignition — 640 r.p.m. engine diesel.

Cut-out RB 107

Electrical settings similar to RF.97.

Gap settings.

1. .025"-.030" (.65-.76 m m) with armature pressed down.
2. .015"-.020" (.39-.52 m m) with armature released. The cut-out fixed contact follow through must not exceed .020 .

HEATER PLUG

Diesel engine.

Lodge No. 320. Current 27 amp. at 12 volts.

SERVICE INSTRUCTIONS

BATTERIES

12-volt electrical equipment. Positive Earth Return. (Fitted in production from 200,001st Tractor).

Petrol. V.O. and L.O. Tractor.

Lucas Model GTW 7A/1 or GTW 7A/2
Model GTZ 7A/1 or GTZ 7A/2
(dry Charged)

Diesel Tractor.

Up to Tractor Serial No. TE-F 207705. **Two Lucas Model TMX 17/T** batteries connected in series.

Tractor Serial No. TE-F 207706 and future.

Two Lucas Model T TX19E or Model T/TX19T (dry charged) batteries connected in series.

The batteries are connected in series to give a 12-volt supply and housed, one on either side of the driver's seat. The earth cable is connected to the battery, the negative terminal of which connects to the positive terminal of the left hand battery. Mounted on frames fitted to the outer axle housing, the batteries are secured by anchor bolts and protected against physical shock and vibration by rubber mounting pads.

Always fit these batteries at the outer limit of the cradles, thereby avoiding any possibility of damage from the hydraulic lift arms.

Battery Maintenance and Servicing see G4 - 6.

Dry Charged Batteries.

Dry charged batteries, which are supplied for special export requirements, are similar in appearance and operation to the normal lead-acid type, and maintenance in service is the same. The use of porous rubber instead of wood for the separators results in increased mechanical strength and reduces the possibility of short circuits between the plates.

Storage and Charging.

By a special process these batteries are dry-charged and provided the seals remain unbroken, they may be stored indefinitely in all climates.

When required for service, remove seals and fill each cell with sulphuric acid of the correct specific gravity for the battery, and leave to soak for 1 hour. The battery is then 90% charged and ready for service.

A short refreshing charge of not more than 4 hours at the normal recharge rate of the battery will ensure that it is fully charged.

DYNAMO

12V. Lucas Model C39 P2. Serial No. 22[illegible]59A.

The dynamo is a shunt wound, two pole, two brush machine, arranged to work in conjunction with a compensated voltage control regulator unit, its output automatically controlled by the voltage regulator, and is dependent on the state of charge of the battery.

Maintenance and Lubrication.

(Every 120 hours running time)

Unscrew the cap of the lubricator fitted on the commutator and bracket of earlier models, lift out the felt pad and spring and half-fill the lubricator cap with H.M.P. grease. Replace the spring and pad and screw the lubricator cap back into position.

At engine No. SC.46243E, the wick type lubricator was deleted to provide a more positive method of lubrication for the commutator end bearing. Oil is introduced through a small hole in the end of the bearing housing, and a porous bronze disc held in position by the bearing brush, absorbs the oil and passes it to the bearing. This disc prevents the penetration of dirt into the bearing and at the same time acts as an oil reservoir.

Lubricate with engine oil every 120 hours running time.

Servicing. (See Section G7 - 9).

Test procedure is identical with that outlined on pages G7 and G8 except for the following :—

Testing in Position.

Para 2. Read 0-20 volts and not 0-10 volts.

Para 3. Read 12 volts and not 6 volts.

Field Coils.

Para 1. Read 6.2 ohms and not 2.5 and 3.2 ohms and 12 volts not 6 volts.

STARTER MOTOR

Lucas Model M45G — 12 volt.

Diesel Engine Tractor — Type TEF only.

The starter motor fitted to the Diesel engine tractor is of the pre-engaged type. The pinion of the clutch-type starting drive, unlike that of the inertia-engaged types, is normally in mesh with the teeth of the engine flywheel before the starter motor is connected to the battery. In the event of tooth to tooth engagement this pre-engagement feature is over-ruled by the action of a compression spring and specially sectioned pinion teeth so that the motor starts and the driving pinion slips immediately into mesh with the flywheel. A clutch is incorporated which protects the motor from overload in the event of a backfire.

The driving motor is a compound-wound four brush machine and has four poles, two of the field coils are wound with copper strip, and connected in parallel, share equally the main starting current. The other two wound with fine copper wire, are connected in series between the common field terminal and the starter yoke. Those coils have a braking effect on the armature and at 'no-load' (after the diesel has fired) they halve the starter light load speed.

Maintenance.

The only maintenance normally required by the starter motor is an inspection about every six months of the brush-gear and commutator. Before this can be carried out it is necessary to remove the starter motor from the engine.

Clean the outside of the starter before removing the metal band cover. Check that the brushes move freely in their holders by holding back the brush springs and pulling gently on the flexible connectors. If a brush is inclined to stick, remove it from its holder and clean its sides with a petrol-moistened cloth. Be careful to replace brushes in their original positions in order to retain the 'bedding.' Brushes which have worn so that they will not 'bed' properly on the commutator must be renewed (See page 11)

The commutator should be clean, free from oil or dirt and should have a polished appearance. If it is dirty, clean it by pressing a fine dry cloth against it while the starter is turned by hand from the pinion end. If the commutator is very dirty, clean with a petrol moistened cloth.

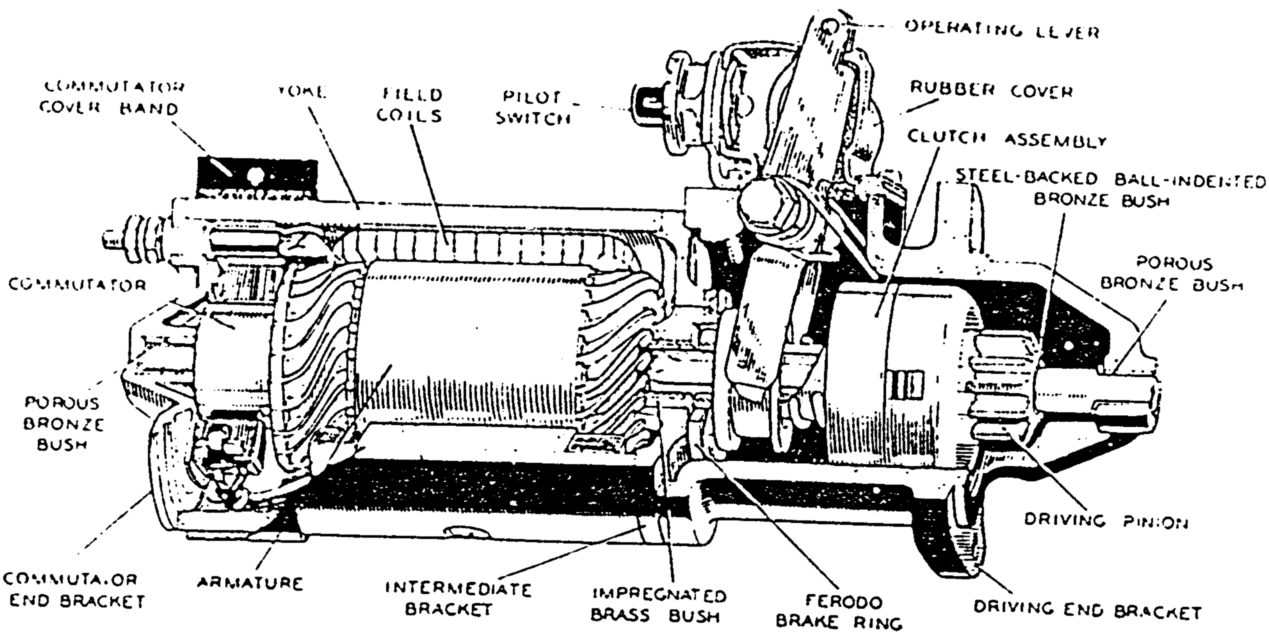


FIG 25.

SERVICING

(a) If the starter fails to operate check to see if the pilot light switch is not at fault, pull back the rubber covering on the lever mechanism and press the pilot switch button by hand. If the starter operates, the pilot switch and electrical circuit is in order and the mechanical linkage should be checked. (See page G34).

(b) If the motor is heard to operate, but does not crank the engine, indication is given of damage to the drive. The starter motor must then be removed for examination.

(c) Sluggish or slow action of the starter motor can usually be traced to a loose terminal connection in the wiring circuit. To carry out a point-to-point check proceed as follows :—

Testing in position.

(a) If the tractor is not equipped with lighting, then connect a 0-20 voltmeter across the battery terminals before proceeding.

1. Switch on the lamps and operate the starter control. If the lights go dim or the voltmeter reading drops to about 6 volts, but the starting motor is not heard to operate, an indication is given that current is flowing through the starting motor windings but that the armature is not rotating. In this case the starting motor must be removed from the engine for examination.

2. Should the lamps retain their full brilliance or the voltmeter reading remain steady at about 12 volts when the starting mechanism is operated, check the circuit for continuity from battery to starting motor via the starter switch. Examine the connections at these units.

3. To test the starter switch circuit :

   Connect the voltmeter between the supply terminal and earth of the pilot switch mounted on the drive end casting of the starting motor. No reading indicates a completely discharged battery, faulty cable or loose connection.

4. Connect the voltmeter between the second terminal and earth. Operate the starter. No reading indicates a faulty pilot switch. To remove the switch, disconnect the pilot cables, unscrew the four rubber grommet retaining screws and remove the rubber shield from the pilot switch bracket. Remove the ring nut and withdraw the switch.

5. Connect the voltmeter to the small terminal on the main starter switch and to earth. Operate the starter and observe reading on voltmeter. No reading indicates faulty cable or loose connection.

6. Connect the voltmeter between the large supply terminal and earth. No reading indicates faulty cable or loose connection.

7. Connect the voltmeter between the second large terminal and earth, and operate starter. No reading indicates a faulty switch, which must be replaced.

8. If the pilot and main switches are in order, check with the voltmeter between the starter motor terminal and earth and operate the starter, when a reading of 6.7 volts should be obtained if the starter is operating normally. A lower or zero reading indicates a faulty internal connection, and the starter must be removed from the engine.

(c) Bench Testing and Examination of Brushgear and Commutator.

1. If it is necessary to remove the starting motor from the engine, first proceed as follows :—

Disconnect the cable from the positive battery terminal to prevent possible short circuits.

Disconnect the heavy cable from the starting motor, and also the light cables from the pilot switch.

Remove the pin which couples the starting motor operating lever with the starting linkage mechanism. Undo the three fixing bolts and withdraw the starting motor.

2. Secure the body in a vice and test by connecting it with heavy gauge cables to a 12 volt battery. One cable must be connected to the starter terminal and the other held against the body or end bracket. Pull back lever a little, in order to disengage drive from Ferodo brake ring. Under these light load conditions the motor should run freely at about 4,500 r.p.m.

3. If the operation of the starting motor is unsatisfactory, remove the cover band and examine the brushes and commutator. Hold back each of the brush springs and move the brush by pulling gently on its flexible connector. If the movement is sluggish, remove the brush from its holder and ease the sides by lightly polishing on a smooth file. Always replace brushes in their original positions. If the brushes are worn so that they will not bear on the commutator or if the brush flexible is exposed on the running face they must be replaced. Check the tension of the brush springs with a spring scale. The correct tension is 30-40 ozs. (840-1134 grms).

If the commutator is blackened or dirty, clean it by holding a petrol-moistened cloth against it while the armature is rotated.

4. Re-test the starter as described under (2). If the operation is still unsatisfactory, the unit must be dismantled for detailed inspection and testing.

(d) To Dismantle.

1. Remove the cover band, hold back the brush spring and lift the brushes from their holders.

2. Unscrew the four screws which hold the pilot switch bracket and rubber cover. Lift off complete pilot switch assembly.

3. To release the return spring, and using a notched screwdriver or similar tool, press inwards and upwards the spring legs.

Undo the hexagon nut securing the operating lever pivot bolt.

Knock out the bolt using a $2\frac{1}{2}" \times \frac{3}{8}"$ (63.5 × 9.52 m/m) stem. The assembly of lever, distance collars and return spring may then be lifted out and will form a complete unit ready for re-assembly.

4. Unscrew the single nut on the starting motor terminal and remove spring washer, washer, and insulating washer from the terminal stem.

5. Unscrew and withdraw the two through bolts from the commutator end bracket, and remove bracket from the starter motor yoke.

6. Remove the driving end bracket, taking care not to lose the thrust washer ; the drive and clutch assembly can then be slid off the armature shaft extension. Remove the intermediate bracket from the starting motor yoke.

7. Draw out carefully the starting motor armature.

To test the series field, check between the starter terminal and both brushes in turn.

To test the shunt field, check between the starter terminal and the starter body. See that the small starting screw and shunt field terminal tag are tight. In both tests the lamp will light to show continuity. F ilure to light will indicate an open-c cuited coil which must be replaced.

2. To test the field coil insulation from pole shoe and yoke :

   Unscrew the shunt field earthing screw, and see that the earthing tag does not touch the yoke.

   Make sure that both brushes are clear of the yoke.

   Examine the insulation of the common field terminal.

   Using a supply mains test lamp check between the common field terminal and the yoke. (When using the mains for testing, the voltage should be not more than 110 volts supplied through a suitable transformer). Should the lamp light, faulty insulation is indicated of one or more coils. To determine which coils are faulty unsolder their connections to the terminal and test each coil individually. Defective coils must be replaced.

3. When carrying out (2) test the insulation of the insulated pair of brush boxes on the commutator end bracket. Clean all traces of carbon deposit before testing. Check between boxes and brackets. Should the lamp light it will indicate faulty insulation and the end bracket must be replaced.

(*j*) **Bearings and bearing Replacement.**

The armature shaft is supported by three bearings. The commutator end bracket and the driving nose each carry porous bronze bushes, while the intermediate bracket carries a graphite impregnated brass bush.

Bearings which are worn to such an extent that will allow excessive side play of the armature shaft must be replaced.

STARTER MOTOR DRIVE

The main feature of the pre-engaged starter fitted to this type of tractor is that the pinion is in mesh with the flywheel ring gear prior to the tongue being applied.

The drive of the pre-engaged starter cc ıprises four main assemblies.

1. A central core (A) keyed to and made to slide along a straight-splined portion of the armature shaft extension.
2. At the armature end of the central core, an operating bush (B) is spring loaded between the shoulder of helically splined portion (C) and brake plate (D).
3. At the pinion end of the central core, a clutch assembly is held between moving member (E) and ring nut (F).
4. Enclosing the clutch assembly, the pinion and barrel unit (G) with cushioning spring (H) and thrust washer (I) is secured by a circlip (J) located on the armature side of retaining washer (K). At the driving end, the pinion is supported by a steel backed bronze bush.

The clutch is made up of inner plates and outer plates, arranged alternatively. The inner or driving plates are keyed to moving member (E) whilst the outer or driven plates are keyed to slots in the enclosing barrel unit.

The clutch protects the motor from overload in the case of a backfire. Also, it prevents the motor being driven by the flywheel if the pinion fails to disengage after the engine has fired, as only the barrel unit and outer clutch plates will continue to rotate at speed.

The clutch is shim-set during manufacture to slip against two to three times normal full load torque (800 — 950 lb. in.). No attempt should be made to alter this setting or to interfere in any way with the clutch assembly. In the case of faulty operation the clutch should be removed from the starter shaft and returned to the manufacturers.

When the gear lever is moved to 'start' and the safety button has been depressed, the lower forked end of the operating lever at first slides the drive outwards along the armature shaft extension until the pinion is in mesh with the flywheel, the upper end of the lever contacts the pilot switch. This energises the solenoid of the main starting switch whose contacts close and connect the starter motor to the battery. Immediately, the armature rotates at a high speed and moving member (E) acting under the force of inertia, is screwed hard against the clutch assembly. A torque is then applied from the starting motor armature to the engine flywheel via the central core (A) moving member (E) the clutch assembly and barrel unit (G).

It will be seen that damage to the flywheel gear and pinion teeth is only likely to result from misuse or mal-adjustment.

In the event of unsatisfactory operation check the electrical circuit (Page G1) before any attempt is made to adjust the mechanical linkage.

If the pilot switch is in order, follow these instructions in order laid down, to ensure that the starter linkage and pilot switch brackets are correctly adjusted.

ADJUSTMENT OF ROD MECHANISM.

Disconnect the operating rod by removing the clevis pin and adjust the rod in length until it just takes up all the free movement of the starter's operating linkage.

N.B. In no circumstances should the operating rod be lengthened beyond the free movement of the starter operating linkage

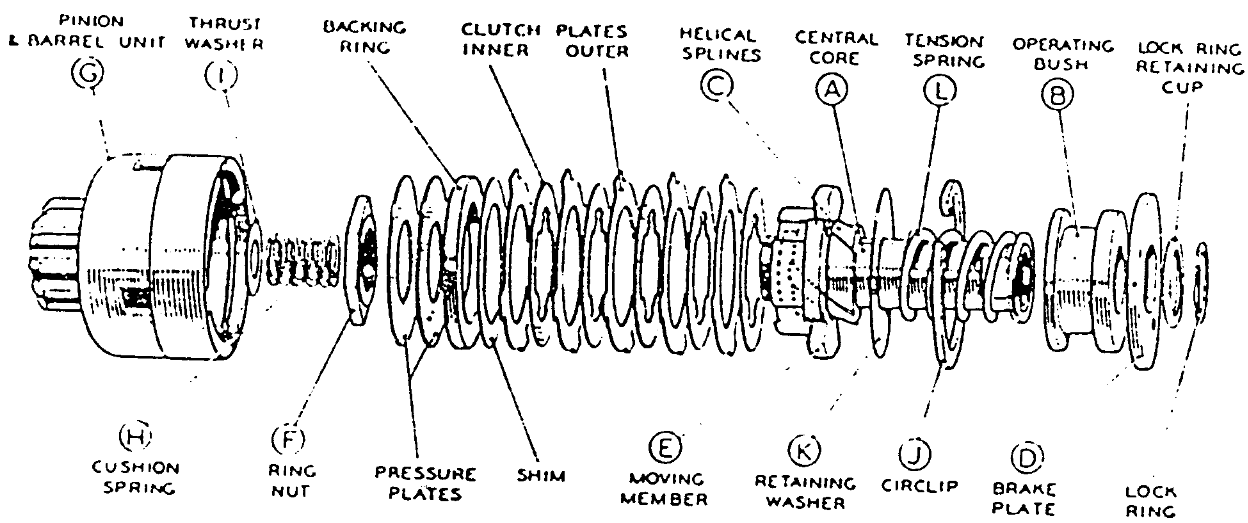


FIG 26

After the engine has fired and the gear lever has been returned to neutral, the rotating drive is brought rapidly to rest by the pressure of brake plate (D) against a Ferodo brake plate.

as this will move the pinion away from its rest position, which will prevent the starter armature brake operating, and reduce the pinion " out of mesh " clearnce, which may result in the pinion fouling the gear ring.

This adjustment may be all that is required, to ascertain this reconnect the operating rod and re-engage the gear lever to check and the starter will operate. If there is no improvement and if all the free movement has already been taken up proceed to check the adjustment of the pilot switch as follows.

Adjustment of Pilot Switch Bracket with Relation to Pinion Travel.

After assembly of the pre-engaged starting motor an important adjustment has to be made before the starter can be safely fitted to an engine. The adjustment concerns the position of the pilot switch bracket with relation to pinion travel. That is, the pilot switch bracket is adjusted so that at the instant of closure of the pilot switch contacts, the fork operating lever must have moved the pinion $\frac{5}{8}$" (15.8 m/m) outwards along the armature shaft extension.

Initially the pilot switch bracket is accurately positioned during assembly of the starter at the factory. But, and this is very important, in all cases where a pilot switch is replaced or the switch bracket disturbed for any reason at all the bracket must be accurately repositioned.

The adjustment procedure is as follows :—

A test lamp and battery should be wired in series with the pilot switch terminals in order to determine the instant of contact closure.

To adjust, slacken the four pilot switch bracket securing screws, actuate the operating lever and position the bracket so that the pinion travel is $\frac{5}{8}$" at the instant of closure of the pilot switch contact.

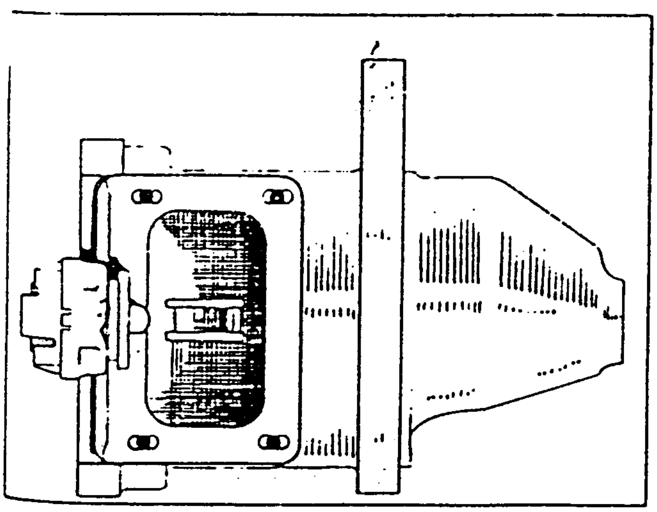


FIG. 27

STARTER OPERATING MECHANISM
(with rubber cover removed)
SHOWING ELONGATED HOLES FOR SWITCH ADJUSTMENT

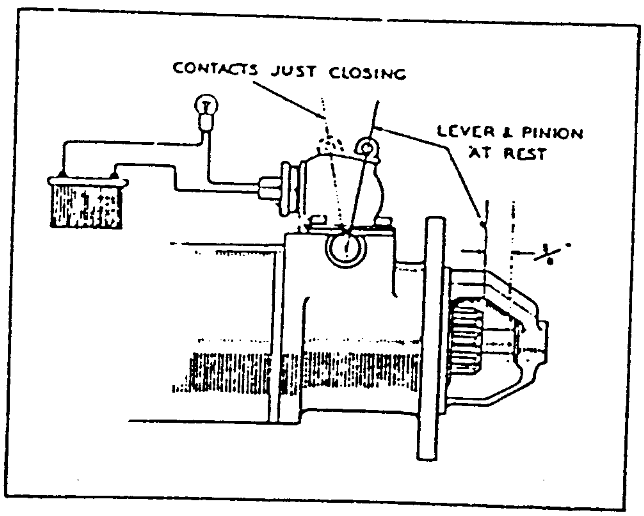


FIG. 28

METHOD OF CHECKING INSTANT OF CLOSURE OF PILOT SWITCH CONTACT WITH RESPECT TO PINION TRAVEL.

STARTER MOTOR SWITCH

Tractor TE-F 20.

The gear change lever operates the starter through the reverse shifter rail which is linked at the front to a cross shaft assembly mounted on the front portion of the clutch housing and connects to the pilot switch on the starter motor.

A spring loaded safety button on the right hand side of the transmission casing must be depressed before the gear lever can be moved into the starting position. This prevents inadvertent operation of the starter motor.

DISTRIBUTOR

Routine Maintenance and Servicing see G13 — 19.

Tractors Type TE-D 20, TE-E 20.

In production, the distributor Part No. 220767, Lucas Service No. 40243A, as fitted to the 85 m/m Petrol engine, replaces the distributor Part No. 200833 Lucas Service No. 40298A, at V.O. Engine No. S.208775E, fitted to tractors S.170174E — S.208775E.

In service it is recommended that the automatic advance springs in Distributor Part No. 200833, Lucas Service No. 40298A are replaced by Lucas Part No. 419130, as fitted in the 85 m/m Petrol engine distributor Part No. 200767. Afterwards a small cross should be scratched on the " O " of " TOP " on the dust cover inside the distributor cap, to record that the springs have been changed.

Lucas Part No. 419130 comprises springs, Lucas Part No. 405395 — 1 off, and Lucas Part No. 416127 — 1 off.

Ignition Timing.

The static setting on the latest version V.O. engine for the petrol type distributor Part No. 200767 or the modified distributor, is 4° (Crankshaft) before T.D.C.

When re-timing remember the following :

(*a*) The timing holes in the flywheel and crankcase, when aligned with tommy bar, give T.D.C. position for 1 and 4 pistons.

(*b*) The existing distributors, before modification, should already be set at 6° (Crankshaft) before T.D.C.

(*c*) One division on timing plate — 2° (Distributor) — 4° (Crankshaft).

V.O. ENGINE NOS. 170, 174E & future

Messrs. Joseph Lucas have modified the springs of existing stocks of Distributor Part No. 200833, Lucas Service No. 40298. These modified distributors may be identified by the suffix E. The following distributors are suitable for use on the V.O. engine :—

1. 85 m/m Petrol Type Distributor stamped 40243 with suffix letter A.
2. V.O. Type Distributors, Lucas 40298, with suffixes A to D and a small 'X' scratched in the 'O' of 'TOP' on the dust cover — denoting modification by Ferguson distributors (see above).
3. V.O. Type Distributor, Lucas No. 40298 with suffix letter E and future — denoting modification by Messrs. Joseph Lucas.

CONTROL BOX

CONTROL BOX RF97

Regulator adjustments and mechanical settings for control box RF97 fitted to tractors up to tractor serial No. 381659 are detailed in Sections G19 — 22.

CONTROL BOX RB107

At tractor Serial No. 381660 a new rubber mounted control box RB107 was incorporated.

The new control box offers easier accessibility to the working part and its method of mounting has been improved by the provision of rubber rings around the attachment holes.

Mechanical Setting (Regulator Air Gap)

Adjustment of the regulator is obtained by altering the spring tension on the blade of the contact set by means of the adjusting screw and lock nut (Fig. 19) as with LRT 9 regulator as used with the RF 97 control box.

The air gaps which are slightly different from the LRT 9 can be re-set as follows :—

1. Unscrew the fixed contact adjustment.
2. Unlock armature securing screws.
3. Insert .015" (.39mm.) feeler gauge between armature and core face.
4. Press armature down squarely against the gauge and re-tighten armature fixing screws.
5. With gauge still in position, screw the fixed contact down until it just touches the moving contact and tighten lock nut.
6. Reset the voltage in the normal manner.

Cut-out Air Gap and Electrical Setting

It is unlikely that the cut-out switch will require any attention or adjustment, but for general information the electrical settings are similar to those for the LRT 9 Unit;

Cut-in Voltage 12.7 - 13.3

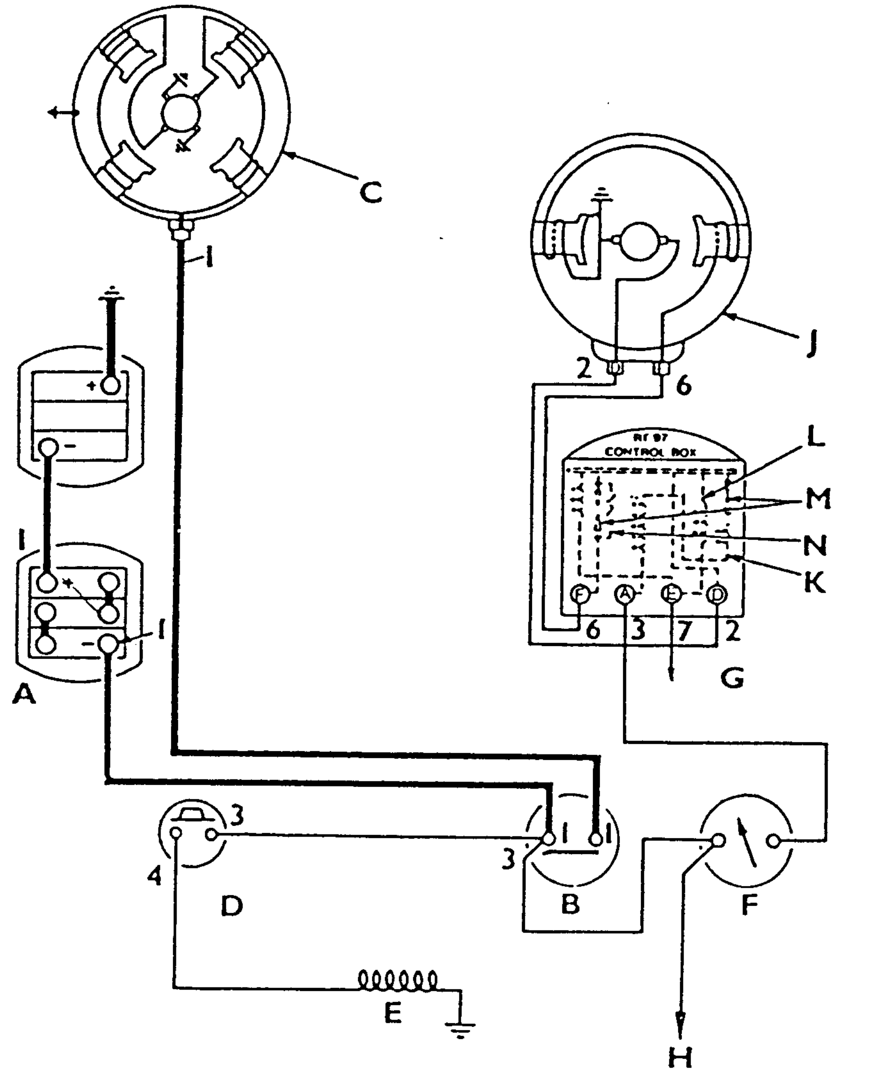
Drop off Voltage 8.5 - 11.0.

The gaps should be :—

A .025" - .030" (.65-.76 mm.) with the armature pressed down.

B .015" - .020" (.39-.52 mm.) with the armature released. The cut-out fixed contact follow through must not exceed .020".

12-VOLT ELECTRICAL SYSTEM



Key

A 2 x 6 volt batteries, positive earth
B Starter motor switch
C Starter motor
D Heater switch
E Heater coil
F Ammeter
G Control box
H Connection to lights
J Dynamo
K Cut-out series winding
L Cut-out shunt winding
M Contact points
N Regulator resistance

Key to Cable Colours

1 H.T. thick cable
2 Yellow
3 Yellow and Black
4 White
5 White and Brown
6 Green and Black
7 Black

TE-F20 TRACTOR WIRING DIAGRAM 12 VOLT DIESEL

Ferguson

SERVICE MANUAL

Section H

LIGHTING SYSTEM

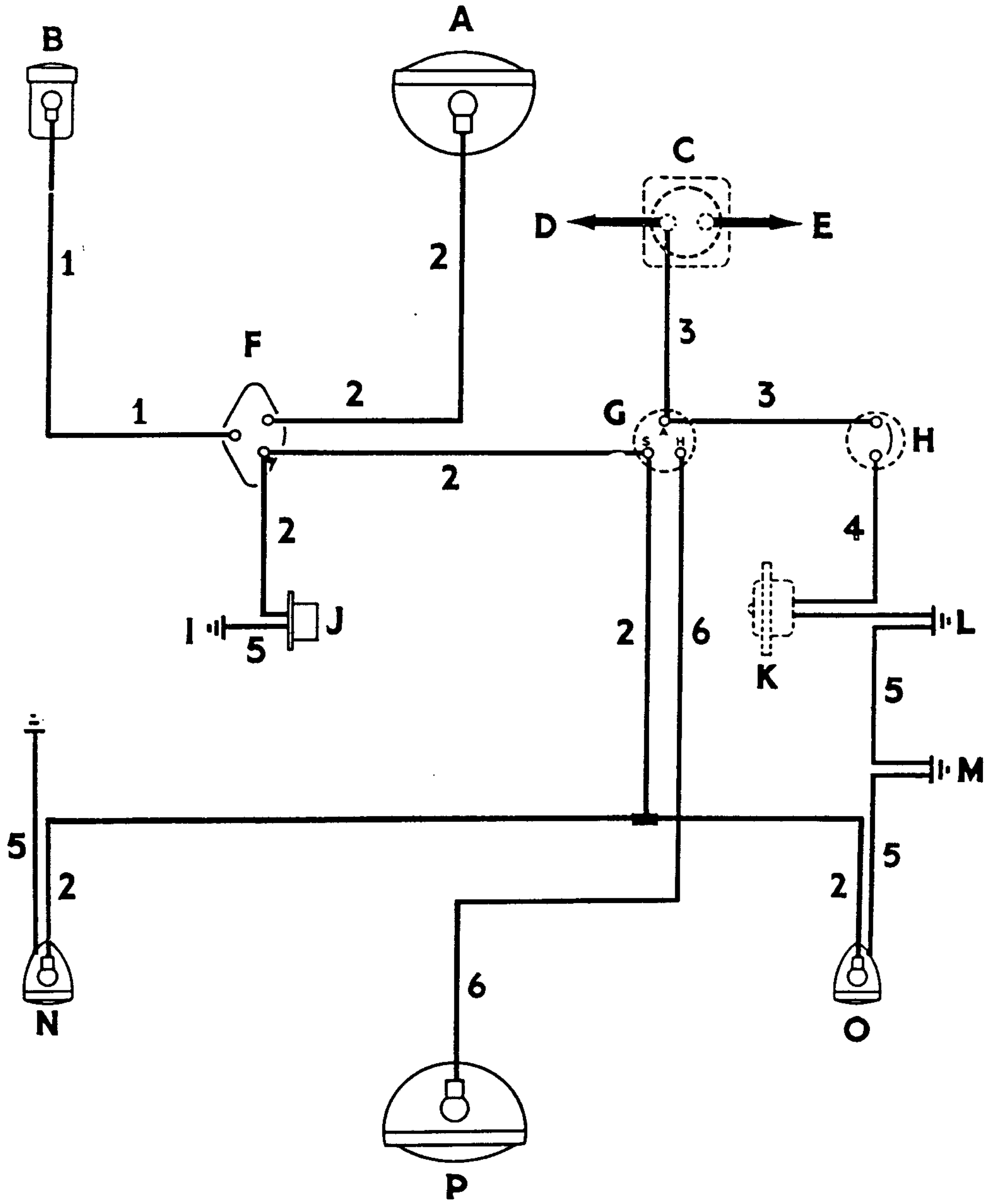


FIG. 1.

WIRING DIAGRAM

Key to Annotation

(A) Rear Floodlight.
(B) Tail Lamp.
(C) Starter Switch.
(D) To Battery.
(E) To Starter Motor.
(F) Tail Lamp and Rear Floodlight Change-over Switch.
(G) Lighting Switch.
(H) Horn Push (When Fitted).
(I) Earthed to Bolt on Number Plate Bracket.
(J) Tail Lamp Socket for Trailer.
(K) Horn (When Fitted).
(L) Earthed to Bolt Securing Fuel Tank.
(M) Earthed to Bolt on Side Lamp Bracket.
(N) Side Lamp. (Right-Hand)
(O) Side Lamp (Left-hand).
(P) Headlamp.

Key to Cable Colours

(1) Green.
(2) Red.
(3) Brown.
(4) Purple.
(5) Black.
(6) Blue.

LIGHTING SYSTEM

GENERAL.

In order that the tractor can be used either for agricultural work or on the road at night, a lighting kit has been designed by Joseph Lucas, Ltd., which can readily be fitted to Ferguson tractors. The lighting kit provides side and tail lamps, a head lamp and a rear floodlight which lights up the plough or other appliance which is being used. The head, side and tail lamps are controlled by a simple and robust switch arranged to be fitted in the instrument panel while the change-over from the tail lamp to the floodlight is made by a push-operated switch conveniently fitted near the rear number plate. In addition, a two-pin socket is provided, enabling a tail lamp to be connected if the tractor is used with a trailer. The kit includes also a cable harness which must be secured in position by means of the clips provided. This lighting kit is exactly the same for all existing normal and narrow width agricultural models, although it is recommended that the cable loom on the Diesel tractor be fitted on the opposite side of the engine, i.e. under exhaust manifold.

DETAILS OF KIT.

(1) Head lamp complete with short fixing nut, spring washer and cable connector (fitted inside stem of lamp).

(2) Head Lamp fixing bracket, securing plate, bolt and washer.

(3) Side lamps complete with spring washers and fixing nuts.

(4) Side lamp brackets complete with eight fixing bolts, nuts, washers, two back plates and also two rubber grommets for cable protection.

(5) Lighting switch.

(6) Rear floodlight complete with fixing base, long fixing nut, spring washer and cable connector (fitted inside stem of lamp).

(7) Rear floodlight bracket complete with two bolts, spring washers and nuts.

(8) Number plate bracket complete with two $\frac{5}{16}$" (8 m/m) diameter bolts, spring washers and nuts, (these are used to replace existing bolts of larger diameter).

(9) Change-over switch and two 2BA screws and spring washers.

(10) Number plate and two fixing bolts, spring washers and nuts. Clip, spring washer and nut (for securing number plate to fender).

(11) Tail lamp complete with securing nut.

(12) Cable harness consisting of the following :—

(a) Main harness for connections between head and side lamps, lighting switch and starter switch. Also leads are included in this harness for horn and push if required.

(b) Long single length of cable (with metal conduit) for connecting between lighting switch and change-over switch.

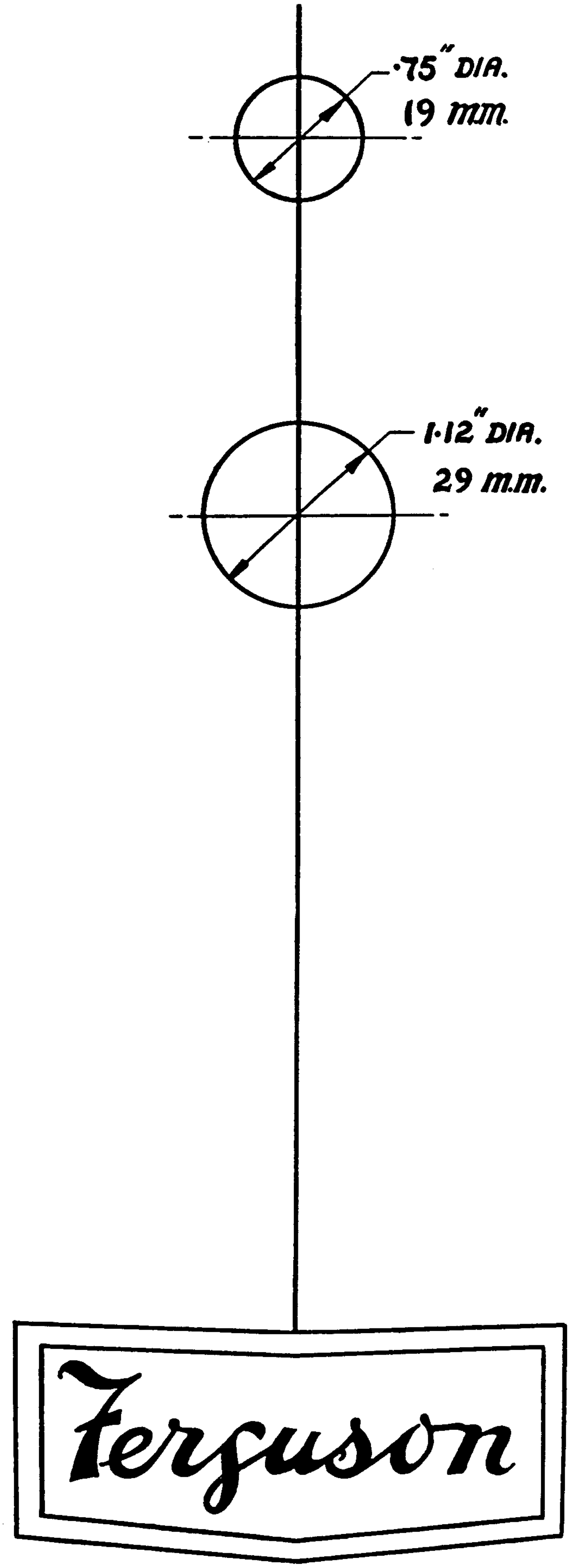
(c) Short single length of cable (with metal conduit) for connecting between floodlight and change-over switch.

(d) Single length of cable for connecting between tail lamp and change-over switch.

(e) Twin leads complete with socket and four fixing screws.

(f) Cable clips (see Fig. 5).

Note : Of the 18 clips supplied, only 15 are required when the tractor is wired for left-hand rule of the road, i.e., when the number plate assembly and rear floodlight is mounted on the right-hand rear fender (as shown



NAME PLATE ON FRONT OF TRACTOR

FIG. 2.

TEMPLATE FOR DRILLING HOLES FOR HEADLAMP MOUNTING in Fig. 10), or 16 clips when wired for right-hand rule of road. The extra clips are provided to make the kit interchangeable throughout the tractor range. The clips to be used when making an installation will be clearly apparent from the illustrations and instructions following.

Additional item (purchased separately if required): 2-pin plug and 23 ft. of cable for trailer. Pt. No. 859332.

DRILLING INSTRUCTIONS

To enable the various components to be fitted to the tractor the following holes must be drilled :—

HEADLAMP.

Drill two holes in the front of the engine hood. A diagram giving the dimensions and positions of these holes is given in Fig. 2.

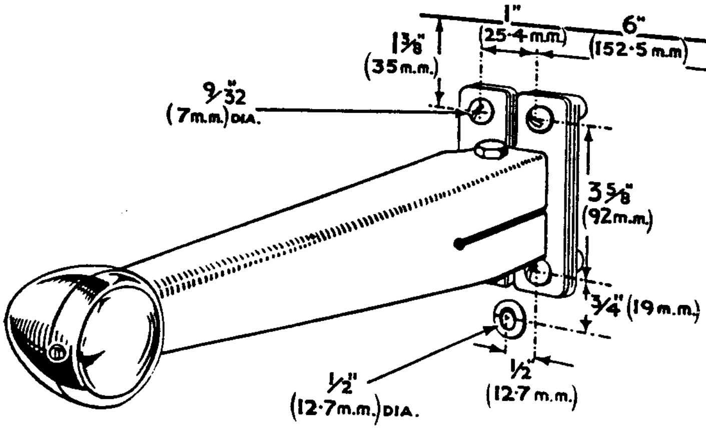


FIG. 3.
SIDE LAMP BRACKET FIXING

SIDE LAMPS.

For the fitting of side lamps, five holes are to be drilled on both sides of the engine hood, an illustration giving the exact dimensions will be found at Fig. 3. Four holes drilled 9/32" (7 mm.) diameter are to locate the fixing pins of the side lamp bracket, the remaining hole ½" (12.7 mm.) diameter is for the cable entry. When threading cable, ensure that the rubber grommet, supplied, is fixed in the aperture to counteract possible cable chaffing.

LIGHTING SWITCH.

Drill one 7/16" (11 mm.) diameter hole in instrument panel as shown in Fig. 4. (On later tractors a 'D' shaped hole is already provided).

REAR FLOODLIGHT BRACKET.

Drill out existing rivet on fender and temporarily fit bracket in position using nut and bolt (7) as shown in Fig. 10. Mark the centre of the other hole in bracket on the fender, remove bracket and drill second hole using same size drill. See that bracket is fitted so that hole to be drilled is to the rear of the tractor.

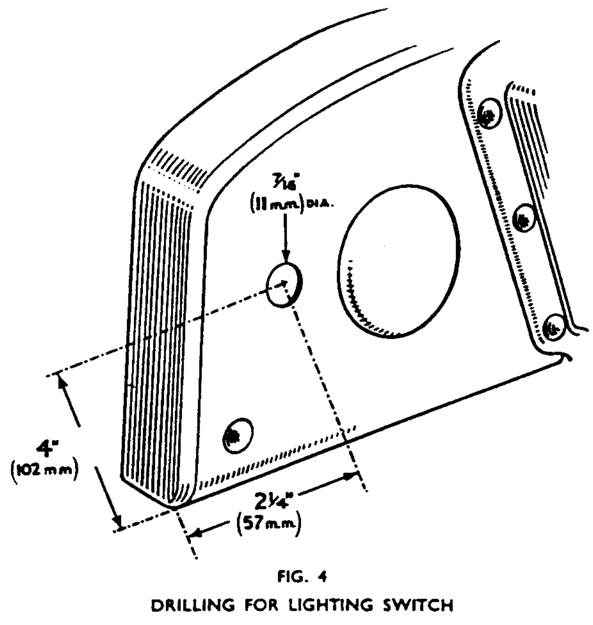


FIG. 4
DRILLING FOR LIGHTING SWITCH

CABLE CLIP FIXING.

Drill one $\frac{1}{4}$" (6.35 mm.) diameter hole in fender as shown in Fig. 10. This hole to be used for securing cable by means of clip. (On some tractors this hole may already be drilled).

FITTING INSTRUCTIONS

Before fitting, lift the engine hood and remove hood stays from the top of fuel tank, so that the inside of hood is easily accessible. Also disconnect the earthing cable from the positive battery terminal. The range of clips provided in the kit is illustrated in Fig. 5, and should be positioned as illustrated in Fig. 14.

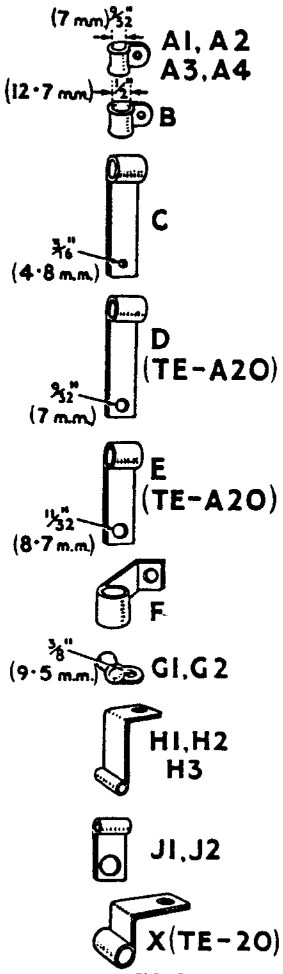


FIG. 5.
CABLE CLIPS

MAIN HARNESS

(a) For use with tractors, type TE-A20.

(1) Hold the main harness in position so that the conduit runs parallel with the cylinder block on the distributor side of the engine and secure in this position by means of clip " D," to bolt on ignition coil bracket and clip " E," to bolt on oil fillerbracket.

(2) Pass the flexible metal covered cable over the water pipe and fix in position to the bottom screw of radiator cowl by means of large clip " C," slotting the hole if necessary.

(3) Take the cables underneath the hood mounting pivot and secure in position on the inside of hood by means of four clips, using clip " B," for flexible metal covering and three clips " A1,"

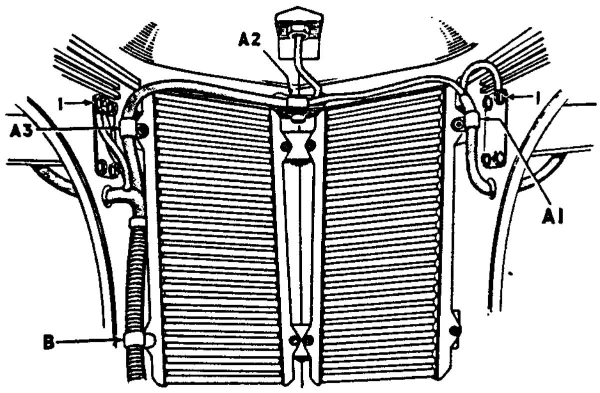


FIG. 6.
VIEW LOOKING INSIDE ENGINE HOOD SHOWING CABLE FIXING

" A2 " and " A3 " for head and side lamp cables, as shown in Fig. 6.

Note : Subsequent removal of the tractor hood is facilitated by the use of a 3-way connector inserted in the main harness between clips 'B' and 'C' (Fig. 14). The additional parts required are: Part No. 850844 — 1 off ; Part No. 900269—6 off.

Further securing of the main harness should not be carried out until units (i.e. lamps, lighting switch, etc.) are being fitted.

(b) For use with tractors type TE-20.

The procedure for securing the main harness is similar to that described above except for the following :

(1) Conduit cable to be secured to two convenient cylinder head bolts by means of clips " X," instead of to coil and oil filler brackets by clips "D" and "E."

ii) Flexible metal covered cable to be passed behind water pipe instead of over the top as on tractors type TE-A-20.

D LAMP.

ead lamp can be distinguished from ear floodlight by its short fixing nut the shape of its fixing base, illustrated 7.

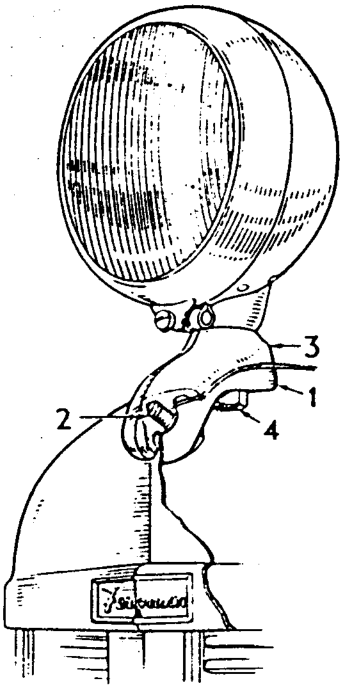


FIG. 7
HEAD LAMP MOUNTING

Fit the head lamp bracket to outside of ngine hood and secure in this position y fitting the head lamp securing late (1) on the inside by means of /16" (7.937 mm.) diameter bolt (2) nd washer.

emove the fixing nut and spring asher from head lamp, thread them n to the blue head lamp cable.

ass the head lamp cable through hole n hood and bracket (3) and push the oldered connector on the end of this able in the sleeve inside the stem f the head lamp.

ecure head lamp to engine hood by neans of the spring washer and nut (4).

LAMPS.

it the side lamps to the brackets by neans of spring washers and fixing nuts and the side lamp brackets to sides of engine hood by means of the bolts, nuts, spring washers and back plates supplied. One of the side lamp bracket fixing bolts (1), Fig. 6, on each side of tractor must also be utilised for securing the black earth leads on the inside of engine hood. Take care to remove all paint from and around the fixing bolts which secure cables.

(2) Pass side lamp cables through cable entry holes and rubber grommets.

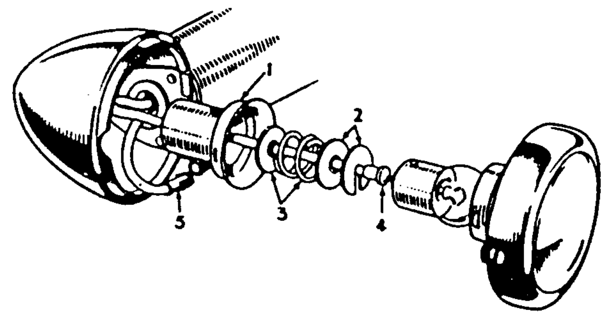


FIG. 8.
CONNECTING CABLES TO SIDE LAMPS

(3) Neatly position cables behind welded clips on the inside of side lamp brackets and connect up to side lamps as follows, with reference to Fig. 8. Remove front rim and reflector from lamp by slackening securing screw, and thread the two cables up the stem of the side lamp. Remove the bulb holder (1) by twisting to the left ; remove bulb and the two thin insulating washers (2). Thread the red cable through the washer and spring (3) in the bulb holder, then fit the washer (round hole) over cable and secure in this position by sliding the washer (slotted hole) underneath the cable nipple (4) afterwards pulling cable back into bulb holder. The black earth lead must be fitted to the sleeve connector (5) on side of bulb holder. Thread the sleeve connector on to the cable, which should be bared approx. $\frac{3}{8}$" (10 mm.) and push the connector home until all the bared portion of the cable protrudes through the holes in the top of the connector. Bend back the strands evenly around the sides of the connector and then push connector into holder. Finally refit bulb, bulb holder and front rim.

NUMBER PLATE, BRACKET, CHANGE-OVER SWITCH, ETC.

Before fitting the above units to the tractor it is recommended to make up a sub-assembly using the following units :

Number plate, complete with bolt, nuts and clip.

Tail lamp.

Short length of cable (for tail lamp).
Number plate bracket complete with bolts, fixing nuts and spring washers.

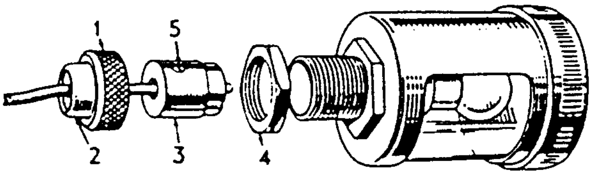


FIG. 9.
CONNECTING CABLE TO TAIL LAMP

Change-over switch complete with two fixing screws and spring washers.

Socket complete with twin cable and four fixing screws.

Long length of cable with metal conduit covering for connecting between change-over switch and lighting switch.

Short length of cable with metal conduit cover for connecting between change-over switch and floodlight.

Fitting tail lamp to number plate bracket.

(1) Remove from the tail lamp the knurled nut (1), cable sleeve (2), moulded adaptor (3), and fixing nut (4), as shown in Fig. 9.

(2) Fit tail lamp to number plate bracket and secure by means of fixing nut, the tail light window being arranged to illuminate registration letters and numerals.

(3) Thread the cable sleeve and knurled nut on to the short length of cable for tail lamp.

(4) Slacken the terminal screw (5) in the side of the moulded adaptor and push bared portion of cable (approx. $\frac{1}{2}$") (12.7 mm.), into terminal and then tighten the screw.

(5) Insert moulded adaptor into sleeve of tail lamp and secure in position by fitting cable sleeve and knurled nut.

Fitting socket to bracket.

Insert socket through hole in bracket from the inside and secure in position by means of four fixing screws.

Connecting cables to change-over switch and fitting number plate.

(1) Remove the three terminals and locking plates from the change-over switch.

(2) Connect to the centre terminal on change-over switch (marked ↑) the red cable from the socket, and the eyelet on the long red cable with metal conduit covering. (Take great care not to damage the conduit. It is advisable at this stage to leave the cable coiled).

(3) Connect the cable from the tail lamp to one of the remaining terminals on the switch and to the other terminal of the switch, connect the eyelet on the short red lead with metal conduit covering.

(4) Fit switch to bracket and secure by means of two 2BA screws and washers.

(5) Fit number plate to bracket by means of bolts, spring washers and nuts.

Fitting number plate assembly to tractor.

All reference to right or left-hand is made when looking from rear of tractor.
See Fig. 10.

(1) Remove from the right-hand fender the two existing bolts and fit number plate bracket to tractor with the two bolts, nuts and washers supplied.

(2) Secure clip (1) behind number plate to fender.

(3) Secure the black lead from the socket (2) underneath the bracket at the fixing bolt near the change-over-switch (3), (taking care to remove all paint from around fixing hole).

(4) Utilise the second fixing bolt for securing cable in position by means of clip " J2."

REAR FLOODLIGHT AND BRACKET —See Fig. 10.

(1) Thread the floodlight fixing nut (4) and spring washer on the short metal conduit covered cable, then pass through hole in bracket (5) and through floodlight fixing base (6).

(2) Push the soldered connector of the cable into the sleeve inside the stem of lamp.

(3) Secure floodlight to bracket by means of fixing nut and washer and fix bracket to tractor by means of two bolts, nuts and spring washers. One of the bracket securing bolts (7) is also utilised for securing cable in position by means of clip " G2."

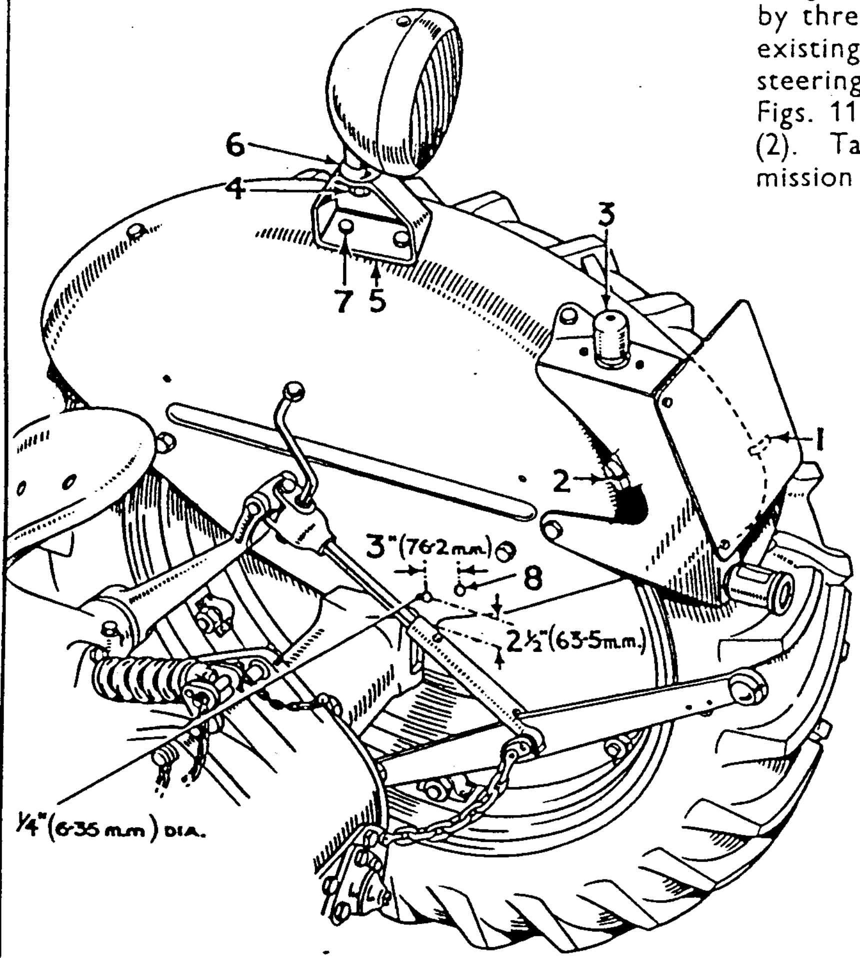


FIG. 10
MOUNTING OF REAR FLOODLIGHT AND NUMBER PLATE ASSEMBLY

CONNECTING CABLE TO LIGHTING SWITCH.

Carefully uncoil the long length of metal conduit cable and secure in position on fender by means of clip " A4 " and 2 BA bolt with spring washer and nut through the previously drilled hole (8), see Fig. 10.

(1). Pass the cable along the rear axle, thread through hole in transmission housing flange and behind steering arm and secure by three clips " J1," " H1 " and " H2 " to existing bolts on axle housing and lower steering housing, respectively, as shown in Figs. 11 and 12.

(2). Take cable across the top of the transmission housing and secure by means of clip " G1 " to one of the existing bolts securing starter switch, and then together with cables in main harness, hold in position at the side of battery and secure in this position by means of clip " F " as shown in Fig. 13. Take care to see that this cable does not foul the hood catch.

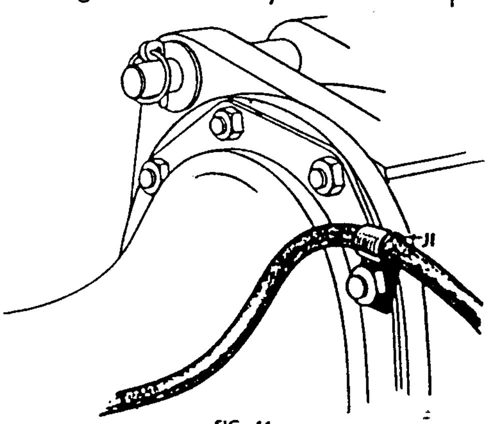


FIG. 11.
VIEW SHOWING CLIP TO AXLE HOUSING

Note : It will be found that the long length of cable from the change-over switch to lighting switch is about 12" too long and the excess must be cut off. This provision is made so that the number plate can be fitted to the left-hand fender for countries where the rule of the road is right-hand. In these cases the fixing of the cable is similar to that described above except that the cable will have to be taken across transmission housing immediately before passing through hole, and it will also have to be secured by another clip " H3 " under the forward left-hand securing screw for the hydraulic lift cover. To allow easy separation of transmission and rear axle centre housing, a single Lucas connector

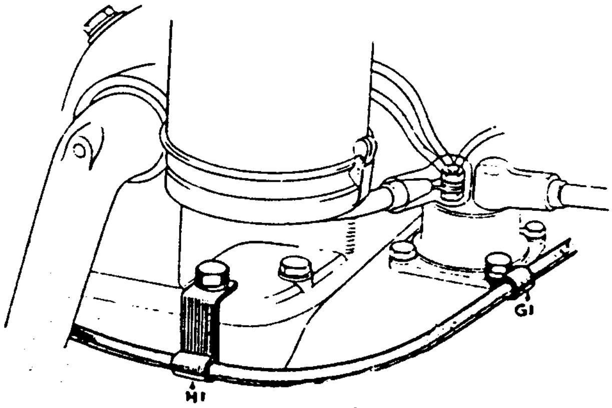


FIG. 12
CONNECTIONS TO STARTER SWITCH VIEWED FROM R.H. SIDE OF TRACTOR.

can be fitted about 5" (12.7 cm) to rear of transmission housing flange, the cable being supported by clip "H3," or similar. Additional parts are: Pt. No. 900269—1 off; Pt. No. 900288—1 off.

LIGHTING SWITCH.

(1) Withdraw knob from switch after depressing spring loaded plunger and unscrew hexagon fixing nut.

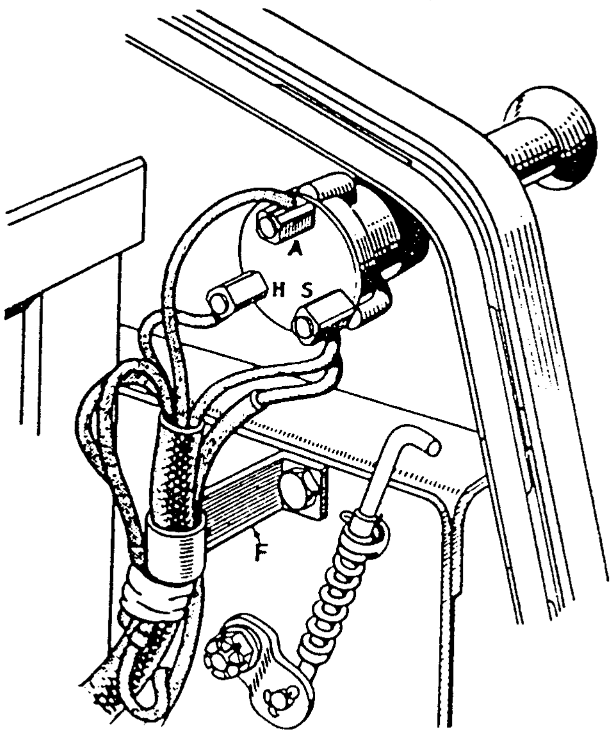


FIG. 13.
CONNECTIONS TO LIGHTING SWITCH.

(2) Connect up cables to lighting switch as follows, with reference to Fig. 13. Two red leads, one from side lamps and one from change-over switch to "S" terminal.
One brown lead to "A" termin
One blue lead from head lamp to "H terminal.

Note : The short lead (brown) and t purple lead are incorporated in the harn so that if necessary a horn can be fitted the tractor. Therefore, the ends of the leads must be taped up **and not connecte to switch.**

(3) Fit the switch to instrument panel an secure in position by hexagon fixi nut, taking care to see that th "gate" or slot in switch moulding at the bottom so as to prevent a ingress of water. In the corre position the "A" terminal of th switch will be at the top (as shown

WIRING

(1) Remove the bolt securing the front fuel tank on the left-hand under-sid and remove all paint from around h
(2) Refit bolt together with black eart lead. The ends of the purple an black cables must be taped up (thes are for use when horn is fitted
(3) Pull off the rubber protecting sleev from the starter switch terminal t switch cables from the ignition sw and control box are already connec and remove terminal nut. Refi together with cable (brown) from main harness.

Reconnect the positive battery cabl connector.

BULBS—SIX VOLT LIGHTING

	Lucas No.	Voltage	Wattage
Headlamp	106	6	24
Side Lamps	200	6	3
Tail Lamps	200	6	3
Rear Floodlight	106	6	24

BULBS—TWELVE VOLT LIGHTING

	Lucas No.	Voltage	Wattage
Headlamp	57	12	36
Side Lamp	207	12	6
Tail Lamp	207	12	6
Rear Floodlight	57	12	36

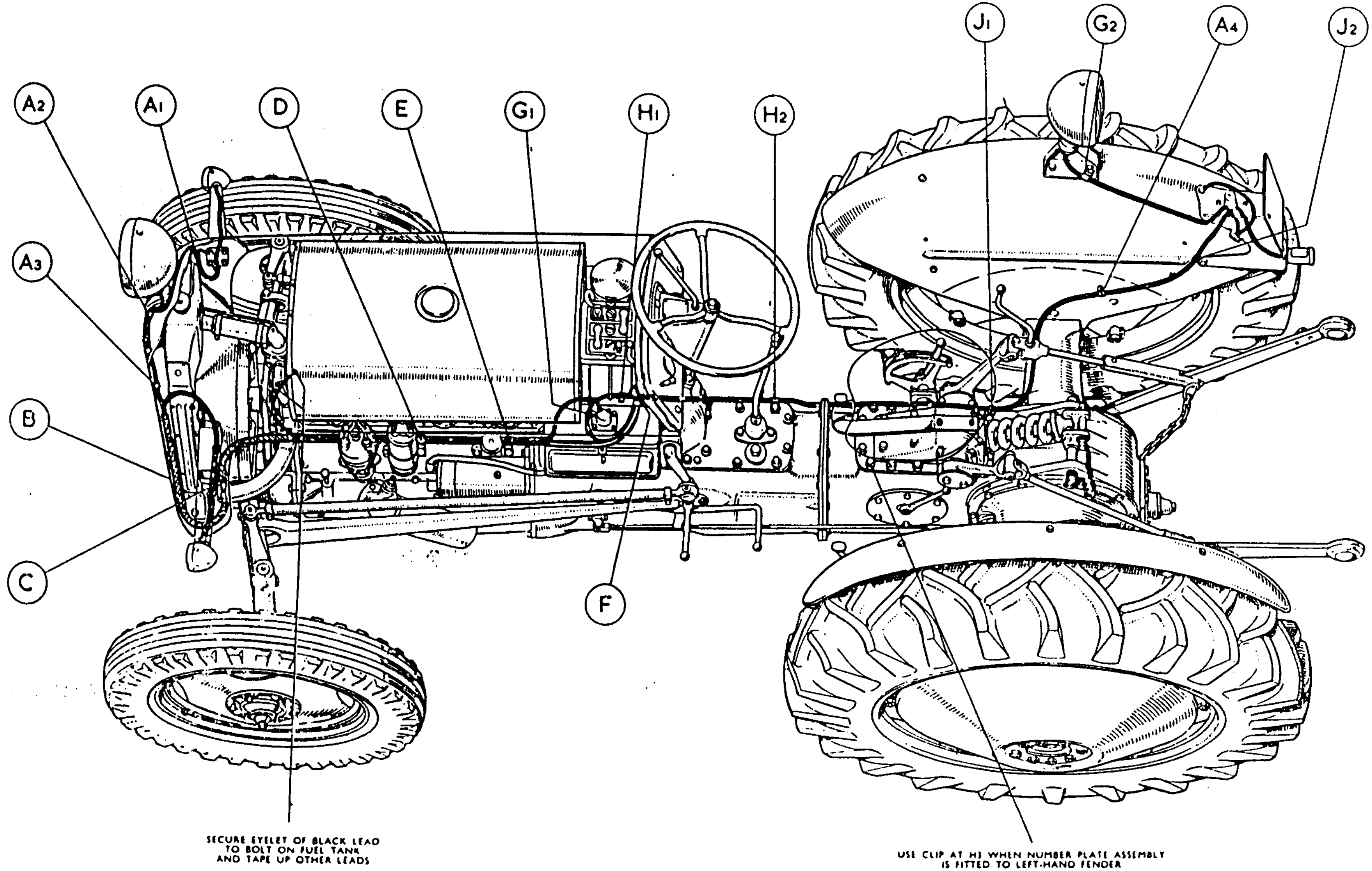


FIG. 14.

GENERAL VIEW OF TRACTOR SHOWING LAYOUT OF LIGHTING CABLE AND CLIP POSITIONS.

LUCAS 'UNIVERSAL' LIGHTING SET.

A Lighting Kit, Lucas Model No. 302, is available for fitting to all tractors.

The Lucas kit complies in full with all requirements of the United Kingdom Road Transport Act 1953, and consists essentially of twin head lamps, with side lamps integr and dipping filament bulbs ; rear lighti complete with reflex reflectors ; a re floodlight operated by a push butt changeover switch and a trailer connectio two pin socket — Waterproof and to B.S. Specification. Full fitting instructions ar included with each set of Lighting Kit.

The FERGUSON SYSTEM
TRADE MARK

Ferguson

SERVICE MANUAL

Section I

CLUTCH

CLUTCH

INDEX

DESCRIPTION

(FIG. 1.)

The single dry plate clutch consists of a driven plate assembly and a cover assembly.

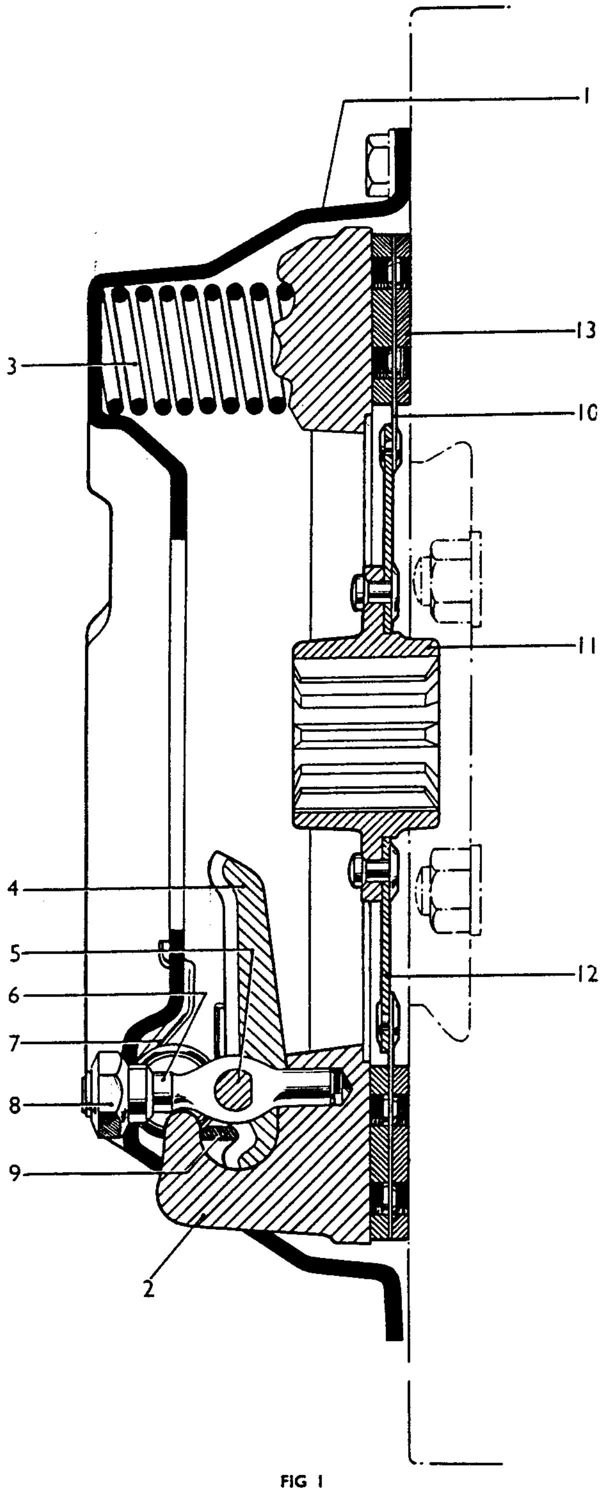


FIG 1

Components are illustrated in Fig. 1 which gives a section of the unit.

The driven plate assembly is rivetted and comprises a splined hub (11) attached to a steel disc (12) fitted with nine cushion segments (10) carrying the two clutch facings (13).

The cover assembly is formed by a pressed steel cover (1) and a pressure plate (2), loaded with nine thrust springs (3). The pressure plate carries three release levers (4) which pivot on floating pins (5) retained by eyebolts (6). Adjusting nuts (8) are screwed to the eyebolts, which pass through the clutch cover and are secured by staking. Struts (9) are interposed between lugs on the pressure plate and the outer ends of the release levers. Anti-rattle springs (7) are fitted between the release levers and the cover.

PEDAL ADJUSTMENT
(FIG. 2)

The only normal adjustment required throughout the life of the clutch facings is periodically to restore the free movement of the clutch pedal ; i.e. movement of the pedal before the release bearing comes into contact with the release levers and commences to withdraw the clutch.

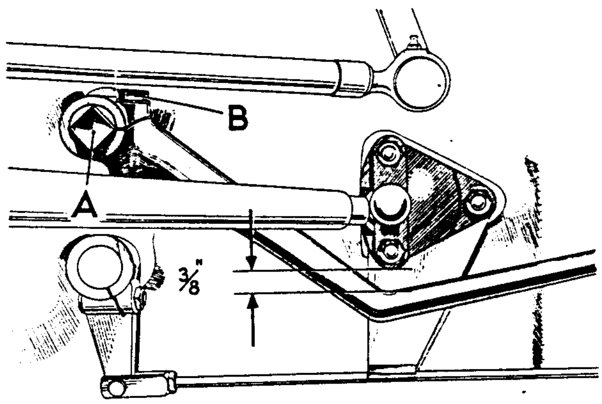


FIG. 2

When making this adjustment, measurements are taken between the upper side of the pedal and the underside of the footrest bracket, as indicated in Fig. 2. Clutch adjustment is correct when free movement, or travel before the withdrawal bearing begins to engage, is $\frac{3}{8}$ inch. (9.5m.m.)

After reasonable usage, re-adjustment will be required and this is obtained by holding the squared end of the clutch bearing shaft (A) with a suitable spanner, releasing the pinch bolt (B) and adjusting the pedal to the correct position. After adjustment, tighten pinch bolt and re-check the measurement.

To obtain a clear release, the inner ends of the release levers should travel .5 inch (13m.m.) toward the flywheel. If the adjustment of the pedal is correct, this movement will be obtained when the pedal reaches the pedal stop, which is not adjustable.

CLUTCH REMOVAL

For this operation no special tools are required except the two trolley jacks and rails provided with the tractor dismantling stand.

Proceed as follows :—

- Raise engine hood.
- Disconnect fuel pipe and remove fuel tank.
- Disconnect battery leads and remove battery.

From the right-hand side—

- Disconnect exhaust pipe from manifold.
- Remove air cleaner connections from pipes to carburetter. (*Type TEA–20 only—to carburetter and crankcase*).
- Disconnect choke control from carburetter.
- Remove connections from dynamo and withdraw cable to rear.
- Disconnect oil gauge pipe from engine.
- Uncouple ball-joint connections to governor control lever at bulkhead and disconnect link by removing split pin.
- Disconnect front axle radius rod from rear and steering drag link assembly at front end.

From left-hand side—

- Disconnect lead from wiring harness to ignition coil.
- Disconnect lead from starter motor.
- Disconnect front axle radius rod from rear and steering drag link assembly at front end.

Tractor type TE–20 only :

- *Remove strut, Part No. 1351, from each side of engine sump.*
- *Remove cover plate, Part No. 7089, from lower portion of flywheel housing.*

Place trolley jacks under engine and front portion of gearbox, carefully adjusting height.

Detach engine at rear end and withdraw complete transmission towards the rear, exposing engine flywheel and clutch assembly.

To remove the clutch, slacken the holding screws a turn at a time by diagonal selection until the thrust spring pressure is relieved. Remove screws and lift complete assembly from flywheel, removing the driven plate assembly.

NOTE : The adjusting nuts (8, Fig. 1) are correctly set and locked when the unit is assembled and should not be altered unless the clutch has been dismantled. Interference with this adjustment will put the pressure plate out of position and cause clutch judder and promote failure of the clutch release bearing.

Re-assembly of the clutch should be carried out in reverse order but attention must be paid to the instruction given in REPLACING CLUTCH ASSEMBLY.

RE-FACING THE CLUTCH DRIVEN PLATE

To remove the old facings, it is essential that the rivets are drilled and not punched out. Each rivet attaches one facing only. Insert a 5/32 in. (4m.m.) dia. drill through the clearance hole in the opposite facing. After removal, thoroughly examine the plate segments for cracks. If present, a new plate assembly should be fitted.

To fit facing, place one side in position with the countersunk holes coinciding with those located on the crown or longer side of each segment.

Insert rivets and roll rivet shanks over securely against segments. If a rolling tool is not available, a blunt ended punch will be satisfactory.

Secure the opposite facing in similar manner. Rivet heads should always face outwards.

Mount assembly on mandrel and spin in lathe for run-out ; if more than .015", (.39m.m.) prise over as necessary.

DISMANTLING CLUTCH ASSEMBLY

(FIGS. 3 & 4)

In order to preserve the balance and adjustment of the clutch, mark the following parts in such a manner that they can be re-assembled in the same relative position to each other : cover, pressure plate lugs and release levers.

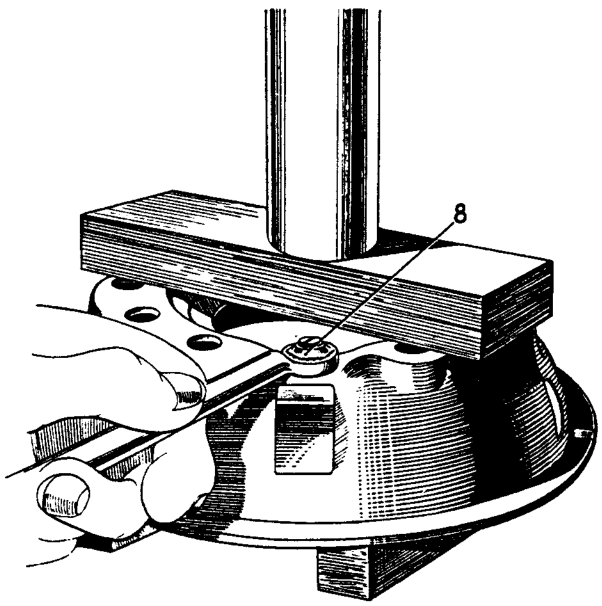


FIG. 3

Place the assembly, less driven plate, under a press with the pressure plate arranged on wooden blocks so that the cover may move downwards when pressure is applied. Place wooden block across spring bosses on top of cover. (Fig. 3).

Compress gently and, while under pressure, remove adjusting nuts (8). Slowly release pressure, and lift off cover.

Remove each release lever (4) by holding lever and eye-bolt (6) so that the inner end of the lever and the threaded end of the eyebolt are as near together as possible, keeping the eyebolt pin (5, Fig. I.)

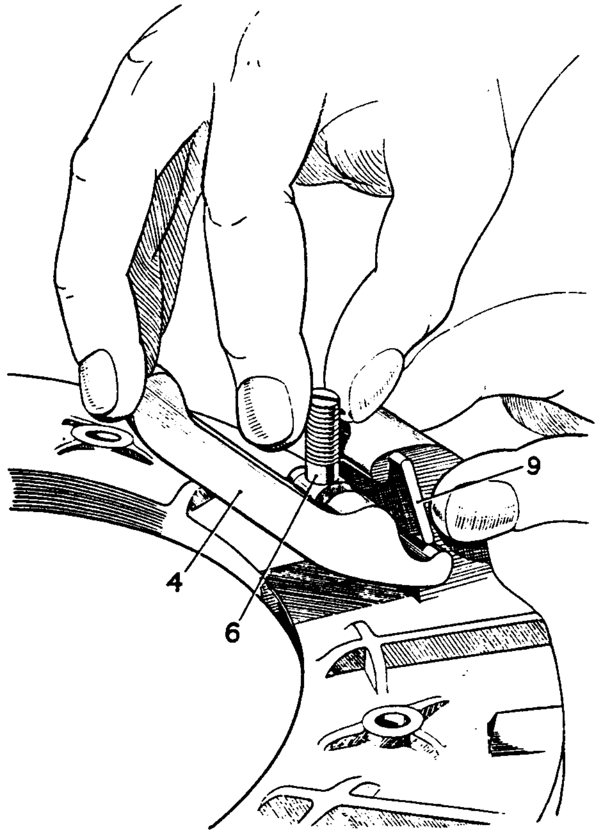


FIG. 4

in position in the lever. Lift the strut (9) over the ridge on the lever and remove the eyebolt from the pressure plate (Fig. 4).

ASSEMBLY OF CLUTCH

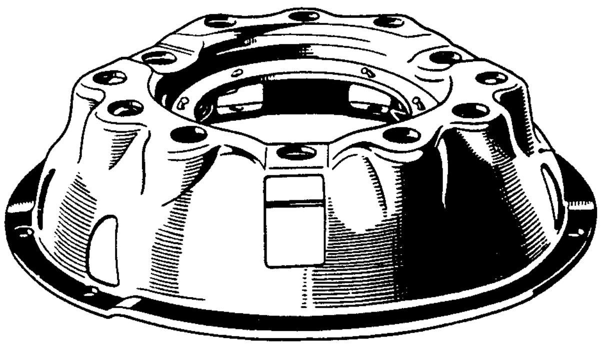
(FIGS. 1 & 5)

Before assembly, thoroughly clean all parts and renew those showing appreciable signs of wear.

A very slight smear of H.M.P. Grease should be applied to the following parts during assembly :—

Lever pins (5) ; Contact faces of struts (9) : Eyebolt seats in cover ; drive lug side on pressure plate (2) ; and plain ends of eyebolts (6).

Assemble release lever (4), eyebolt (6), and eyebolt pin (5) holding the inner end of the lever and the threaded end of the eyebolt as close together as possible. Insert strut (9) in slot in pressure plate lug sufficiently to allow plain end of eyebolt to be inserted in hole in pressure plate.



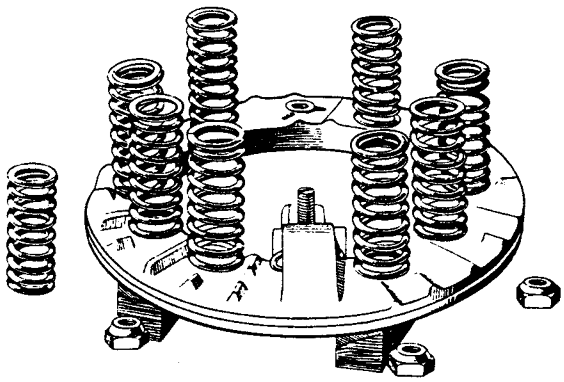


FIG. 5

Move strut upwards into slot in pressure plate lug and over ridge on short end of lever and drop it into groove formed in latter. Fit remaining release levers in a similar manner.

Place pressure plate on blocks under press and arrange thrust springs (3) in vertical position on plate, seating on bosses provided. (Fig. 5)

NOTE : Thrust springs must all be of the same colour, denoting that they are all of the same strength.
On **no** account should springs of different colours be assembled together.

Lay cover over assembled parts, ensuring that anti-rattle springs are in position and that tops of springs are directly under seats in cover ; also that machined portions of pressure plate lugs are beneath slots provided for them. Care must be taken that parts marked before dismantling are in their correct relative positions.

Place wooden block across spring bosses on cover and compress in hand-press, guiding eyebolts and pressure plate lugs through holes in cover.

Screw adjusting nuts (8) on to eyebolts and secure by staking. Operate clutch a few times with hand press to ensure that working parts have fully settled.

If it has been necessary to fit any new parts which might affect adjustment it is essential that the release levers are re-adjusted.

ADJUSTMENT OF RELEASE LEVERS

(FIG. 6)

Special tools required :—
Gauge plate, Part No. CG.192.
Clutch Plate Centraliser, Part No. FT.2

Satisfactory clutch operation is entirely dependent on correct adjustment of these levers and should only require attention if new parts have been fitted. The maximum difference permitted in height of release levers is .015″. (.39m.m.)

Mount clutch assembly to flywheel, substituting gauge plate, CG.192, for driven plate assembly, as shown in Fig. 6. Insert plate centraliser, FT.2., (Fig. 7), to ensure that gauge plate is centrally mounted, and tighten cover plate bolts a turn at a time by diagonal selection until fully home.

Place straight-edge across gauge plate boss and top of one release lever and adjust lever, if necessary, by turning eyebolt nut until top of lever is exactly level with top of gauge boss. Adjust remaining levers in similar manner. If carefully carried out, the setting should be within .005″. (.13m.m.)

Remove clutch assembly and gauge plate.

NOTE : Release lever gauge plate, part number CG192, is available on demand from Borg and Beck Ltd., Leamington Spa, England. If overseas distributors experience difficulty in obtaining supplies of this gauge, orders can be placed through Harry Ferguson Ltd., Coventry.

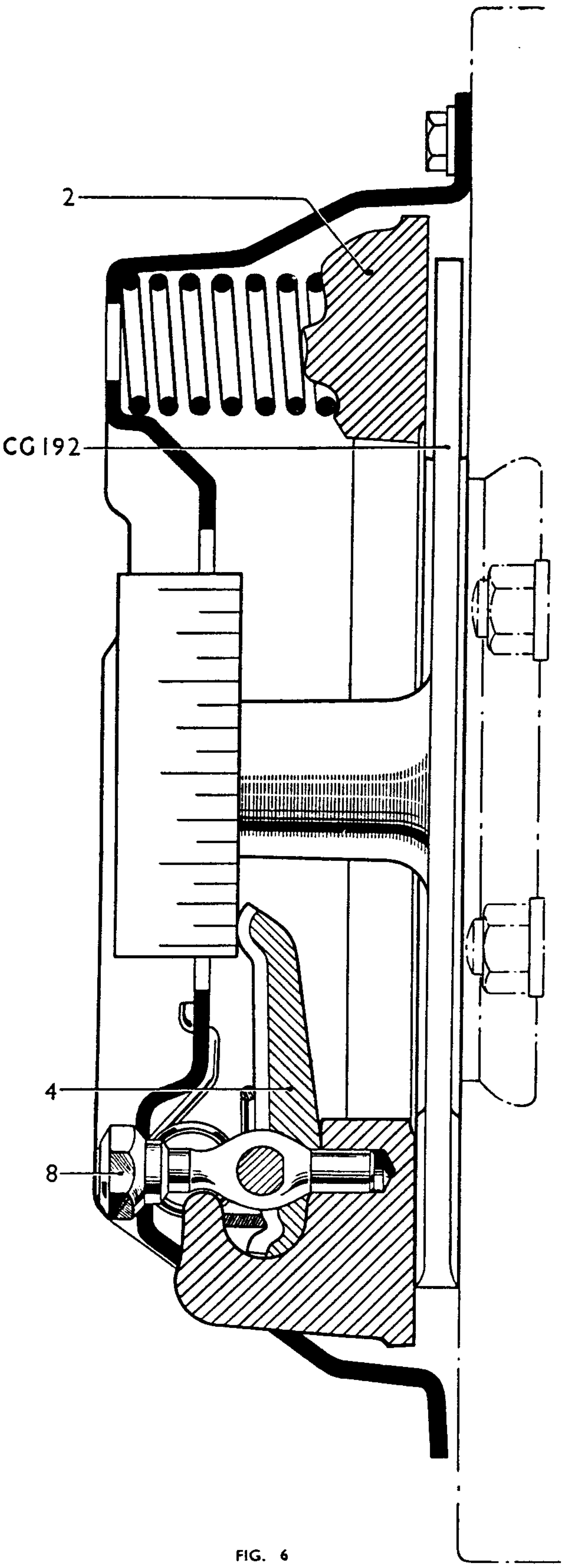


FIG. 6

REPLACING CLUTCH ASSEMBLY (FIG. 7)

Special tool required :—
Clutch Plate Centraliser, Part No. FT.2. (Fig. 7).

Assemble driven plate to flywheel with the centraliser inserted into spigot bearing. The larger chamfered splined end of the driven plate hub should be toward the rear of the tractor.

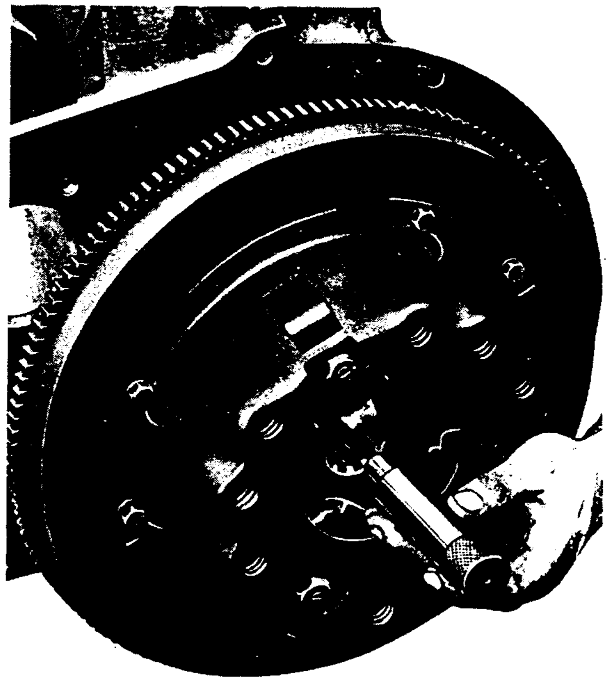


FIG. 7

Fit cover assembly to flywheel by tightening holding bolts one turn at a time by diagonal selection until fully home. Remove special tool when fully tightened.

CLUTCH RELEASE BEARING (PART NO. 4069) (FIG. 8)

Special tool required :—
Clutch Thrust Bearing Remover and Replacer, Part No. FT.–20.

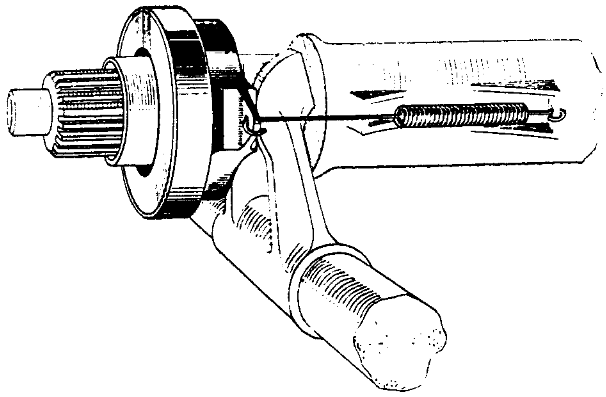


FIG. 8

No attention should be required between major tractor overhauls.

The bearing, which is of the self-lubricating type, is packed with H.M.P. grease on assembly.

To remove bearing proceed as for clutch removal and expose assembly. With the transmission withdrawn from the engine, the release bearing will remain in position on its hub, floating on the main drive gear bearing retainer, Part No. 7071, and retained by two release bearing springs (Fig. 8).

By releasing the springs from the hub, Part No. 4119, the bearing and hub can be slid off the mounting and the bearing then removed, using special tool FT.20—Clutch Thrust Bearing Remover and Replacer (Fig. 9).

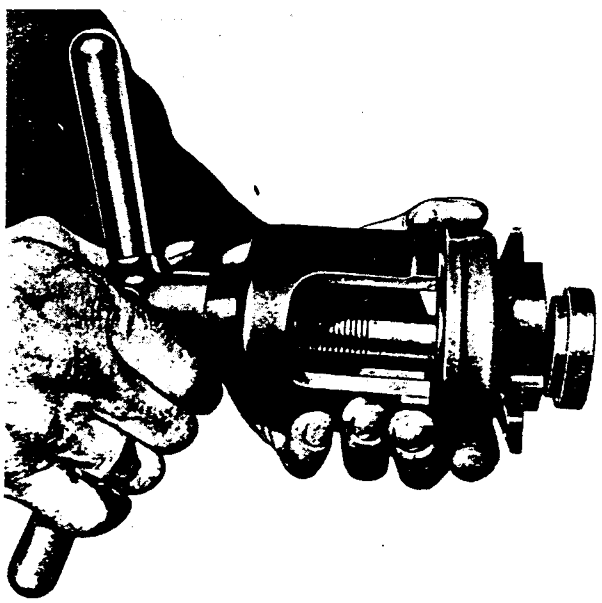


FIG. 9

It is recommended that the bearing should be replaced at major tractor overhauls.

Bearing adjustment is obtained by positioning the clutch pedal. See PEDAL ADJUSTMENT.

CLUTCH PILOT BEARING
(PART NO. 1112)

The transmission main drive shaft is supported in the engine flywheel by this self lubricating bearing which may be examined when the clutch assembly is removed.

No service attention should be required, as this bearing is of the self-lubricating type. It should be examined for wear during major overhaul and renewed if necessary.

CLUTCH AS FITTED TO DIESEL ENGINE TRACTOR

TYPE TE-F20

GENERAL

The Diesel Engine Tractor is fitted with a 10" Single Plate Clutch, which has 12 thrust springs but is otherwise similar in principle to that fitted on carburettor engine tractors.

SERVICING

The instructions given in the preceding pages should be followed, using Borg and Beck Plate C.G. 14322 (instead of C.G. 192), or Churchill No. 99 Clutch Assembly Fixture (see below).

When removing the clutch, first separate the tractor transmission from the engine ; working on the lines indicated in Section C, page C. 127.

On later Diesel tractors, the clutch face of the flywheel has a relief where the clutch casing is mounted. Borg and Beck plate C.G.14322 is not suitable for use with relieved flywheels, and Churchill No. 99 Clutch Assembly Fixture, which can be set to accommodate this relief, must be used.

CHURCHILL No. 99 CLUTCH ASSEMBLY FIXTURE

This fixture is suitable for use with clutches fitted to all Ferguson Tractors. It should be utilised as follows :—

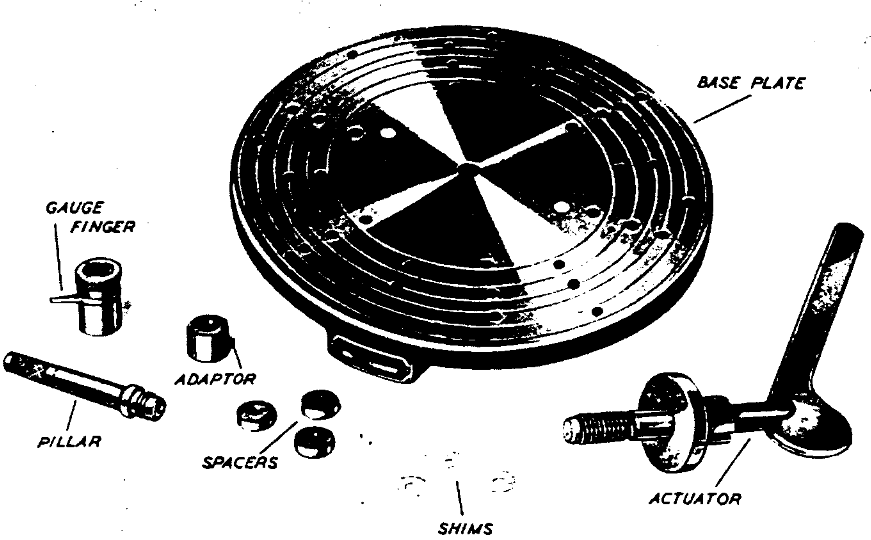


FIG. 10

DISMANTLING.

Remove from the box the gauge finger, the pillar and the actuator, as shown in Fig. 10, and consult the code card to determine the reference of the adaptor and the spacers appropriate to the clutch which is being serviced.

Rest the base plate on a flat surface, wipe it clean and place the spacers upon it in the positions quoted on the code card (Fig. 11).

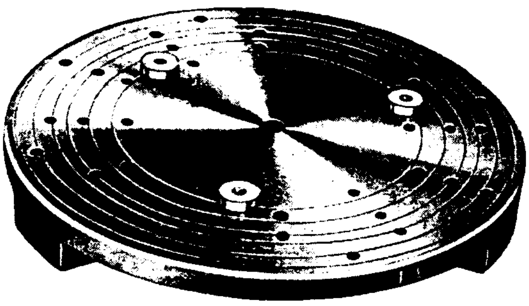


FIG. 11

Place the clutch on the spacers, aligning it with the appropriate tapped holes in the base.

Screw the actuator into the centre hole in the base plate and press the handle down to clamp the clutch. Then screw the set bolts provided firmly into the tapped holes in the base plate and remove the actuator (Fig. 12).

FIG. 12

Remove the adjusting nuts (Fig. 13) and gradually unscrew the set bolts to relieve the load of the thrust springs. Lift the cover off the clutch and carry out whatever additional dismantling may be desired.

FIG. 13

ASSEMBLY

After carrying out the necessary servicing of the clutch components, reassemble the parts on the clutch pressure plate, place the cover upon it and transfer the assembly to the base plate, resting on the spacers and aligned correctly.

Important

On later Diesel engine tractors the flywheel has a relief in the position where the clutch casing is mounted. When servicing clutches which are to be fitted to these tractors, it is necessary to use an additional shim .010″ thick with each spacer, to compensate for the depth of the relief. These shims are included in the No. 99 Clutch Assembly Fixture Kit.

FAULT	POSSIBLE CAUSE	ADJUSTMENT REQUIRED
Clutch drag or spin	Oil or grease on driven plate facings. Improper pedal adjustment not allowing free movement to release bearing. Damaged pressure plate or clutch cover. Driven plate hub binding on splined drive pinion shaft. Distorted driven plate Broken facings of driven plate. Dirt or foreign matter in the clutch.	Fit new plate. Correct pedal adjustment. Replace defective part. Clean up splines and smear with small quantity of grease. Fit new plate. Fit new plate. Dismantle clutch from flywheel and clean with dry rag. See that all working parts are free.
Slip.	Oil or grease on driven plate facings. Weak thrust springs. If excessive slip is allowed to occur, the heat generated will soften the springs and aggravate the trouble. Binding of clutch pedal mechanism. Improper pedal adjustment preventing full engagement.	Fit new driven plate. Fit a new set of thrust springs. Free bearings. **Note.**—The clutch shaft bushes in the transmission case are self lubricating. Oil or grease should ON NO ACCOUNT be applied. Correct pedal adjustment.
Fierceness or snatch.	Oil on driven faces. Binding of clutch pedal mechanism. Worn out driven plate facings.	Fit new driven plate. See above. Fit new driven plate.
Judder.	Oil, grease or foreign matter on driven plate facings. Contact area of friction facings not evenly distributed. Note that 100% contact will not occur until clutch has been in use for some time, but contact area should be evenly distributed round the facings. Buckled driven plate.	Fit new driven plate. Adjust release levers correctly, using gauge plate (Borg. & Beck, Part No. CG.192). If this does not cure the trouble fit new driven plate. Fit new driven plate.
Rattle.	Anti-rattle spring(s) broken. Damaged driven plate. Worn parts in release mechanism. Excessive backlash in transmission. Wear in transmission bearings.	Fit new parts as necessary.
Abnormal facing wear.	Usually produced by over-loading and by excessive slip when starting.	In hands of the operator.

Carefully bolt the cover to the baseplate and screw the adjusting nuts on to the eyebolts until flush with the tops of the latter. Screw the actuator into the base plate (Fig. 12) and pump the handle a dozen times to settle the clutch mechanism. Remove actuator.

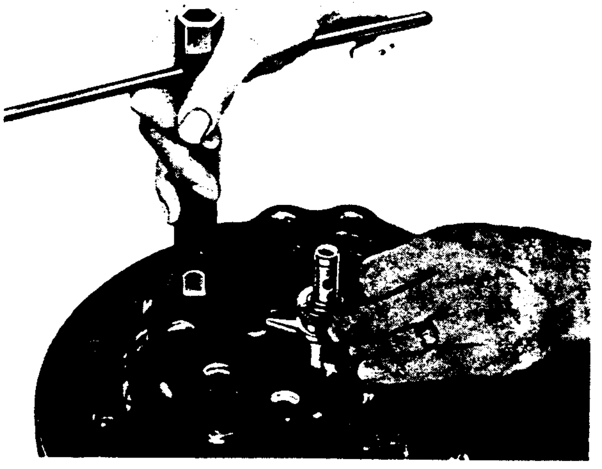


FIG. 14

Screw the pillar firmly into the base and place upon it the appropriate adaptors—See Code Card—recessed face downwards, and the gauge finger.

Turn the adjusting nuts until the finger just touches the release levers, pressing downwards on the finger assembly to ensure that it is bearing squarely on the adaptor (Fig. 14).

After adjusting the height of the toggles to suit, remove the finger, adaptor and pillar and replace the actuator. Operate the clutch by actuating the toggles continuously until, after a series of several applications, the height of the toggles remain constant. This is most important as it will be found that the height will vary repeatedly until the assembled components are well seated.

Finally, lock the adjusting nuts.

Ferguson

SERVICE MANUAL

Section J

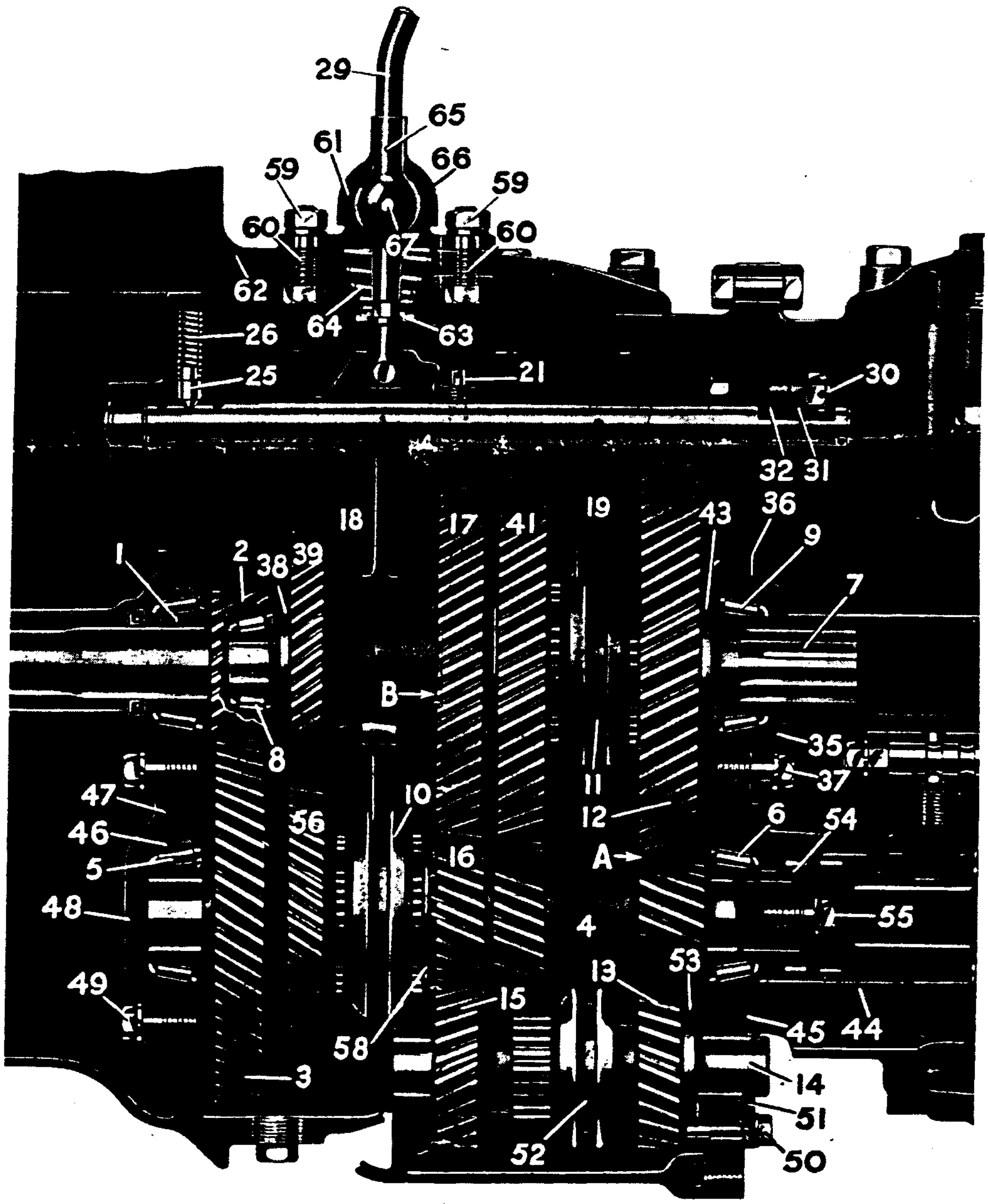
TRANSMISSION

TRANSMISSION

GEAR RATIOS.

1st	11.8 : 1	3rd	6.22 : 1
2nd	8.56 : 1	4th	2.98 : 1

Reverse .... 10.4 : 1



Drive.

The transmission assembly is of the double reduction type, giving four forward speeds and reverse, all indirectly driven. Mounted on a taper roller bearing (1), the transmission main drive pinion (2) drives gear wheel (3) splined to countershaft (4), the latter being mounted on two taper roller bearings (5) and (6). Through one of the four sets of constant mesh gears the drive passes to the mainshaft (7) which is also carried by two taper roller bearings (8) and (9). The front bearing is a spigot in the transmission main drive pinion.

Engagement of the two higher gears is by an internally-toothed coupling (10) on the countershaft, first and second speeds being engaged by a similar coupling (11) on the mainshaft. This is shown in Fig. 2.

The drive for reverse gear is taken through the countershaft via the 1st gear pinion, (view A, Fig. 3) through mainshaft 1st gear idler (12) to the reverse idler (13) running on a fixed spindle (14) and which can be coupled to the reverse driver (15) (view B, Fig. 3). This is in constant mesh with the free-running third speed idler (16) on the countershaft, the final output being to the 3rd speed driven gear (17) which is splined to the mainshaft. It will be seen that when reverse gear is engaged, the 3rd speed idler on the countershaft is revolving in the opposite direction to the countershaft itself. A phosphor-bronze bush is pressed on to the countershaft to support this gear wheel.

Selector Mechanism See Fig. 1 and 4.

The shifter forks (18), (19), (20) are secured by screwed taper pins (21) to shifter rails (22), (23), (24) which slide in holes in the end walls of the transmission casing. Chisel ended spring plungers (25) work in notches in rails to locate selectors for appropriate gears, while rail interlocking is by two balls (27) in a drilling in the casing between selector rails, with a central plunger (28) sliding in a cross hole in the central rail (22).

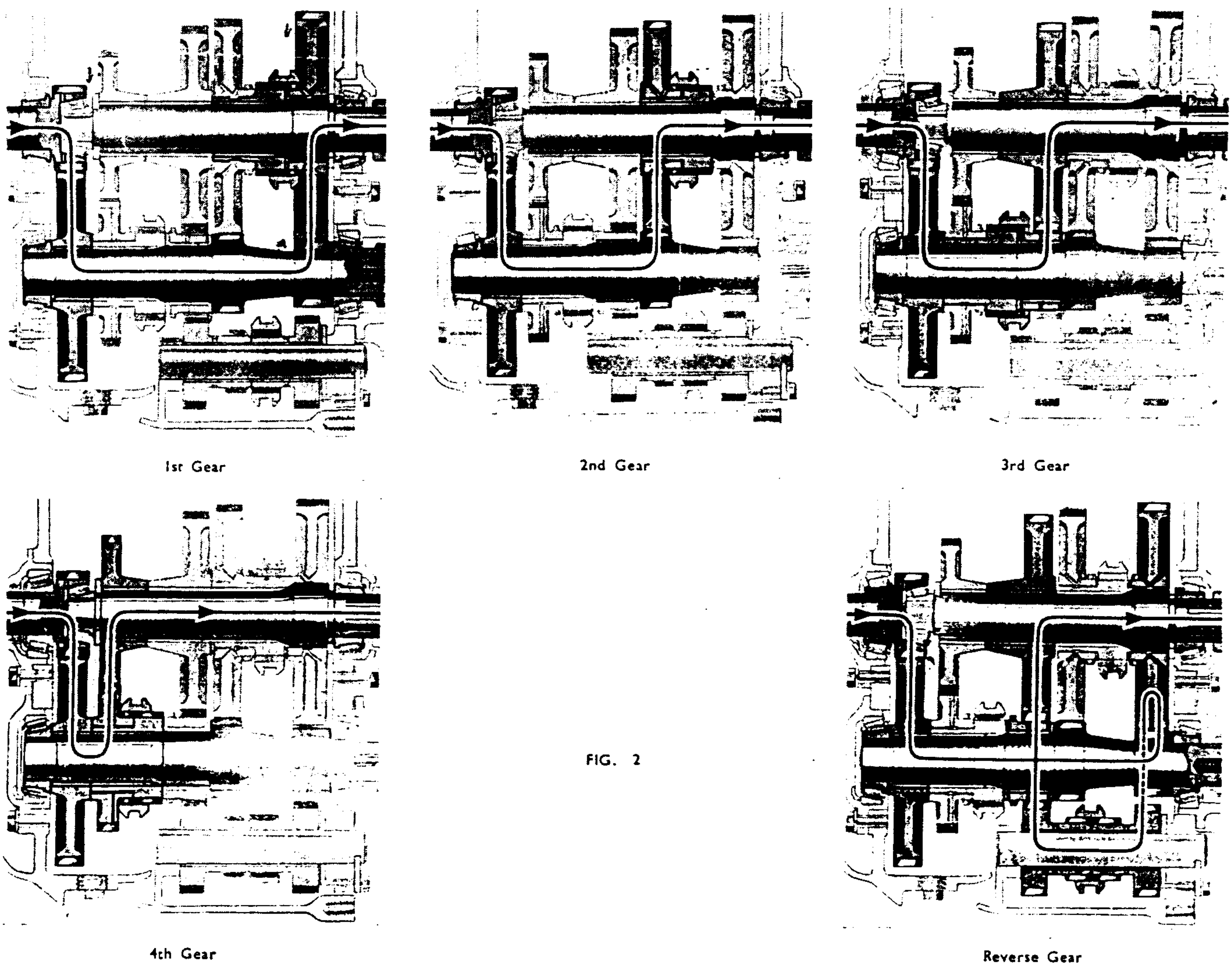


FIG. 2

The centrally placed ball-mounted gearshift lever (29) is lifted to engage the reverse selector, and, when moved in the opposite direction from reverse (i.e. forward) operates the starter switch, thus obviating any possibility of starting the engine with a gear engaged.

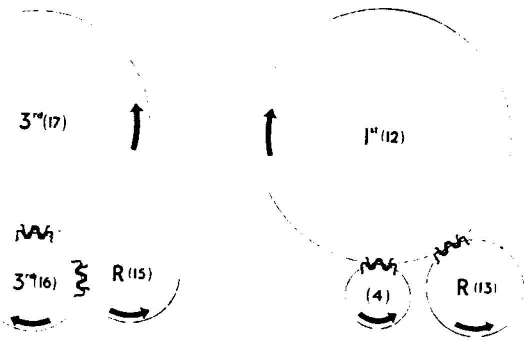


FIG. 3

PREPARATION FOR DISMANTLING TRANSMISSION ASSEMBLY

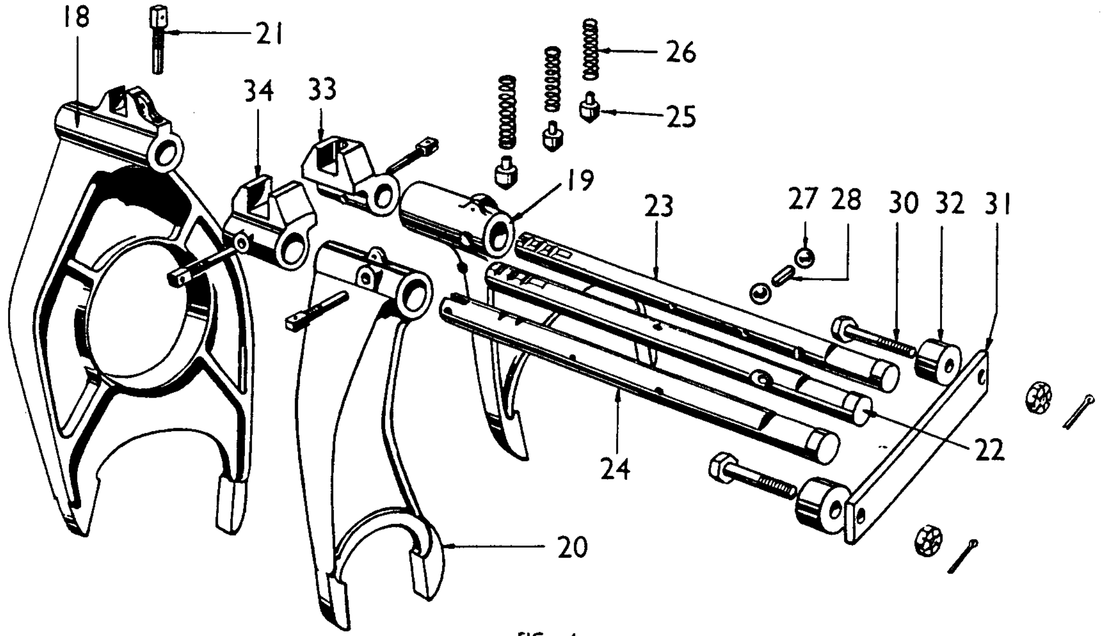


FIG. 4

Before dismantling the transmission assembly it is first necessary to remove the steering assembly and rear axle centre housing from the transmission casing.

To Remove Steering Assembly.

1. Remove hood support, and lower hood forward over radiator.
2. Disconnect fuel pipe at sediment bowl.
3. Remove petrol tank.
4. Remove battery.
5. Disconnect lead at coil, all leads at starter switch and plug connectors at dynamo.
6. Disconnect rubber hoses of air cleaner.
7. Remove knob from choke control lever.
8. Disconnect throttle rod at U-bolt, and at dash by unscrewing link rod assembly from throttle rod plate.
9. Withdraw throttle rod to rear.
10. Disconnect steering rods at rear.
11. Remove set screws and lift out steering assembly complete with wiring and gear shift lever assembly.

To Remove Rear Axle Centre Housing from Transmission Housing.

1. Drain oil.
2. Place jack beneath rear end of transmission casing and adjust so that it will just support the casing. Block front wheels.
3. Disconnect forward ends of brake rods.
4. Remove inspection cover at L.H. side of rear axle centre housing.
5. Remove from rear of rear axle 4 bolts securing P.T.O. shaft housing and withdraw shaft to rear.
6. Disconnect exhaust pipe rear clip.
7. Place a trolley jack beneath forward end of rear axle centre housing.
8. Remove bolts securing transmission housing to rear axle centre housing and draw rear axle assembly complete to rear from transmission assembly.
9. Mount transmission housing to tractor stand and withdraw jack.

Note :-
The use of the tractor dismantling stand is illustrated in section U—page 9.

TO DISMANTLE TRANSMISSION ASSEMBLY

Figs. 4, 5 and 6. See also Fig. 1.

1. Remove and inspect gear shifter rail plungers (25) and springs (26). Replace weak springs.
2. Remove locking wires from gear shifter forks, selectors and lock pins.

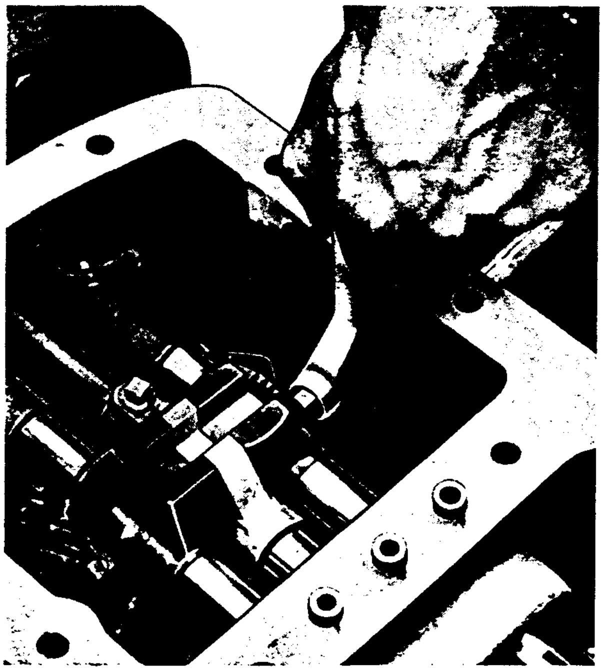


FIG. 5

3. Unscrew and remove pins (21). If square headed pins are fitted, Special Tool, FTB. 11 (Fig. 5), should be employed.

Should a pin head break off, the shifter rail will have to be driven forward, shearing the pin. Suitable packing must be utilised to ensure that all driving load is taken on the transmission casing.

4. Withdraw cotter pins and unscrew slotted nuts from shifter stop securing bolts (30).
5. Withdraw bolts and remove shifter rail stop (31) and spacers (32). Detach starter link from reverse shifter rail by removing clevis pin.
6. Withdraw shifter rails to the rear, removing selectors (33) and (34) and 1st and 2nd gear shifter fork (19). Remove plunger from central (3rd and 4th gear) shifter rail (22) and balls (27) from drilling in casing joining selector rail locating holes. Examine oil seal in reverse shifter rail locating hole. Remove and renew if any indication of oil leakage has been shown. Renew expansion plugs where necessary.
7. Remove rear mainshaft bearing retainer (35) Fig. 6 and shims (36) secured by 4 setscrews (37) with lockwashers.
8. Withdraw the mainshaft to the rear. If necessary, lightly tap 1st gear wheel to disengage shaft from pilot bearing (8) in main drive pinion.

Remove :-

Thrust Washer (38) (front).
4th Mainshaft gear wheel (39).
3rd and 4th gear shifter fork (18).
3rd Mainshaft gear wheel (17).

Mainshaft coupling connector (40) with 2nd mainshaft gear wheel (41) and sliding coupling (11).

1st mainshaft gear wheel (12).

Thrust washer (rear) (43, fig 1).

Note :-

Do **not** at this stage withdraw transmission main drive pinion shaft (2) and bearing assembly (1). The removal of the bearing cup and oil seal entails the removal of the bearing retainer. Access for this operation can only be gained by the removal of the engine from the transmission casing. For instructions on removal of :

—main drive bearing (8)
—main drive bearing cup
—main shaft rear bearing (9)
—mainshaft rear bearing cup.

See " Removal and Replacement of Bearings and Gears."

9. Remove countershaft and P.T.O. bearing support (44) with shims (45) secured by four setscrews with lockwashers (as shown in fig. 1). Remove reverse shifter fork (20), Fig. 4.

10. The countershaft assembly can now be lifted out.

11. To remove the countershaft front bearing cup (46), Fig. 1, the retainer (48) and gasket (47) secured by four setscrews (49) with lockwashers must be removed. Discard the gasket and renew on assembly.

12. Remove screw (50), washer and reverse shaft stop (51) ; withdraw shaft (14) to the rear, removing :
—Reverse drive gear (15).
—Reverse sliding coupling (52).
—Reverse idler gear (13).
—Reverse thrust washer (53).

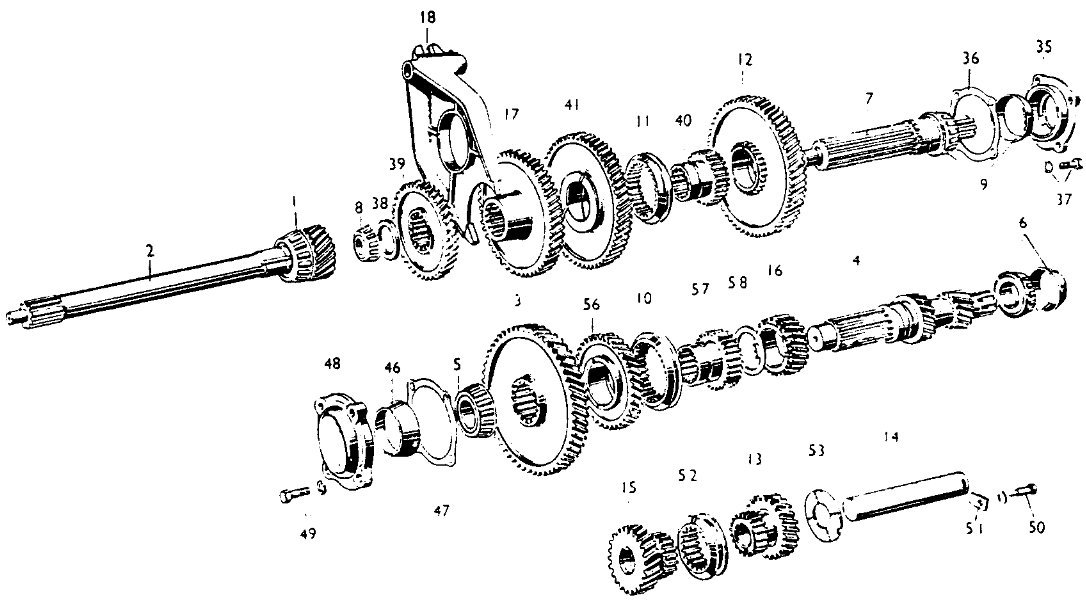


FIG. 6

To Dismantle Countershaft Assembly. See Figs. 6 and 1.

Withdraw the P.T.O. clutch hub (54) from the splines of the countershaft after removing the securing bolt (55) and washers.

Using appropriate bearing puller, remove the taper roller bearings from the countershaft, as instructed in " Removal and Replacement of Bearings and Gears."

The following can now be removed for examination :

—Countershaft reduction gear wheel (3).
—Countershaft 4th gear wheel (56).
—Countershaft connector and coupling (57) and (10).
—Countershaft thrust washer (58).
—Countershaft 3rd gear wheel (16).

To Build up Countershaft Assembly.

Proceed in the reverse order as instructed in "To Dismantle Countershaft Assembly."

Removal and Replacement of Bearings and Gears.

If bearing rollers or cups have become pitted due either to normal wear or excessive pre-loading, they should be replaced as matched pairs.

If gear wheels are to be replaced because of worn or broken teeth they should be paired (driver and driven).

The use of service tool F.T.49 with adaptors illustrated in Fig. 7, will facilitate removal and replacement of the transmission cone-and-roller assemblies.

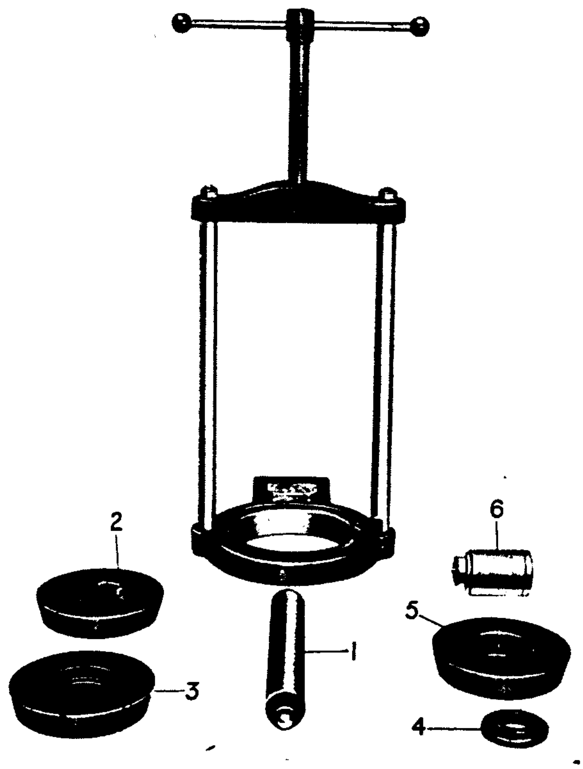


FIG. 7

OPERATION	ADAPTORS REQUIRED WITH FT.49	ILLUS-TRATION	REMARKS
Countershaft.			
To remove front bearing.	1.	Fig. 8	Locate large gear wheel on press base.
To remove rear bearing.	1 and 2	Fig. 9	Hold shaft in position with small (1st) gear above press base. Assemble the 4 parts of adaptor 2 around shaft so that adjacent edges have similar stamped letters. Lower shaft into position and turn, bringing bearing in in contact with thrust plate.
To replace front bearings.	3, 4 and 6	Fig. 10	Place ring, 4, inside plate, 3. Do not replace bearing without first mounting large gear wheel on shaft, because of difficulty of subsequent removal.
To replace rear bearings.	3, 4 and 6	Fig. 11	Place ring, 4, inside plate, 3.

OPERATION	ADAPTORS REQUIRED WITH FT.49	ILLUSTRATION	REMARKS
Mainshaft.			
To remove rear bearing.	1 and 3	Fig. 12	
To replace rear bearing.	3 and 4	Fig. 13	Place ring, 4, inside plate, 3.
Main drive shaft.			
To remove bearing.	5	Fig. 14	
To replace bearing.	1, 4 and 3	Fig. 15	Place ring, 4, inside plate, 3.

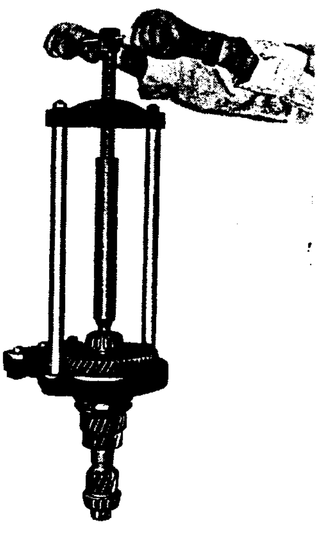


FIG. 8

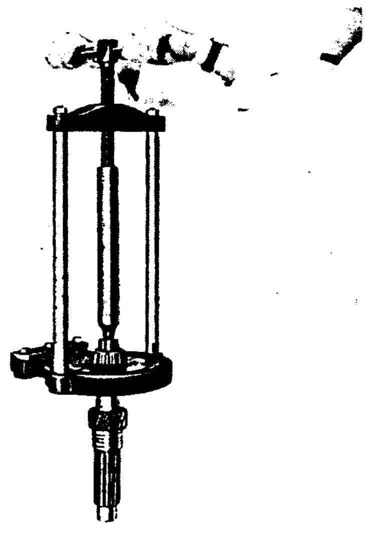


FIG. 9

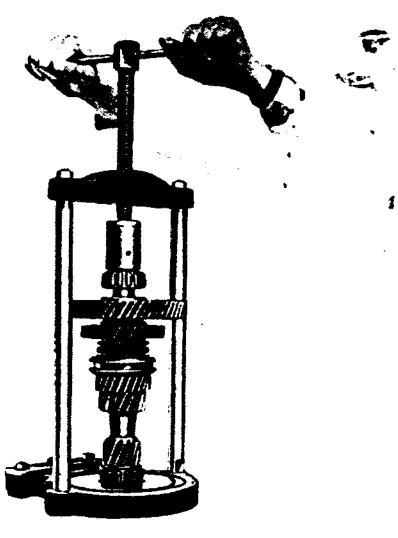


FIG. 10

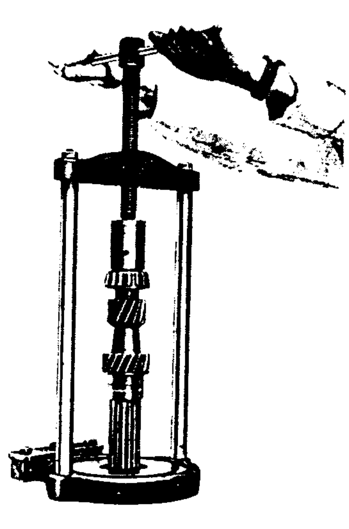


FIG. 11

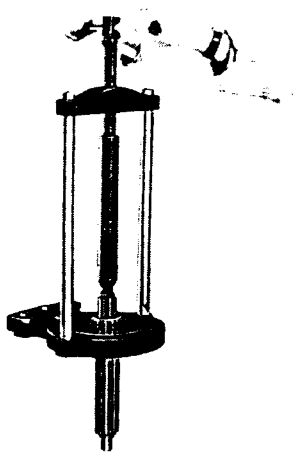


FIG. 12

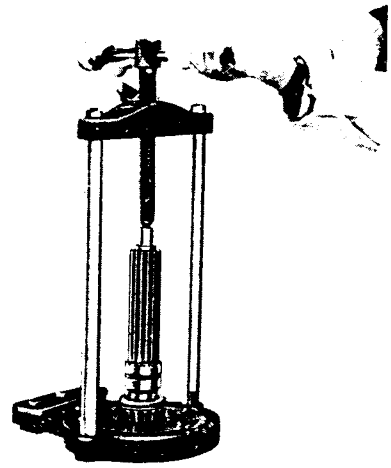


FIG. 13

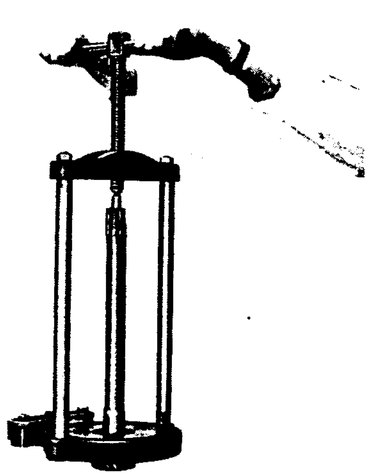


FIG. 14

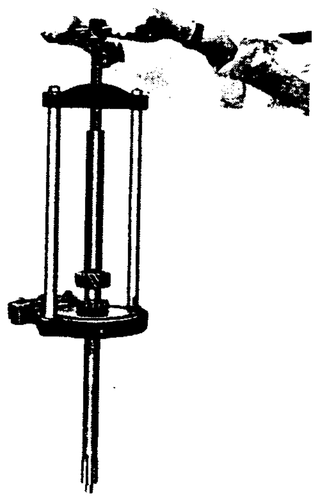


FIG. 15

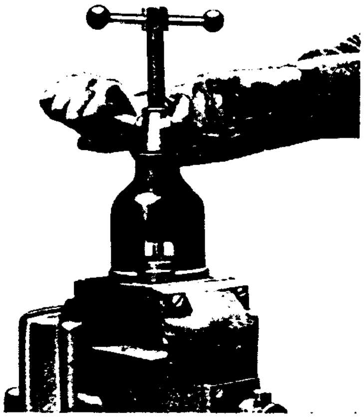


FIG. 16

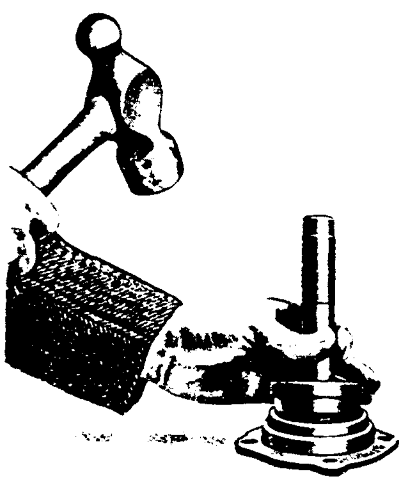


FIG. 17

The use of service tool F.T. 51 Fig. 16 and F.T. 50 Fig. 17 will respectively facilitate removal and replacement of bearing cups located in :—

1. Main drive gear bearing retainer.
2. Mainshaft bearing retainer.
3. Countershaft front bearing retainer.
4. P.T.O. shaft bearing support (i.e. countershaft rear bearing retainer).

TO RE-ASSEMBLE TRANSMISSION
Figs. 18, 19, 20. See also Fig. 1.

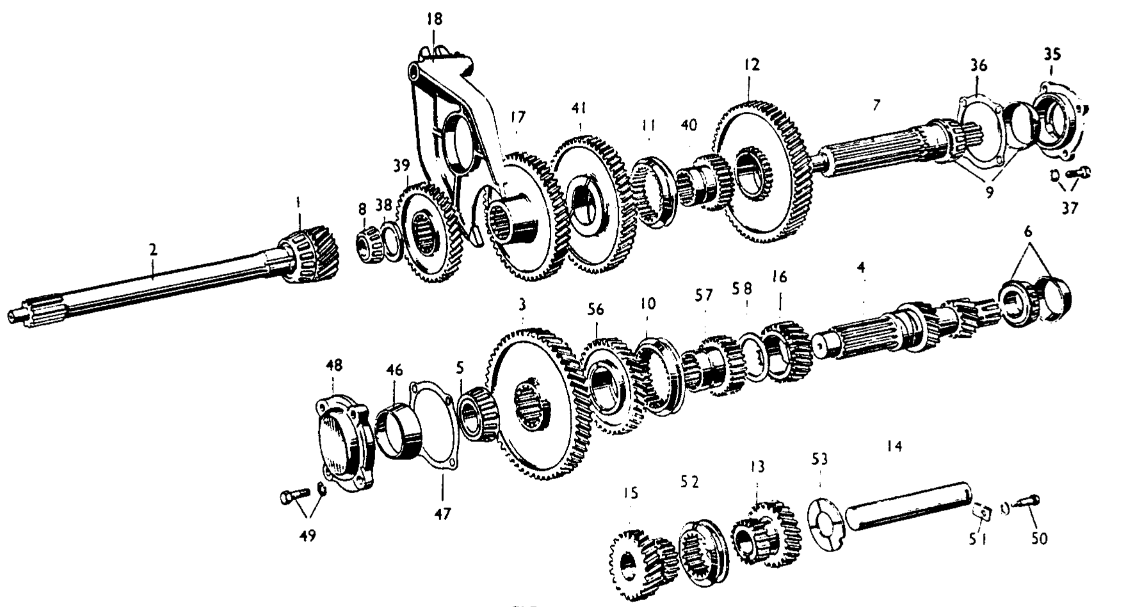


FIG. 18

On re-assembling the transmission it is convenient first to build up the countershaft assembly as previously described.

Lubricate all screw threads before tightening.

1. **Replace Reverse Shaft Assembly.**

Push reverse shaft through its rear locating hole and mount gears and thrust washer in the following order :—

(i) Thrust washer (53) with oilways towards reverse idler gear position.

(ii) Reverse idler gear (13).

(iii) Reverse sliding coupling (52), with the lead on the teeth away from the idler gear (i.e. forward).

(iv) Reverse driver gear (15).

as shown in Fig. 1.

2. Push reverse shaft (14) into its forward locating hole. Lock in position by inserting reverse shaft stop (51) into slot in shaft and tightening stop bolt (50). The dowel end of the bolt protrudes through the trans-

mission casing and locates in a notch in the thrust washer (53).

3. **Replace Countershaft Assembly.**

Secure countershaft front bearing cup retainer (48), fitting new gasket, to transmission casing with 4 setscrews (49) and lockwashers. Lower countershaft assembly into position locating the front thrust bearing in its cup.

4. The countershaft rear thrust bearing is located in its cup by mounting the power take-off shaft bearing support (44), fig. 1.

Shims (45), Fig. 1, are to be fitted between the machined face of the transmission casing and the P.T.O. shaft bearing support flange, so that the countershaft has a torque loading of 7-12 inch pounds (see Note below). An approximate indication of this loading is given if the shaft will turn fairly easily with no end float.

5. **Replace Mainshaft Assembly.**

Note :

To obtain a true indication that the mainshaft (7) will not be excessively pre-loaded, the shaft should first be mounted in its bearings without gear wheels. Place mainshaft front thrust washer (38) in position on shaft and push on mainshaft pilot bearing (8). Locate the bearing in its cup in main drive pinion (2) and tighten down rear mainshaft bearing retainer (35), with cup, on to thrust race (9).

Sufficient shims (36) should be fitted between the rear bearing retainer and the machined face of the transmission housing to ensure that the shaft has a torque loading similar to that of the countershaft, but refer also to Important Note below.

Remove rear bearing retainer and shims. Withdraw mainshaft and remove pilot bearing and thrust washer. Feed mainshaft through rear bearing retainer housing hole in transmission casing, mounting gears etc., in the following order :—

- (i) Mainshaft rear thrust washer (43), fig. 1.
- (ii) Mainshaft 1st gear wheel (12).
- (iii) Reverse gear shifter fork (20) (locate on reverse sliding coupling) (52).
- (iv) Mainshaft coupling connector (40) (to splines).
- (v) Mainshaft sliding coupling (11) (to connector teeth).
- (vi) Mainshaft 2nd gear wheel (41) (to connector).
- (vii) Mainshaft 3rd gear wheel (17) (to splines with larger boss toward clutch).
- (viii) 3rd and 4th gear shifter fork (18) (locate on countershaft sliding coupling).
  Place pilot bearing (8) in cup in main drive pinion.
- (ix) 4th gear wheel (39) (to splines with larger boss away from clutch). Keep shifter fork (18) back to 3rd gear selection position.
- (x) Mainshaft front thrust washer (38).
- (xi) Push or lightly tap shaft to seat in pilot bearing (8). Replace 1st and 2nd gear shifter fork (19) (locate on mainshaft sliding coupling).

6. Replace rear bearing retainer (35), fitting exact number of shims (36) determined by operation (5).

Important : *Special care must be exercised when selecting both countershaft and mainshaft shims. Incorrect assembly can result in noisy transmission, difficult gear changing and jumping out of gear.*

TO REPLACE SHIFTER RAILS AND SELECTORS (FIG. 19)

1. Slide 3rd and 4th gear shifter rail (22), with plunger (28) mounted in hole at rear of rail, forward through central rear locating hole in casing and through locating hole in 3rd and 4th gear shifter fork (18), into central forward locating hole in casing.

2. Place ball (27) in drilling between central and right-hand shifter rail locating holes.
3. Slide 1st and 2nd gear shifter rail (23) through right hand locating hole at rear of casing, and through holes in :—

(i) 1st and 2nd gear shifter fork (19).

(ii) 1st and 2nd gear selector (33) positioning the selector in line with 3rd and 4th gear shifter fork (18).

(iii) Right hand forward locating hole in casing.

(ii) Reverse gear selector (34).

(iii) Reverse gear shifter fork (20).

(iv) Left-hand locating hole at rear of casing.

Turn rail so that the ball engages with notch allowing fore-and-aft movement to any one of the rails.

6. Mount selector rail stop (31), spacers (32), bolts (30) and washers. Secure with slotted nuts and cotter pins.

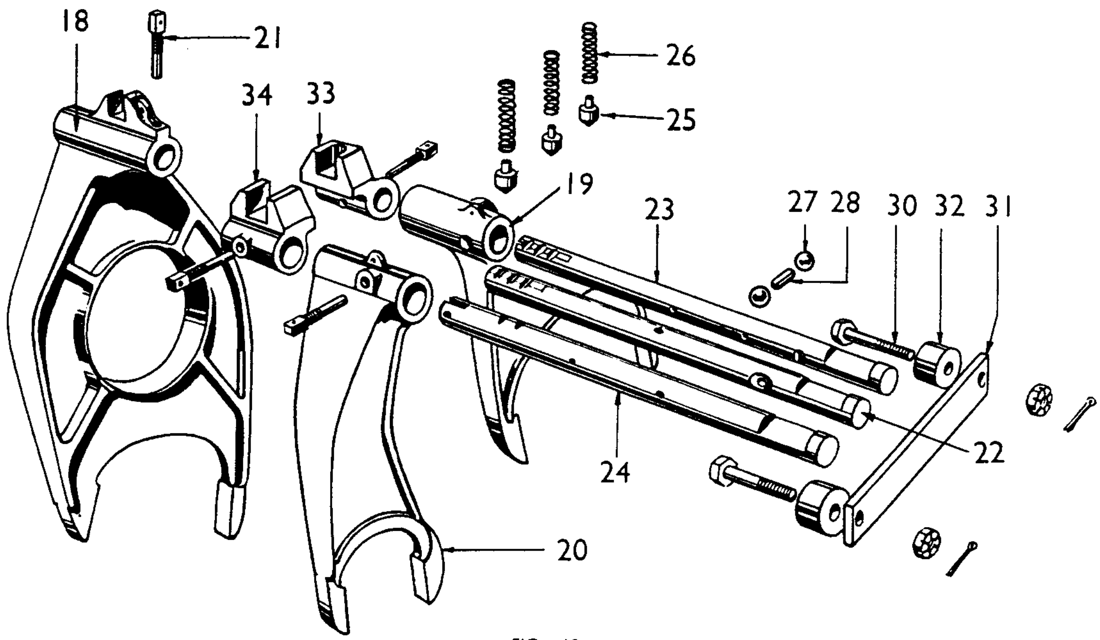


FIG. 19

Ensure that the ball is located in its notch in the 1st and 2nd gear shifter rail.

4. Place ball (27) in drilling between central and left-hand shifter rail locating holes.
5. Fit reverse shifter rail (24).

Note :-

Always slide the reverse shifter rail **from front to rear** through —

(i) Oil seal in left hand locating hole at front of casing.

7. Secure selectors and shifter forks to rails by screwing in lock pins (21). The plain shanks of the pins locate in drillings in rails.

Note :-

On earlier tractors the pins are square headed and a special tool "Selector Fork Lock Pin Wrench" F.T.B.11 (fig. 5) should be used.

8. Wire up pins and their forks or selectors.

9. Place the three shifter rail plungers (25) and springs (26) in their drillings in the transmission casing.

10. Replace steering housing assembly with gearshift lever assembly in position, ensuring that the lever-end engages the lugs of the selectors.

11. Replace rear axle assembly fitting new gaskets and coating flange faces with "Titanine."

TO DISMANTLE GEARSHIFT LEVER ASSEMBLY

Fig. 20. See also Fig. 1.

Remove nuts (59) with lockwashers, from studs (60) securing shift lever cup (61) to steering housing (62), fig. 1. Remove spring seat (63) and spring (64).

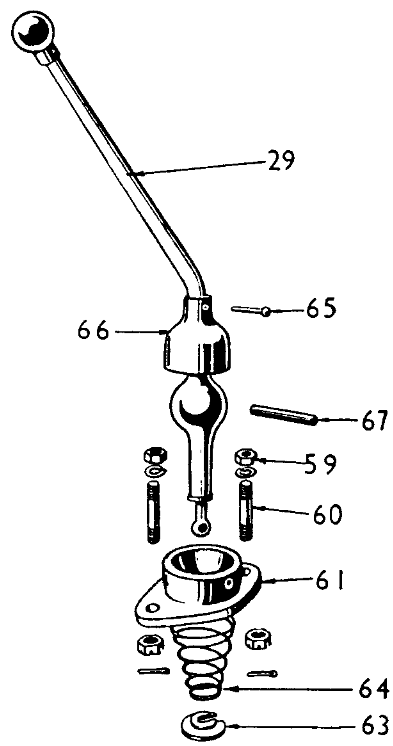


FIG. 20

Remove rivet (65) locating cover (66) on lever (29) and draw cover up lever. Withdraw pin (67) from lever ball seat and lift lever clear.

To Build up Gearshift Lever Assembly.

Lubricate screw threads before tightening.

Place shift lever (29) in operating position in cup (61). Push pin (67) through locating holes in cup and lever ball mounting.

Thread lever cover (66) over lever and rivet in position over ball mounting. Locate spring (64) on lever under cup by mounting spring seat (63). Mount cup and lever assembly on steering housing (62).

Secure cup to steering housing by screwing down nuts (59) with lockwashers on to studs (60).

To Replace Steering Assembly.

Proceed in reverse order to instructions given in "To Remove Steering Assembly." Renew the gasket between transmission case and steering housing.

To Fit Rear Axle Centre Housing to Transmission Housing.

Proceed in reverse order to instructions given in "To Remove Rear Axle Centre Housing from Transmission Housing." Renew the gasket between transmission case and rear axle centre housing and coat contact faces of electron components with "Titanine."

TRANSMISSION FAULT TABLE

FAULT	POSSIBLE CAUSE	ADJUSTMENT REQUIRED
Jumping out of gear	Selector fork faces worn or fork bent.	Replace selector fork.
	Worn teeth on sliding coupling or connector.	Renew coupling and connector.
	Shifter rail plunger worn or springs weak.	Renew plunger or springs.
	Incorrect pre-load on either main or countershaft.	Re-fit as instructed with necessary shims.
	Operator lifts gear shift lever when selecting forward gears.	Do not lift lever when selecting forward gears.
Sticking in gear.	Incorrect pre-load on either main or countershaft.	Re-fit, as instructed, with necessary shims.
	Drag on clutch.	See " Clutch."
Oil leaks to clutch housing.	Displaced or damaged oil seals.	Inspect, and renew where necessary the following :— 1. Shifter rail expansion plugs. 2. Reverse shifter rail oil seal. 3. Main drive pinion shaft oil seal.
	Countershaft or main drive pinion bearing retainer loose or unevenly tightened.	Remove retainers and retighten evenly and diagonally. Renew gasket.
Difficult to engage reverse gear.	Reverse sliding coupling assembled wrong way round.	Re-fit as instructed.
Noisy transmission.	Incorrect pre-load on either main or counter-shaft.	Re-fit as instructed with necessary shims.

The FERGUSON SYSTEM
TRADE MARK

Ferguson

SERVICE MANUAL

Section K

REAR AXLE AND HUBS

REAR AXLE AND HUBS

Rear Axle Assembly—Fig. 1.
Drive from the transmission mainshaft is transmitted by a short internally splined and (33), which run on taper roller bearings (23) and (35) supported by cups in outer axle housings (13), overload thrust being

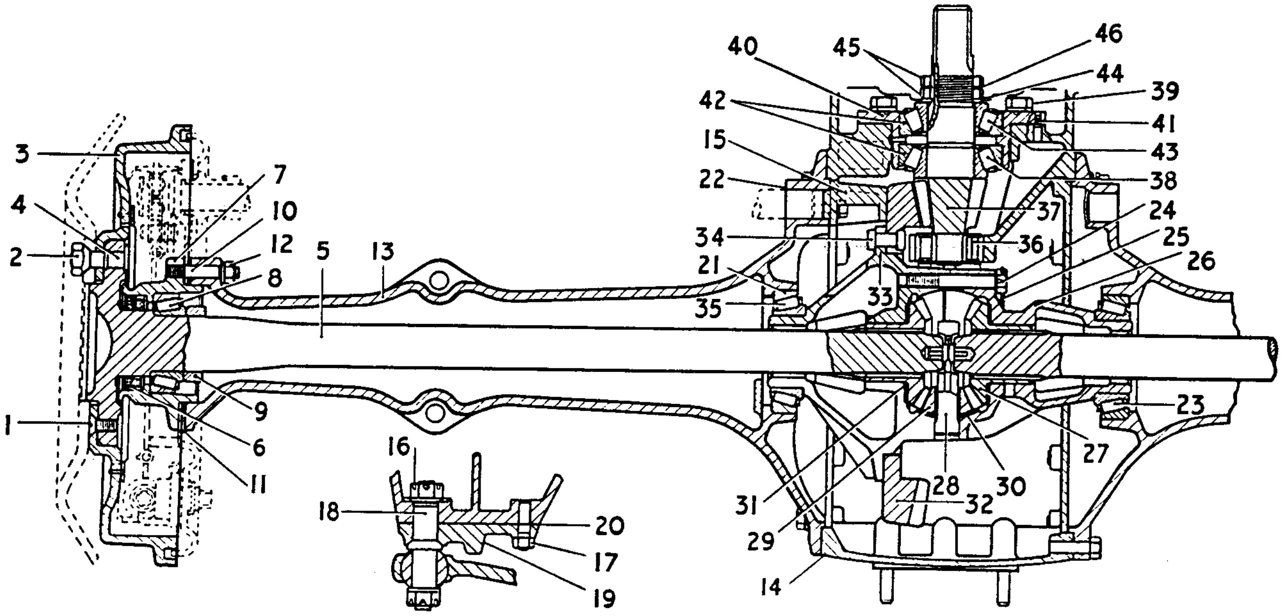


FIG. 1

drive shaft through a spiral bevel pinion (37) to the crown wheel and differential unit; tooth ratio between crown wheel and pinion being 40 : 6. The pinion shaft is carried in two opposed taper roller bearings (38) and (43), housed in a sleeve assembly (40) mounted on a web in the centre axle casing. A second outrigger web houses a plain roller bearing (36) supporting the pinion nose. The crown wheel (32) is spigoted on the split differential case (26) taken on a shimmed block (15) mounted in left-hand housing.

Internally splined differential gears (27) run directly in a cage, while planet bevel pinions (29) are mounted on a spider (28) supported between the two halves of the differential casing, end thrust on gears and pinions being taken by thrust washers (30) and (31).

The semi-floating axle shafts (5) are supported at splined inner ends in the differential gears, and at outer ends in taper roller bearings (8) housed in retainers (7) mounted on outer axle housings. The cages of these bearings are located on the shafts by shrunk-on collars (9), while the splash oil supply through holes in differential bearing housing webs is retained by seals (6) between bearing and outer flanges,

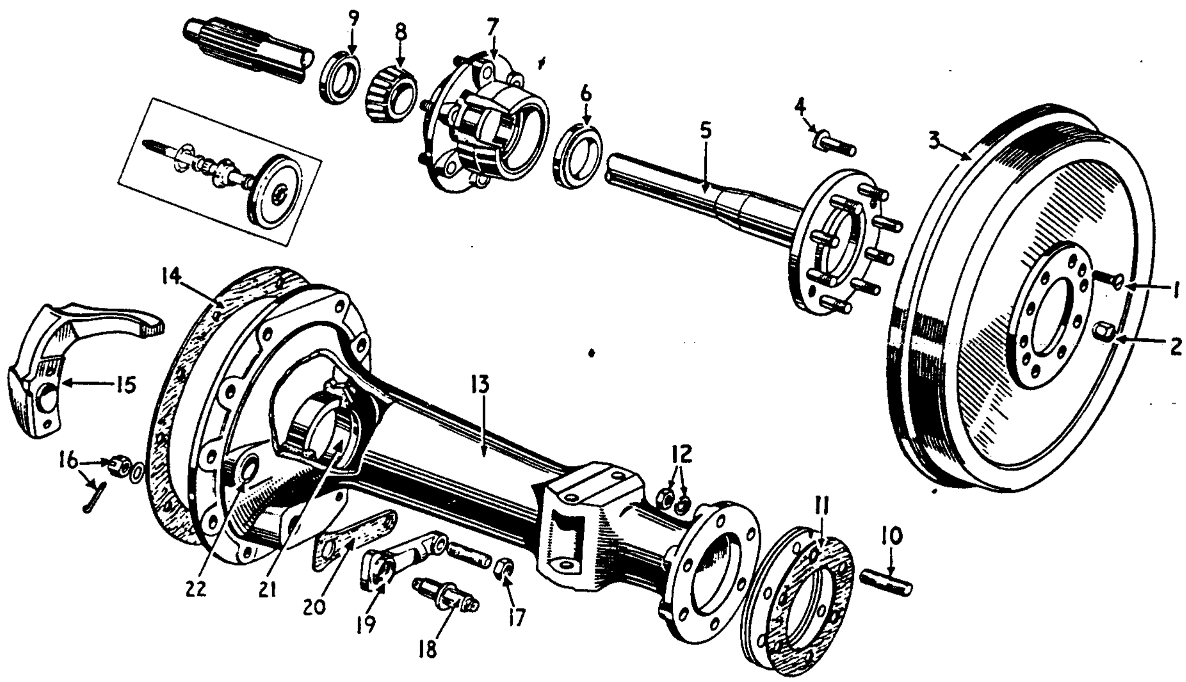


FIG. 2
(Annotation as for Fig. 1)

on which are mounted brake drums and wheels. On tractors after serial No. 96,932 brake linings are further protected by oil catchment rings riveted to drums. Axle shaft bearing end float is controlled by shims between brake back plate and axle housing gaskets, all of which are located on hub bearing retainer studs (10).

To Remove Axle Shaft Assembly—Fig. 2.

For each, proceed as follows :—

1. Jack up rear axle assembly and drain oil from rear axle centre housing.
2. Remove appropriate rear wheel—eight nuts (2).
3. Remove brake drum (3)—two screws (1).
4. Remove nuts (12) and lock washers from the six studs holding rear hub bearing retainer (7) and brake backplate to flange of outer axle housing (13).
5. Withdraw shaft and brake assembly.

6. Withdraw axle shaft (5) with hub bearing retainer (7) from brake assembly and remove shims and gaskets (11) from studs (10).

Note. It is recommended that the appropriate brake rod is disconnected from stop assembly and that axle shaft and brake assembly are removed together, disengaging brake shaft from bush (22) in casing, and the axle shaft from splines in differential gears. To permit removal of brake rod clevis pin, slacken pinch bolt on linkage and tap latter outwards on key to clear clevis head.

After disconnection of brake rod, apply parking brake. This will centralise the other axle shaft and so protect its oil seal and assist location of axle shaft inner end on differential splines during subsequent replacement.

The shanks of rear wheel securing bolts (4) are a press fit in axle shaft flange. Replacement of these bolts entails removal of shaft.

To Fit Axle Shaft Assembly.
(Fig. 2).

If axle shaft assembly has been dismantled, e.g., for replacement of bearing (8) or oil seal (6), the replacement operation should include a check for end float. Patience exercised during this check will be amply repaid by subsequent reduction in wear of inner end of axle shaft.

With hub bearing retainer located in position on axle, proceed as follows :—

1. Mount brake assembly on axle shaft hub bearing retainer studs (10) with two outer housing gaskets (11) but no shims.

2. Mount this assembly on flange of outer axle housing, inserting brake shaft in casing bush (22) without attachment of brake rod, and inner end of axle shaft into differential splines.

3. Tighten nuts (12) on studs (10) and attempt to turn axle shaft wheel flange. If rotation of the shaft is difficult or if both shafts rotate in the same direction shaft ends are butting together, and the assembly must be removed and shims interposed, one at at time, between outer axle housing

flange gaskets (11) until shaft is just free to turn with stud nuts tight. Now add further shims of total thickness .008″ —.010″ (.203 —.254 mm.) to provide the correct amount of end float.

4. Tighten stud nuts (12), mount brake rod, drum, and replace wheel.

To Dismantle Axle Shaft Assembly. (Fig. 2).

For access to oil seal (6), it is necessary to remove hub bearing (8). Besides being a press fit on the shaft, this bearing is further retained by a shrunk-on collar (9) and special tools are available for removal of collar and bearing.

1. Remove axle shaft assembly—See page K.2.

2. Up-end shaft assembly and drill through collar as shown in Fig. 3, using aligning jig and extension drill FT.26B. Place plain locating ring over shaft on collar and pegged ring over shaft nose, with pegs located between splines to align top and bottom of extension drill, then drill as far as permitted by stop collar on drill extension.

3. Split and remove collar by cutting with chisel parallel to shaft.

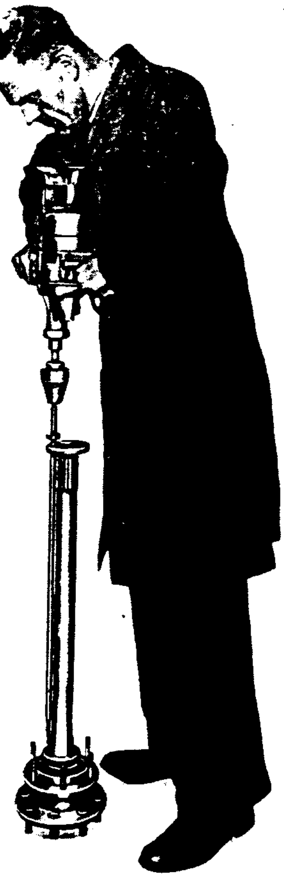


FIG. 3

4. After removal of collar, apply shock load to bearing by means of Service Tool FT.28, See Fig. 9. Then clean up outer end of axle shaft with fine emery cloth and apply penetrating oil or paraffin.

5. With axle shaft up-ended, locate flange of bearing remover FT.26 on the six studs of bearing retainer flange and secure in position by tightening **all six** nuts dead tight.

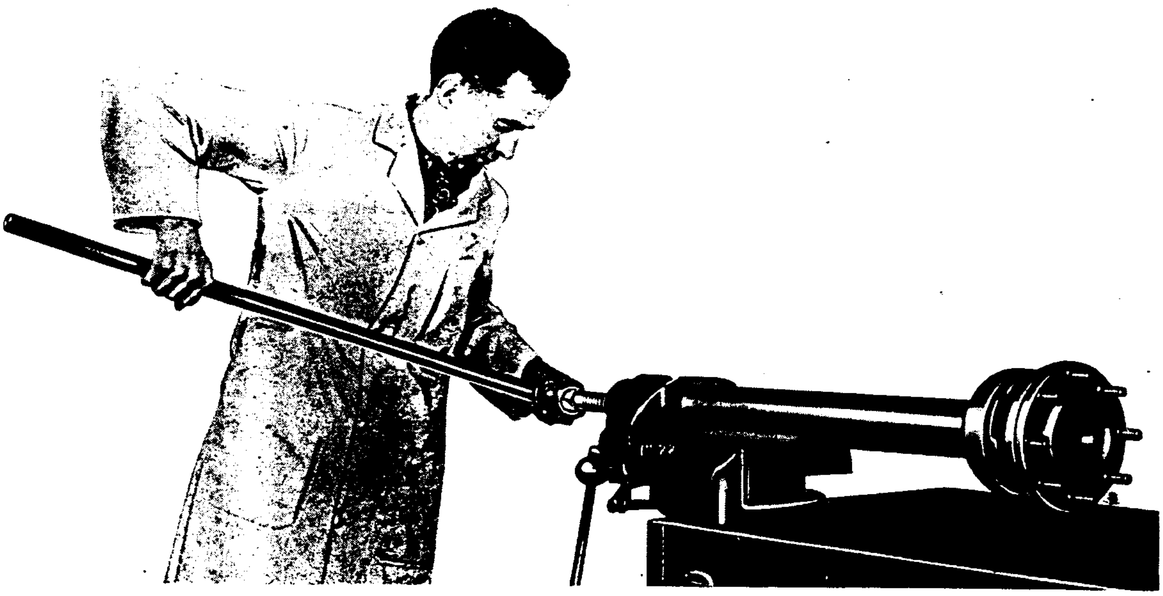


FIG. 4

6. With tool mounted securely in bench vice, apply a slight load as shown in Fig. 4, then smartly tap all round bearing retainer with a copper-faced mallet.

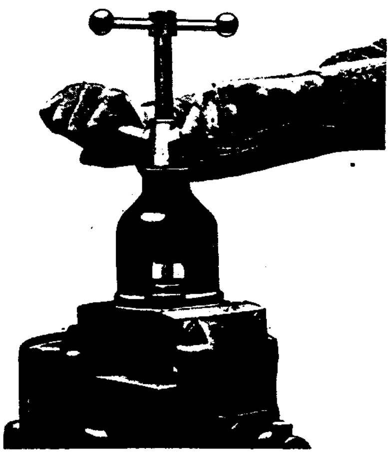


FIG. 5

7. Repeat instruction 6 above, until retainer and bearing assembly is free.

8. Lever out oil seal from housing in bearing retainer and withdraw bearing cup using withdrawal tool FT.51, Fig. 5. Note : This tool, as illustrated, is shown removing the transmission mainshaft bearing cup.

Note. On tractors after Serial No. 119,107, a specially shaped oil retaining shim is located between base of bearing cup and retainer. This may be damaged during bearing removal and should be renewed.

FIG. 6

After removal of bearing retainer from axle shaft, the wheel securing bolts (4) can be driven out of the mounting flange. On subsequent replacement, bolt threads should be peened over, using Service Tool FT.54 as shown in Fig. 6.

To Re-Build Axle Shaft Assembly. (Fig. 2.)

1. Press rear hub bearing cup in position in retainer (7) (over oil retaining

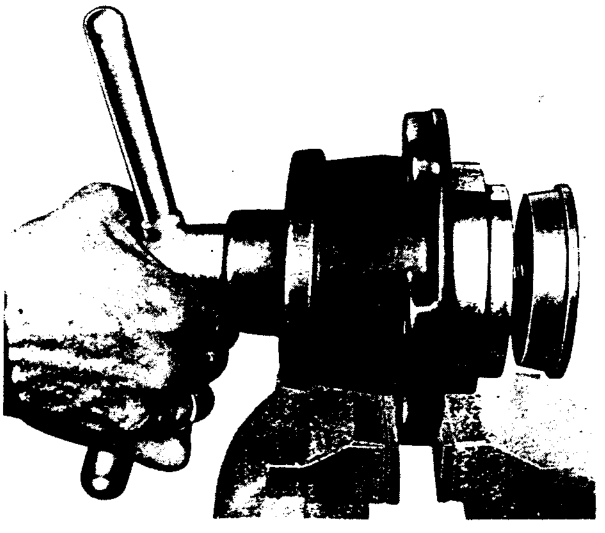


FIG. 7

shim, if fitted) using Service Tool FT.30B, as shown in Fig. 7.

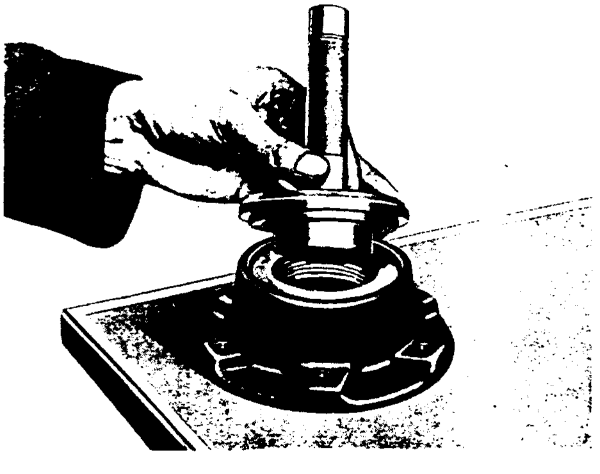


FIG. 8

Note. If oil retaining shim is to be fitted for the first time, extra shims to an extent of .006" (.152 mm.) must be fitted, when replacing each axle shaft assembly, to maintain existing end float.

2. Press or tap in seal (6), lip inwards, using Service Tool FT.29, Fig. 8.
3. Place retainer assembly over shaft, pressing seal over shoulder to locate housing on shaft flange.

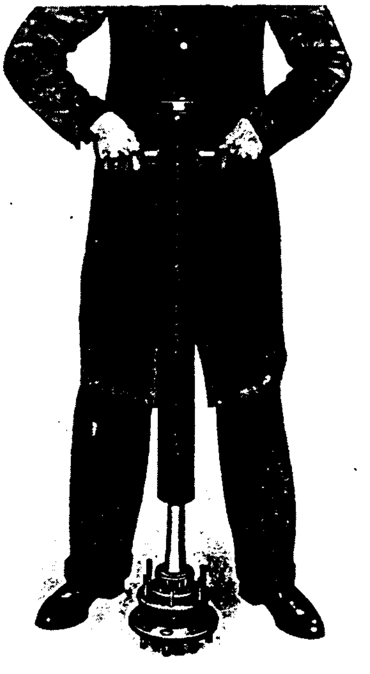


FIG. 9

4. Up-end assembly and, using Service Tool FT.28, Fig. 9 drive bearing into position in cup, securing retainer assembly on shaft.
5. Expand retaining collar (9) by heating, then drop over axle shaft and locate against bearing, using Service Tool FT.28, and allow to cool.
6. Replace axle shaft assembly—see page K.3.

To Remove Differential Assembly. (Refer to Fig. 2)

1. Drain oil from rear axle centre housing.
2. Disconnect left lower link at forward ball joint.

3. Remove left-hand fender.
4. Withdraw left-hand axle housing and shaft assembly after removal of securing nuts from studs, having supported weight of housing assembly on trolley jack.
5. Remove complete differential assembly from its location on right-hand bearing cup and axle shaft splines.

Note. Crown wheel overload thrust block (15) can now be removed by taking out the two set screws shown

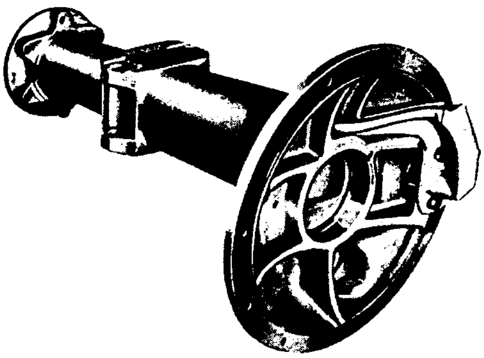


FIG. 10

in Fig. 10. Shims should be inserted or removed at this point.

Access can now be gained for replacement of lower link shaft (18) plate (19) and gasket (20), after removal of nut and split pin (16).

After withdrawal of axle assembly from housing, the differential bearing cup (21) can be removed, using Service Tool FT.32A, as shown in Fig. 11.

Right-hand axle housing assembly can be removed in a similar manner to that given above, access now being gained to tap out the expansion plug from its location behind brake shaft bush.

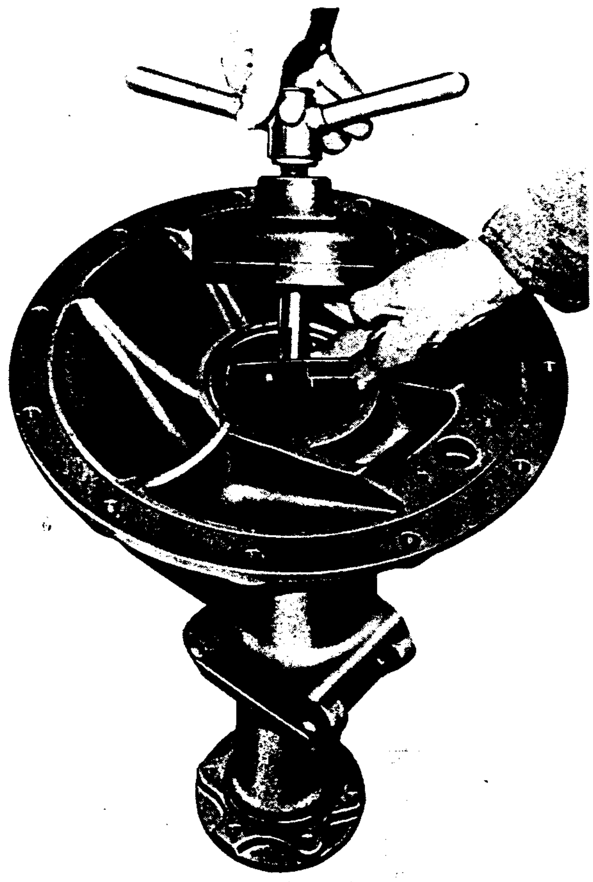


FIG. 11

To Replace Differential Assembly.

Replacement is a reversal of removal instructions given above. Running clearance between crown wheel and overload thrust pad can be checked by up-ending the outer axle housing assembly and mounting the differential assembly on the bearing cup. The clearance should be .013" to .020" (.330 — .508 mm.)

A damaged gasket or oil seal should be renewed if backlash between crown wheel and pinion is insufficient, due to preload on differential bearing, causing noisy operation of the assembly ; it is permissible to fit an extra gasket (14) between outer axle housing and centre housing.

To Dismantle Differential Assembly, Fig. 12.

1. Extract cone and roller assemblies (23) and (35) respectively, from right-hand and left-hand halves (26) and (33) of differential cases using Service Tool FT.4221 with split pressure plate Code 1, mounted on base plate FT9, supported on bench plate FT.10, as shown in Fig. 13.

2. Split casing after removal of eight set screws (24) which are locked together by continuous wire (25).

3. Side bevel gears (27) and pinions (29) with thrust washers (30) and (31) and spider (28) can now be lifted out.

4. Removal of crown wheel (32) necessitates drilling through heads of twelve rivets (34) and breaking off with a cold chisel, then drilling shanks clear and tapping wheel off spigot on differential cage (33).

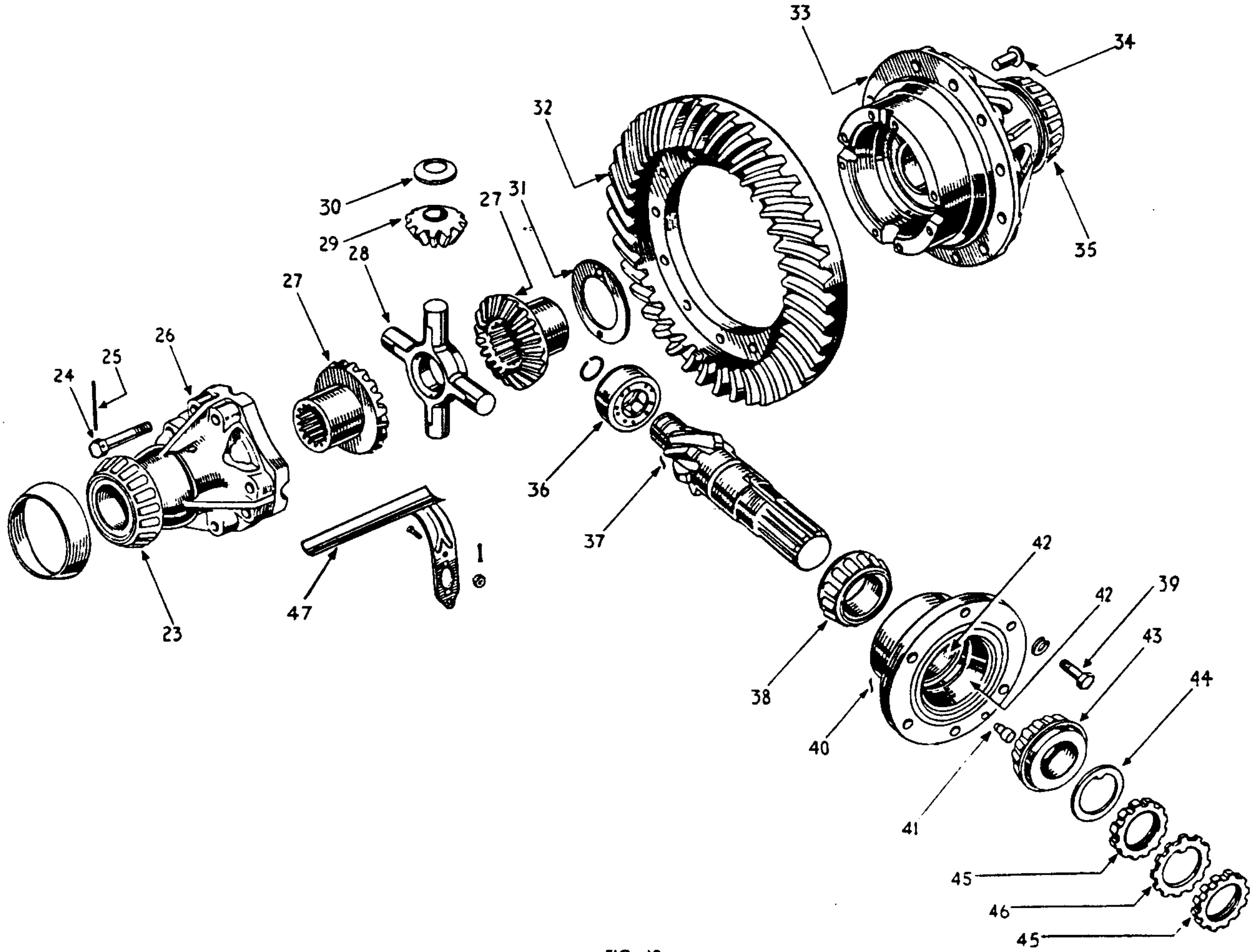


FIG. 12
(Annotations as for Fig. 1)

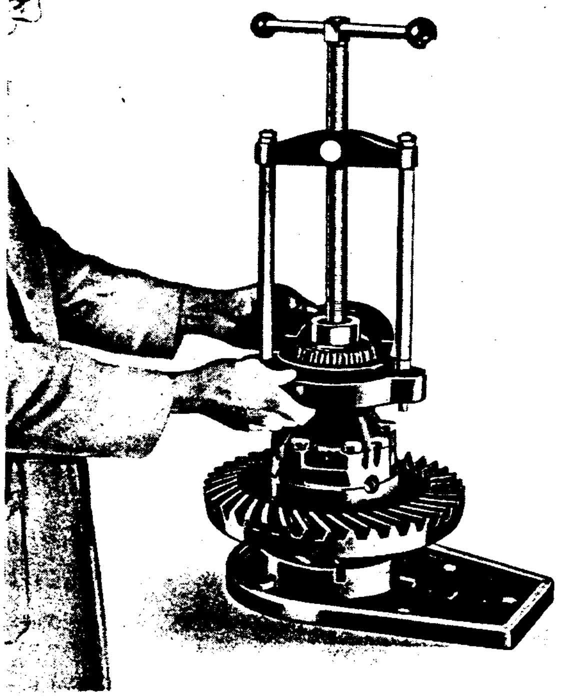


FIG. 13

To Re-Build Differential Assembly— (Fig. 12).

Replacement of Gears.

If any of the bevel or pinion gears (27) and (29) are found to be damaged, the remaining gears should be closely examined as they are also likely to have been affected. Crown wheels and pinions are matched and should always be replaced as an assembly. Attachment of a replacement crown wheel to differential casing is by high tensile steel bolts with castellated nuts, shanks being peened into castellations.

Assembly is a reversal of dismantling procedure, Service Tool FT.12 being used to replace cone and roller assemblies (23) and (35) in differential casing, as shown in Fig. 14, and Service Tool FT.32B Fig. 15 to replace cup in outer axle housing (21, Fig. 2).

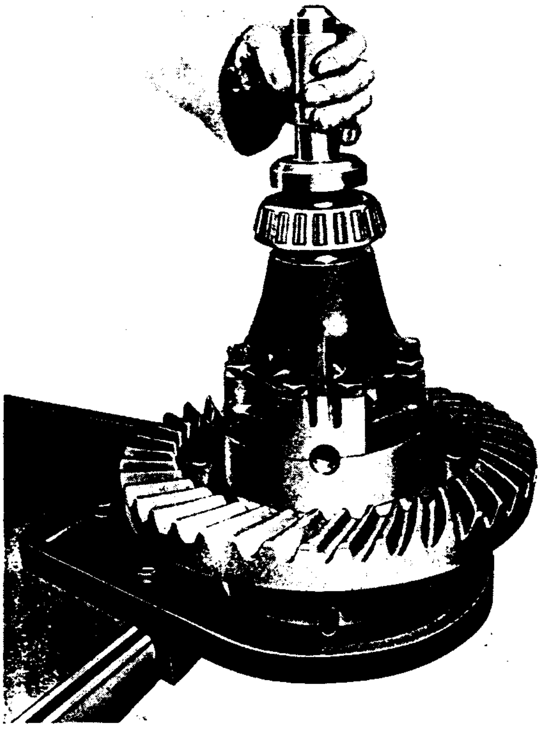


FIG. 14

Note. This cup should be initially driven in for approximately $\frac{1}{8}''$ (4 mm.) to ensure correct alignment before using Service Tool FT.32B.

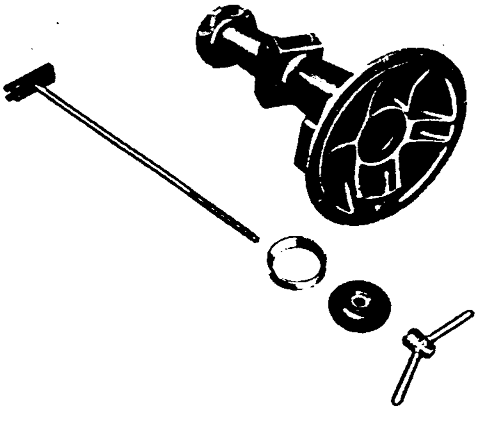


FIG. 15

To Remove Driving Pinion and Sleeve Assembly.

For access to this assembly, it is necessary to remove the rear axle assembly from the transmission casing, also the hydraulic lift cover assembly from centre housing. The use is recommended of tractor dismantling stand FT.27 illustrated in Section U, page 9.

1. Drain oil from transmission and rear axle centre housing.
2. Remove P.T.O. shaft—see Section M. Page 1.
3. Disconnect exhaust pipe at manifold and remove—see Section E, page 7.
4. Support tractor weight on trolley jacks just below transmission housing and forward end of rear axle centre housing.
5. Remove nuts from bolts and studs securing centre housing to transmission housing, and draw former to rear, free from internally splined drive shaft. Mount forward face of centre housing on dismantling stand, using four suitable nuts and bolts.
6. Disconnect both lower links at forward ball mountings.
7. From side walls of centre housing remove inspection covers and expand hydraulic hand control fork legs to disconnect control valve yoke.—See Section L, page 9.
8. Disconnect hydraulic control spring rocker by withdrawal of long linch pin from lugs in top of centre housing. Remove fourteen set screws, and lift clear hydraulic lift cover assembly complete with seat, control spring, lift assembly and lower links—see Section L. Page 13.
9. Withdraw pinion and sleeve assembly, which is located in its housing web in casing by a dowel (41) and secured by six set screws (39) with lock washers. (See Fig. 12).

Note. Withdrawal is assisted by provision of two tapped holes in sleeve flange through which suitable bolts can be screwed to develop a forward thrust on flange.

Replacement of Driving Pinion and Sleeve Assembly. (See Fig. 12).

Proceed in reverse order to removal, entering spigot of sleeve (40) into casing, locating on dowel (41) feeding pinion nose into pilot bearing (36). A very small reduction in depth of mesh between teeth of pinion (37) and crown wheel (32) can be obtained by interposing shims between pinion sleeve flange and housing.

If clearance between crown wheel and thrust block (15) is outside the limits given in specification, Section B (Fig. 2) Page 3, the left-hand outer axle housing must be removed and shims added or removed from their location behind thrust block.

Pinion Bearing.

After removal of pinion and sleeve assembly the opposed taper thrust bearings (38) and (43) must be immediately removed using the method described below. However, access for removal of the rear pilot bearing (36) from its housing in casing web can only be gained after removal of differential assembly.

Thrust Bearings—Removal. (Fig. 12.)

Front :—

1. Remove pinion and sleeve assembly—see page K.10.

FIG. 16

2. Bend back tabs of lock washer (46), then, using wrenches FTB.6 remove lock nuts (45) and thrust washer (44) as shown in Fig. 16. Drive shaft Part No. 4028 or 4381 held over splines of pinion shaft will facilitate removal of lock nuts. Front bearing cone and roller assembly (43) can now be withdrawn if flange of sleeve (40) is located in Service Tool FT4221 instead of adaptor plate illustrated in Fig. 17.

Rear :—

Mount pinion (37) and bearing (38) in Service Fixture FT. 4221 and withdraw bearing, having entered bevel pinion into pressure adaptor plate Code 2, as shown in Fig. 17.

Replacement.

If both bearings have been removed, the rear bearing (38) should be replaced first.

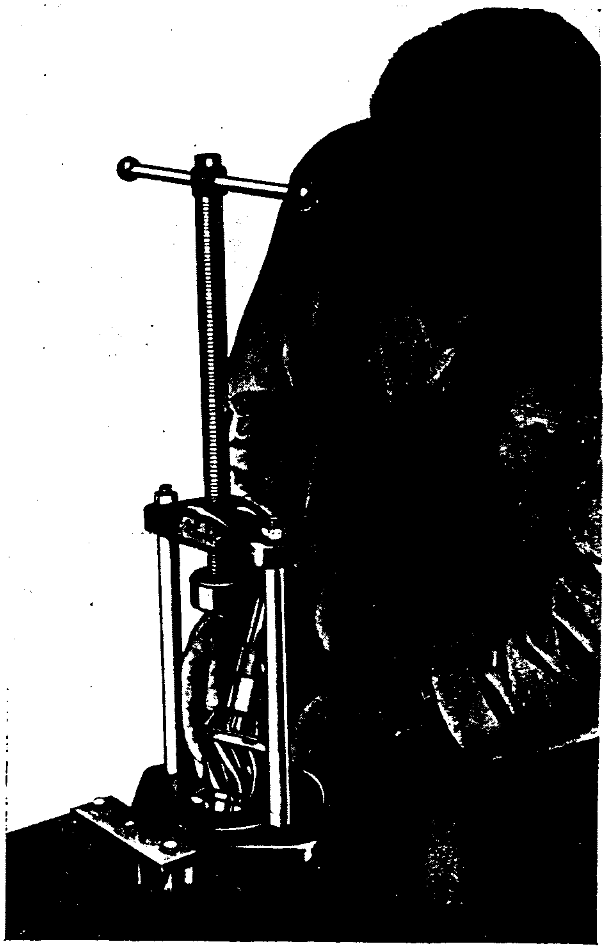


FIG. 17

Rear :—

Mount pinion in Service Fixture FT. 4221 using adaptor plate Code 3 over pressure plate Code 2 to replace bearing, as shown in Fig. 18.

Front :—

After replacement of rear bearing, mount pinion shaft in sleeve (40) place bearing (43) over shaft (37) and press into position by tightening lock-nut

(45) on to thrust washer (44) until shaft is free to turn with no end float.

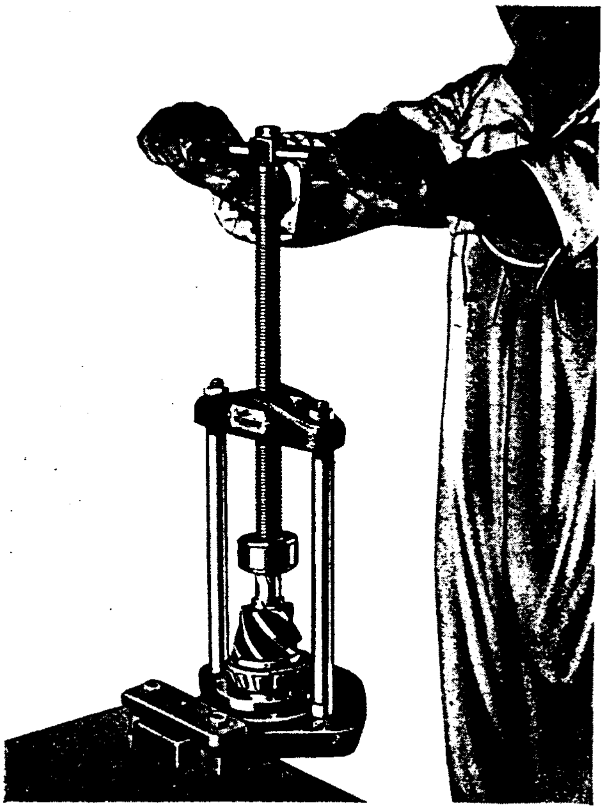


FIG. 18

Replace lock washer (46) and lock nuts (45) bending back tabs of former sufficiently into slots to secure.

Note.

Pilot bearing bush can, if necessary, be removed from pinion nose by use of a drift, after removal of retaining circlip. To replace, press into position and secure by circlip.

Thrust Bearing Cups.

After removal of pinion (37) from sleeve (40), cups (42) can be withdrawn and replaced as shown respectively in Figs. 19 and 20, using Service Tools FT.23 and FT24.

Pilot Bearing. (Refer to Fig. 12).

Removal :—

1. Remove differential and pinion assemblies. See pages K.6. and K.10.

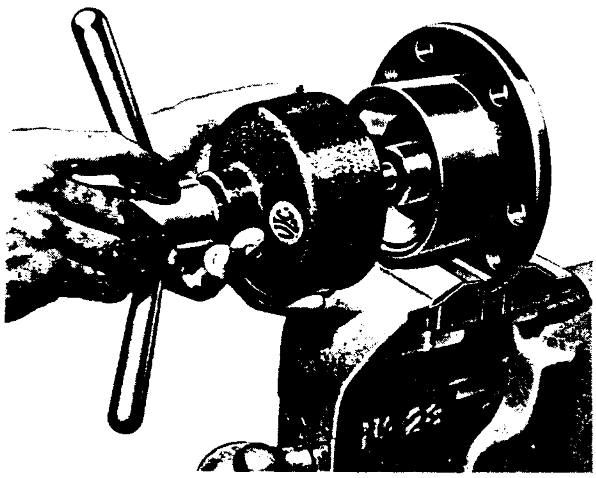


FIG. 19

2. Remove oil trough (47)—two castellated nuts with cotter pins.

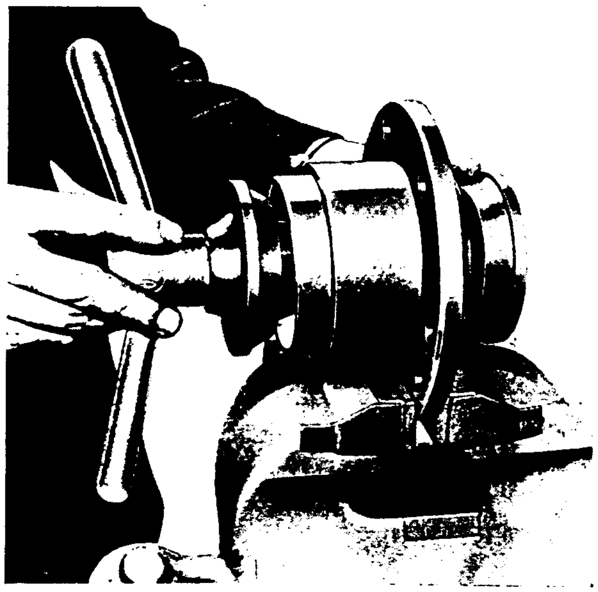
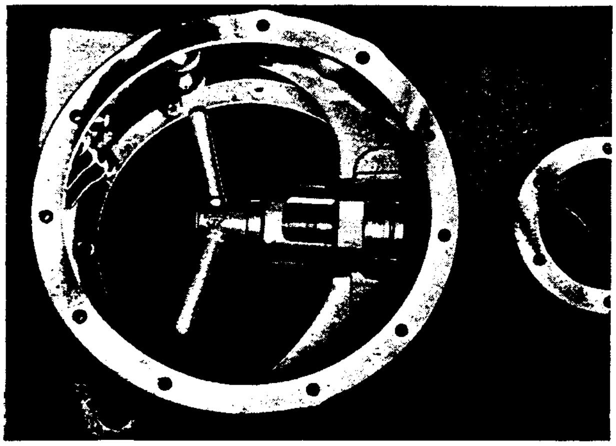


FIG. 20

3. Withdraw bearing (36) to rear, using puller FT.20, with suitable adaptor as shown in Fig. 21.



Replacement :—

This is a reversal of the instructions given for removal, the bearing being entered in the same direction as for removal, i.e. from front to rear.

REAR AXLE AND HUBS

The following modifications have been incorporated in the rear axle and hubs. In these instances, where the alterations affect servicing procedure, further instructions have been added.

At Tractor serial number, 325001 a modified tractor rear axle assembly was incorporated.

INTERCHANGEABILITY

In principle, the new design was similar to the previous Axle Assembly and, as the complete assembly will completely interchange, the centre housing to transmission case mounting flange was unaltered and the original drive shaft assembly would mate directly with the splines of the new driving pinion. It will, however, be necessary to replace the hand lift fork assembly of the hydraulic control valve — the set of the bottom forks having been slightly modified to avoid fouling the pinion front bearing under shock loading conditions.

COMPARATIVE SPECIFICATION

Crown Wheel and Pinion :

The driving surface of the teeth was lengthened, thereby increasing the outside diameter of the crown wheel from 12.66" to 13.15" (32.14 to 36.99 mm.). The number of teeth, however, was unaltered and the final drive ratio remains at 6.66 : 1.

The mounting flange for the pinion sleeve assembly was identically situated in the centre housing. This position was maintained by slightly reducing the distance between the two driving pinion thrust bearings — which were themselves unchanged and by locating both bearings further forward, thereby restricting the travel of the hydraulic control fork—hence the fork modification.

The pinion pilot bearing was a complete roller bearing unit without a retaining circlip, rearward movement being prevented by the bracket of the oil trough.

The material of the new crown wheel and pinion was E.N. 355 as before, and bolts were used for securing the crown wheel.

Centre Housing :

To accommodate the larger diameter crown wheel, the diameter of the housing was accordingly enlarged and the number of fixing studs for the axle housing increased. The width, distance from the centre line of axle transmission case flange, the flange mountings for the hydraulic pump base and lift cover were unaltered.

Rear Axle Housing :
Trumpet diameters were increased to conform with the centre housing to accommodate the larger diameter crown wheel. The location for the differential bearings, however, was as the previous designs.

Interchangeability of brakes and wheels was not affected, but hub bearings are grease lubricated, with nipples provided for maintenance and an inner oil seal was added inside the axle housing. The oil catchment ring fitted adjacent to the bearing was, therefore, no longer required.

Thrust Block and Oil Trough :
These items were modified to suit the strengthened design but were otherwise similar in principle and application.

Lower Link Plate and Shaft Assembly :
The link plate was replaced by a boss integral with the axle housing and the link shaft fitted directly into the housing, with taper fitting to prevent oil leakage and was retained internally by a Simmonds Nyloc Nut.

Axle Shafts :
The top diameter of the splines was increased but the shaft was otherwise unaltered and the size of the bearings and their location was identical to the previous design.

Gears — Differential :
The new gears have strengthened teeth and the number of teeth reduced from 20 to 16. Bearing areas are increased.

Pinion — Differential :
Teeth strengthened and the number of teeth reduced from 11 to 10, the spherical radius enlarged and the bearing area for thrust washers increased.

Spider — Differential :
4 star, as previous design, but pin length increase by 1" on diameter. Previous design had pins drilled through centre for lubrication purposes but this feature was not incorporated in the new design.

Case — Differential :
Case is modified accordingly to suit these alterations.

DATA

Crown Wheel and Pinion Backlash :	.008" — .011" (.3150 — .4331 mm.)
Half shaft End Clearance :	.088" — .010" (.3150 — .3937 mm.)
Crown Wheel and Thrust Pad Clearance :	.013" — .020" (.5118 — .7874 mm.)
Driving Pinion Thrust Bearings Preload ;	20 lbs./in. (22.93 kgs./cm.) (when new)
	10 lbs./in. (11.46 kgs./cms.) (after service)

CROWN WHEEL AND PINION

The crown wheel and pinion are a matched pair and carry identification numbers. The number on the crown wheel is etched between two of the fixing bolt holes and on the end face of the pinion. These numbers must always agree.

The date of manufacture is also etched on the inside face of the crown wheel adjacent to the identification marking.

CROWN WHEEL NUTS

The torque loading specified for the bolts securing the crown wheel to the differential casing is determined by the nut size.

.688"/.675" across the flats — 80/90 lbs./ft.
(17.4/17.1 mm.) (11.06/12.44)
.750"/.730" across the flats — 90/100 lbs./ft.
(19.1/18.6 mm.) (12.44/13.82)

Before tightening the crown wheel bolts, the size of nut should be measured and the appropriate torque applied. Only one hexagon size nut should be used for any one crown wheel.

SPECIAL SERVICE TOOLS

Upon the introduction of the modified rear axle. certain special tools were revised to accommodate design changes.

The application and use of these tools is basically identical to the instructions contained on Pages K4 — K13 under the appropriate headings.

MODIFIED REAR AXLE TOOLS

FT. 9 10. Differential Housing Holder Adaptor and Bench Plate :

The original FT. 9 is suitable for use on one operation on the modified axle but a new additional Adaptor, FT. 9 M., is necessary when handling the reverse side of the modified axle.

This tool is known as FT. 9 M. Differential Housing Holder Adaptor.

FT. 23. Drive Pinion Bearing Cup Remover :

A new set of pegs is necessary to modify this tool. The new pegs are easily inserted. A set of 4 PT 4 Pegs for FT. 23 should be ordered.

This tool is known as FT. 23 A. Drive Pinion Bearing Cup Remover.

FT. 24. Drive Pinion Bearing Cup Replacer :

To modify this tool it is only necessary to add a spacing Washer, FT. 24 A.

This tool is known as FT. 24 B. Drive Pinion Bearing Cup Replacer.

FT. 26. Axle Shaft Bearing Remover :

A conversion exchange is in operation for this tool.

This tool is known as FT. 26 S. Axle Shaft Bearing Remover.

FT. 26 B Jig and Extension Drill :

A conversion exchange is in operation on this tool.

This tool is known as FT. 26 C. Jig and Extension Drill.

FT. 30 B. Rear Hub Bearing Cup Replacer :

The existing body casting is unsuitable for dealing with the bearing on the modified axle. A new body, Pt. No. 1 for FT. 30 B. is required.

This tool is known as FT. 30 C. Rear Hub Bearing Cup Replacer.

FT. 4221 A. Differential Bearing Cone Remover and Pinion Bearing Cup Replacer :

Two new Code rings are necessary for this tool and they are suitable for both types of axle.

New Code 1 A for removal of Transmission Crown Wheel Bearing also new Thrust Pad. New Code 2 A for removal of Pinion Bearing.

These tools are known as — New Code 1 A for FT.4221 A. Part 11 Thrust Pad for use with Code 1A. and New Code 2A. for FT.4221 A.

FT. 143. Pinion Pilot Bearing Remover and Replacer :

This is an additional ring pad and thrust button for use with FT. 4221 A. and is required for modified axles only.

FT. 12 B. Differential Bearing Cone Replacer :

This is a new tool of double-ended design suitable for both types of axle. It is not possible to convert present FT. 12 which is suitable for early axles only.

FT. 132. Rear Axle Inner Oil Seal Replacer :

This is a new tool necessary for the modified axle only.

The FERGUSON SYSTEM
TRADE MARK

Ferguson

SERVICE MANUAL

Section L

THE HYDRAULIC SYSTEM AND LINKAGE

THE HYDRAULIC SYSTEM AND LINKAGE

INDEX

HYDRAULIC SYSTEM

GENERAL DESCRIPTION (FIG. 1)

The hydraulic system actuates a mechanism which both controls automatically the depth of the implement when it is in the ground and lifts the implement for transportation.

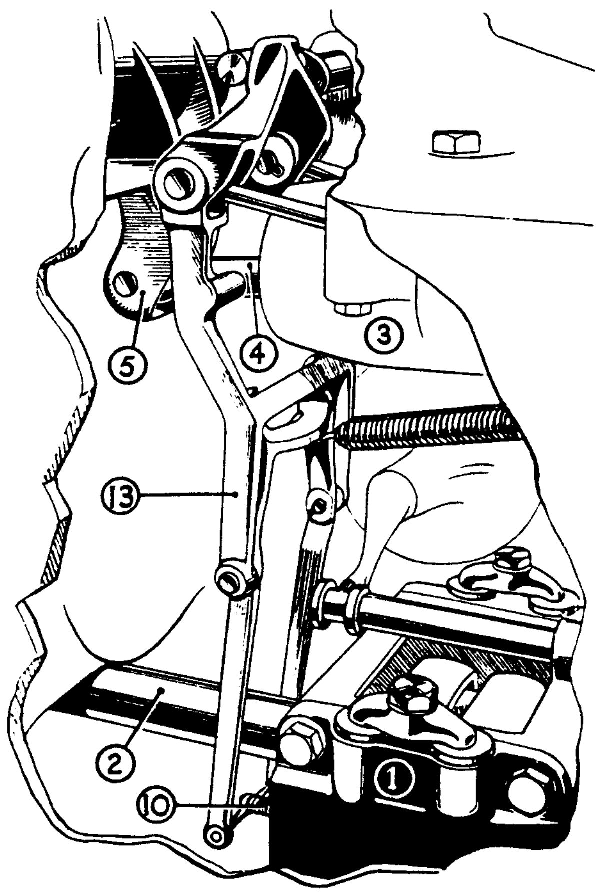


FIG. 1

It is located within and about the tractor rear and centre housing. The simplicity of the design and layout is illustrated in Figs. 1 and 2.

The system comprises a four cylinder pump (1) driven by the power take-off shaft (2) which supplies oil to a hydraulic cylinder (3). A connecting rod (4) from the cylinder engages the ram arm (5) of a lift shaft, the ends of which project from the top of the casing. Splined to each end of the lift shaft is an arm (6) to which is attached, through a universal joint, a lift rod (7) which is in turn connected to the midpoint of the lower link (8). The right hand rod is adjustable for

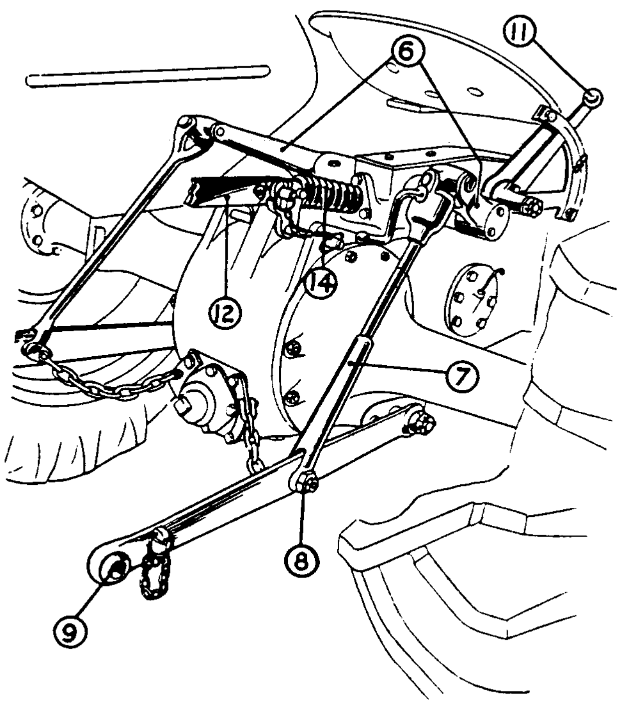


FIG. 2

length by means of a levelling lever. The implement is attached at rear ball mountings (9) to the lower links, which can pivot on their forward ball mountings at the base of the rear axle casing.

Flow of oil through the pump is controlled by a simple sliding valve (10) located in the pump assembly and operated by a lever (11) beside the driver's seat. In addition, when the tractor is drawing an implement, loads on the top link (12), connected to the top of the implement, actuate a fork assembly (13), through a control spring (14) to operate the control valve. It is this feature, in conjunction with the manual setting, which automatically maintains the implement at its correct depth.

In operation this system is exceptionally simple and trouble-free, and no maintenance or adjustment is normally required throughout a long period of service, apart from ensuring absolute cleanliness of the assemblies and the use of scrupulously clean oil of the correct grade. The importance of cleanliness cannot be overstressed, as almost every fault can be attributed to the presence of foreign matter.

PUMP DRIVE COUPLING

(FIG. 3.)

The hydraulic pump is located behind the transmission assembly and carried in the rear axle centre housing. It is driven by

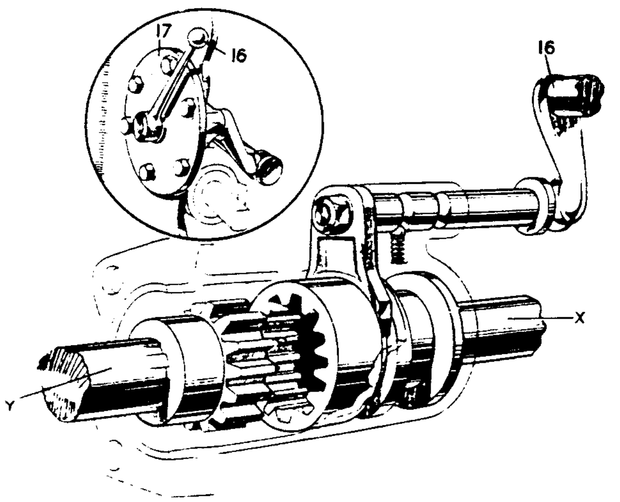


FIG. 3

the power take-off shaft (X) which is connected at the front end by a sliding coupling to the transmission countershaft (Y) and extends to the rear of the rear axle casing for attachment to power driven implements. The shaft may be connected or disconnected by the sliding coupling, actuated by a lever (16) mounted on the left-hand inspection plate (17). When the lever is towards the rear, the power take-off shaft is engaged.

Note :—

A full description of the operation of both the power take-off shaft and the sliding coupling, together with service instructions for dismantling and assembly with the use of special Service Tools will be found in section M—" Power Take-off Shaft."

FUNCTION OF THE HYDRAULIC PUMP

(FIG. 4)

The power take-off shaft (2) passes through two cams (18) which rotate in cam blocks and impart horizontal movement to piston assemblies (19). Secured on either side of the pump body and located by a dowel is a valve chest assembly (20) fitted with two pairs of inlet and outlet valves and springs, mounted on valve guides (21). The valve chamber is closed above each assembly by a plug retained by a clamp (22).

A check valve (23) prevents any back pressure reaching the pump; and a pressure relief valve (24) operates if a pressure of 2,000 lbs. sq. in. (1,500 lbs. sq. in. on earlier tractors) is exceeded in the hydraulic system. This would be caused by attempting to lift a load of more than 800 lbs. (600 lbs. on earlier tractors) at the point of implement attachment, or by trying to lift an implement caught beneath an obstruction.

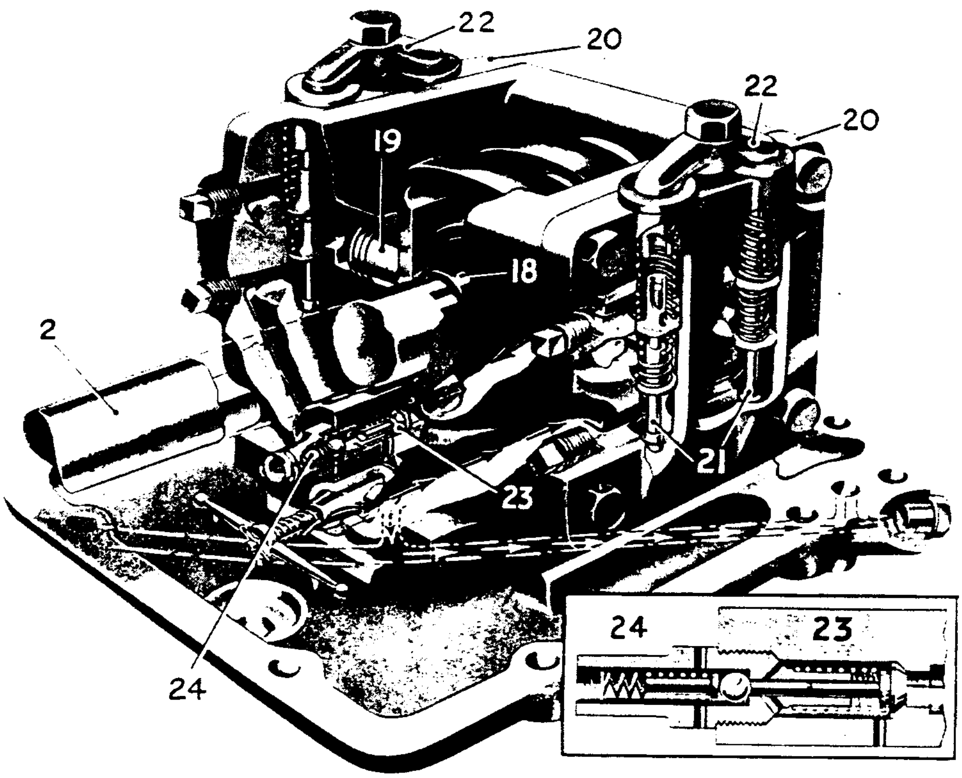


FIG. 4

CONTROL VALVE (FIG. 5)

Flow of oil through the pump is controlled by a simple sliding valve, mounted at the rear of the assembly. This valve is operated both by the hand control lever and by the action of the top link, connected to the implement through the control spring. When the control valve is positioned centrally no oil can pass either into or out of the pump or the hydraulic cylinder. When it is pushed inwards, oil is drawn in by pistons and is fed to the hydraulic cylinder, thereby lifting the implement; when it is drawn outwards the inlet passages are closed and the oil is allowed to drain away from the cylinder, lowering the implement.

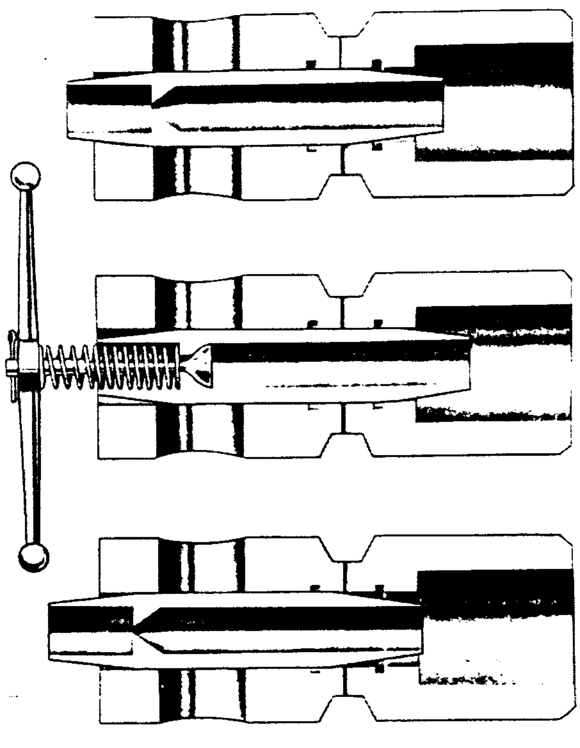


FIG. 5

CONTROL VALVE BUSH (FIG. 6)

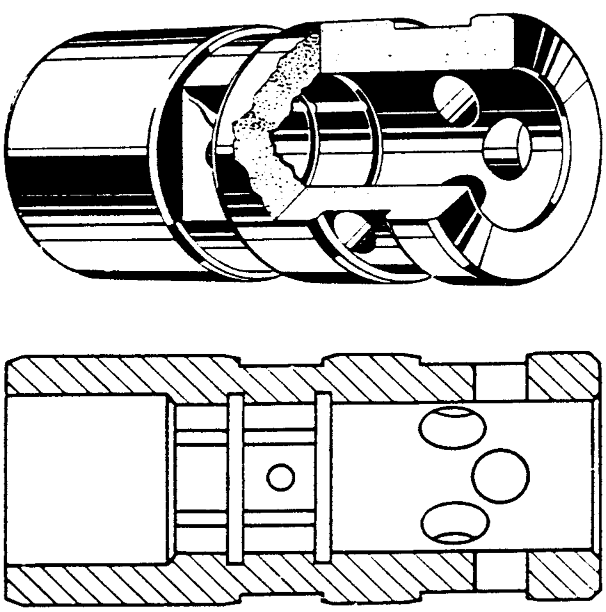


FIG. 6

The two annular and four longitudinal grooves are cut in the bush to provide lubrication for the valve and to prevent "sticking." When an implement is at rest in the "up" position, or being raised, oil under pressure is directed through the outlet ports on to the valve body.

The inter-section of the annular and longitudinal grooves, limits the valve area which can be presented to high pressure oil, relief being obtained through the grooves before an excessive pressure has been built up.

OIL CHAMBERS AROUND CONTROL VALVE BUSH

(FIG. 7)

CIRCULAR CHAMBER A.

When lifting the implement, oil drawn into pump cylinders by pistons, passes through inlet ports of control valve bush, through Chamber A, and into passages cast diagonally in the pump body.

CIRCULAR CHAMBER C.

Oil is next forced from pump cylinders into Chamber C. The only outlet for the oil from this chamber leads upwards and rearwards past the check valve to Chamber B and the pressure relief valve.

CIRCULAR CHAMBER B.

Oil coming from Chamber C via the check valve enters Chamber B through an opening at the top and leaves through a hole at the bottom towards the hydraulic cylinder (control valve in "lift" position closing outlet ports in valve bush).

When lowering the implement, oil under pressure returning from the hydraulic

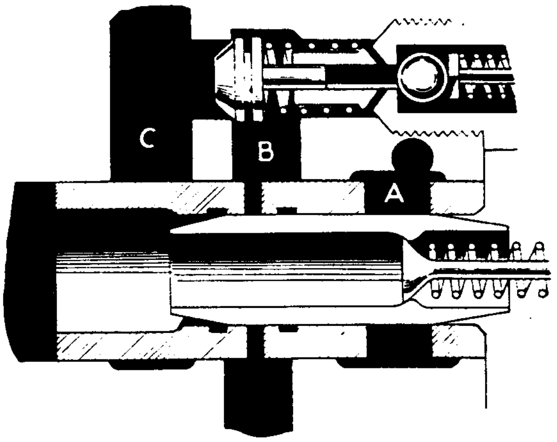


FIG. 7

cylinder enters Chamber B through the bottom hole, holding closed the check valve to Chamber C, and leaving through outlet ports on the valve bush to reservoir (control valve out to "lower" position opening outlet ports in valve bush).

ACTION OF THE PUMP *(See Figs. 7 and 4)*

Oil from Chamber A in the pump body enters drilled horizontal passages which connect the two valve chambers in each valve chamber assembly. In each case the horizontal passage is located just below the inlet valves and serves as a common chamber from which oil is drawn into the two cylinders on that particular side of the pump.

As one of the pump pistons moves out of its cylinder it creates suction in that cylinder. This suction lifts the inlet valve from its seat and draws oil past this valve and into the cylinder. During this inlet stroke the outlet valve is held closed by suction from the piston, the outlet valve spring, and the pressure of the oil above it. At the instant the piston reaches the end of its inlet stroke, the inlet valve is closed by the pressure of the inlet valve spring.

As the piston starts to travel back into the cylinder, the resultant pressure on the oil keeps the inlet valve closed and lifts the outlet valve. This pressure forces the oil past the outlet valve and the horizontally drilled passage which is located just above the outlet valves in the valve chamber assembly. This upper horizontally drilled passage serves as a common outlet for the oil being pumped by the two pistons on that side of the pump.

The above action, as described for one cylinder only, is completed for that cylinder each time the P.T.O. shaft makes one revolution. The other three cylinders are working in the same manner so that there are four uniformly spaced impulses of oil from the pump assembly for each revolution of the P.T.O. shaft.

CONTROL MECHANISM

TO LOWER IMPLEMENT (FIG. 8)

The control valve (10) is actuated by a hand control fork assembly (25) which is operated by the hand control lever (11). Forward movement of the lever causes the fork to end of the fork to pivot against the tension of the fork retracting spring (26).

With the implement in the ground,

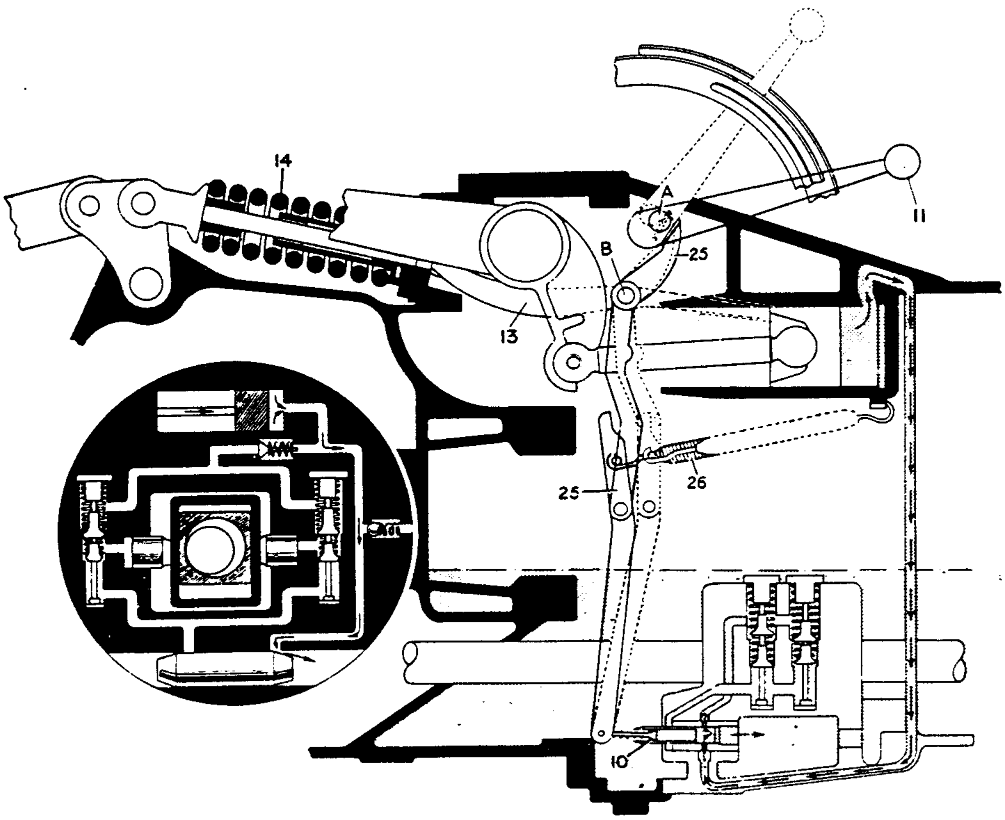


FIG. 8

pivot about connection B on the control spring fork (13) and to withdraw the control valve. It will be seen that withdrawing the control valve allows the oil to flow away from the cylinder, when the implement weight forces the piston forward, so lowering the implement. The amount the valve can be withdrawn is limited by the lower ends of the fork contacting the centre axle housing, from which point further movement of the control lever causes the lower forward movement of the tractor causes a forward pressure, set up at the top of the implement, against the control spring (14) pivoting the hand control fork about control lever shaft at point A. The implement will continue to penetrate until the pressure against the control spring moves the control spring fork and, with it, the hand control fork and valve sufficiently to bring the valve to the central position. While this state of balance is maintained, the implement position remains constant, but should the tractor pitch or fall, the pressure on the control spring varies, alters the position of the control valve, and maintains an even implement depth irrespective of the tractor movement. The pressure required against the control spring to reach this state of balance will progressively increase according to the distance forward that the hand control lever has been moved. Implement depth is therefore dependent on the setting of the hand lever.

TO RAISE IMPLEMENT (FIG. 9)

Rearward movement of hand control lever (11) allows hand control fork (25) to pivot about point B on control spring fork (13) under the action of fork retracting spring lift arms (6), thus raising the implement.

Pump shut-off is obtained when the skirt of the piston protrudes far enough out of the

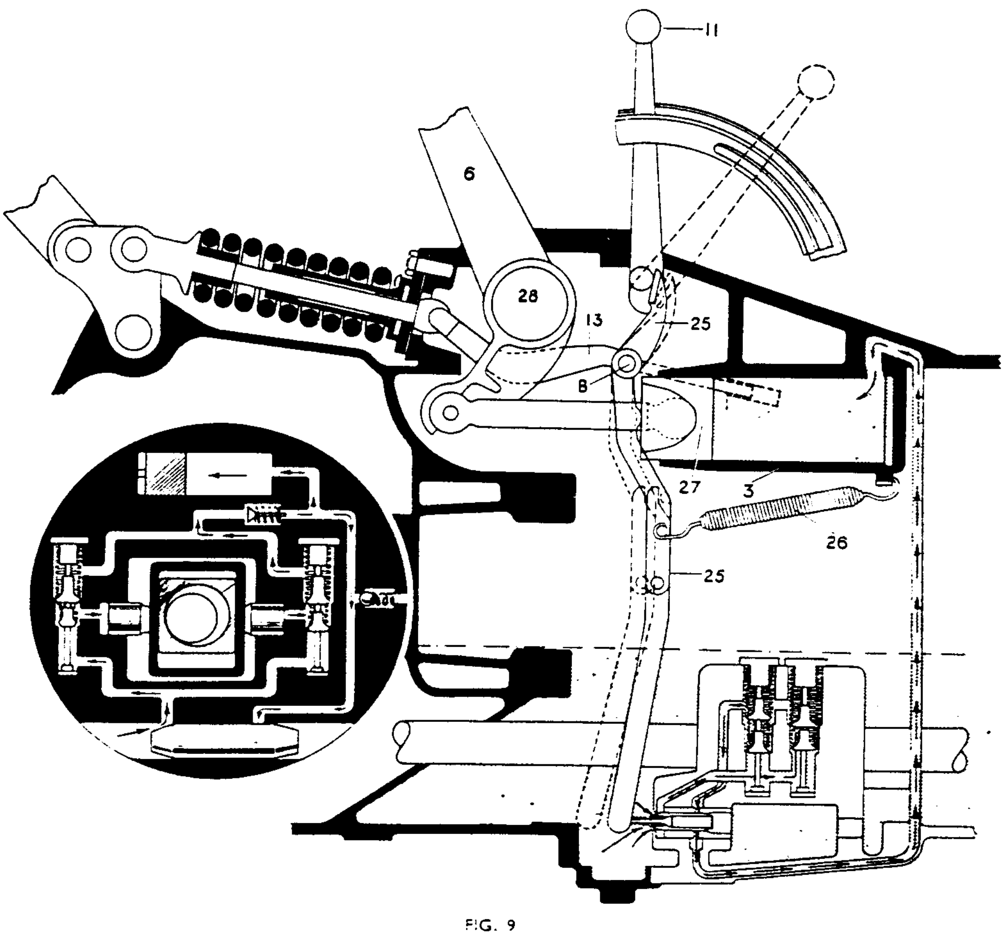


FIG. 9

(26) so pushing the control valve to the "lift" position. Oil is pumped into hydraulic cylinder (3) moving piston (27) along cylinder and turning lift shaft (28) with cylinder to bear against lugs on the hand control fork, pivoting it about point B until the control valve returns to the central position.

SAFETY DEVICE (FIG. 10)

Excessive forward movement of the control spring fork (13), which occurs if the implement meets an obstruction causes control fork moves the control valve out to the "drop" position. This relieves the effective weight of the implement from the

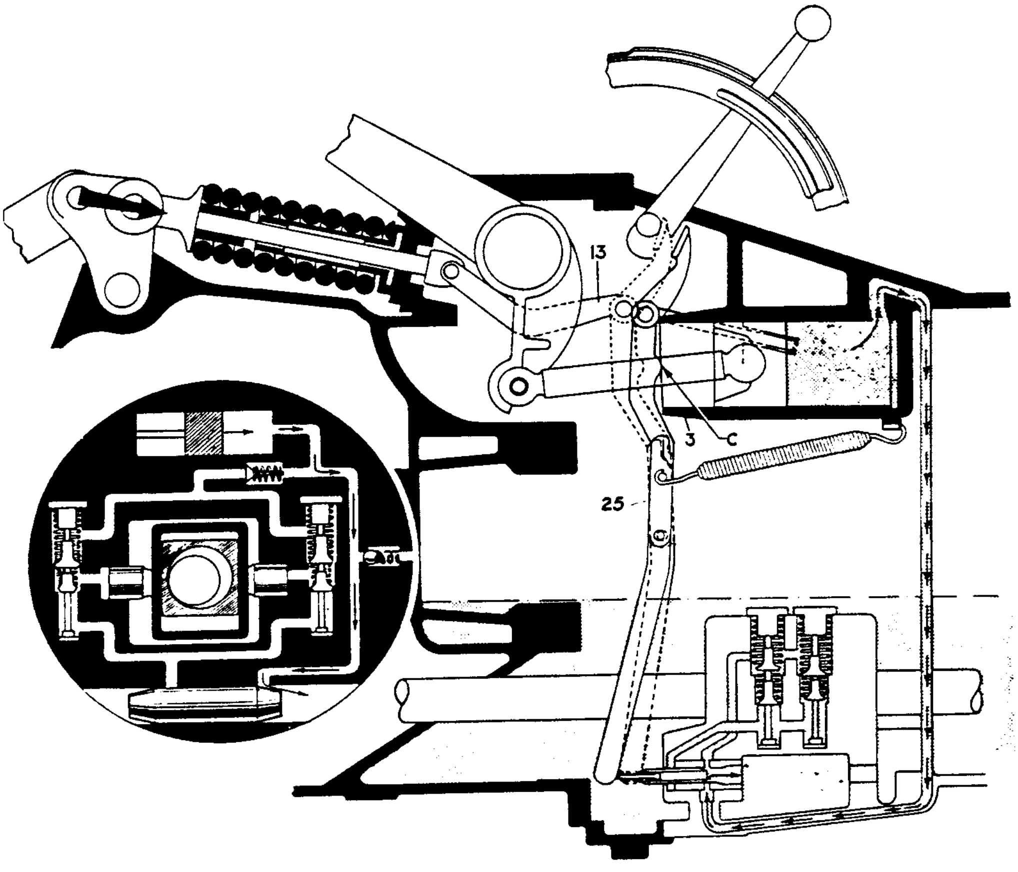


FIG. 10

the lugs on the hand control fork (25) to strike the skirt of the hydraulic cylinder (3) and pivot about point C. Thus the reverse movement at the lower end of the hand tractor rear wheels which thereby lose traction and the tractor stops with rear wheels spinning, without damage to the implement.

THE HAND CONTROL FORK

It will be seen that the pivoting action of the lower end of the hand control fork is an important feature in the design of the automatic depth control and setting of the implement. The hand control fork linkage is so designed that a small movement of the control spring fork can produce a comparatively large movement of the control valve. This ensures sensitive operation of the control valve.

If the hand control fork were a rigid structure the control lever range would be limited by the travel of the control valve. The pivoting action of the lower end of the fork when the control valve is withdrawn to its limit (*i.e.* when the fork end butts against the centre axle housing) ensures a wider range of control lever movement, besides preventing damage to the fork mechanism when the overload release is in operation.

TO REMOVE HYDRAULIC PUMP

Drain oil from transmission housing and rear axle centre housing by removing all three drain plugs.

NOTE :—By dropping the tractor front wheels about 12—15 inches into a depression it is possible to drain the oil sufficiently far forward to enable the power take-off shaft to be withdrawn and minor service operation to be carried out to the control valve or safety valve assembly.

1. (*See Fig. 11a*) Remove both inspection plates from the sides of the transmission housing, disconnecting the power take-off lever when removing the left plate.

2. (*See Fig. 11b*). Take out the four bolts retaining power take-off shaft housing to rear axle housing and withdraw shaft complete.

NOTE :—Since the power take-off shaft is withdrawn, the Safety valve assembly and control valve may be removed without removing the pump assembly from the tractor.

3. (*See* Fig. 11*c*). By working through inspection plate opening, disconnect hand control fork and remove the control valve. The hand control lever should be in the " lift " position. The lower ends of the fork are sprung on to the ends of the control valve assembly.

4. (*See Fig. 11d*). Push control valve forward to its limit. Remove bolts retaining the pump assembly and draw assembly to the rear before gently lowering. This will prevent the pump body from fouling the power take-off shaft bearing support. The tube connecting the pump base to the hydraulic cylinder requires no attention and should not be removed from the rear axle centre housing.

Fig. 11 A

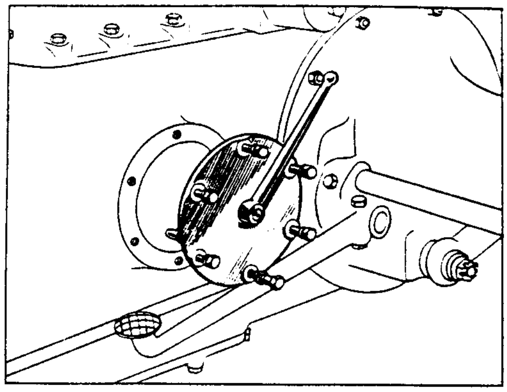


Fig. 11 B

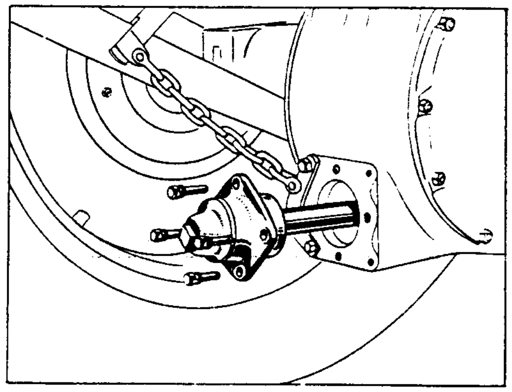


Fig. 11 C

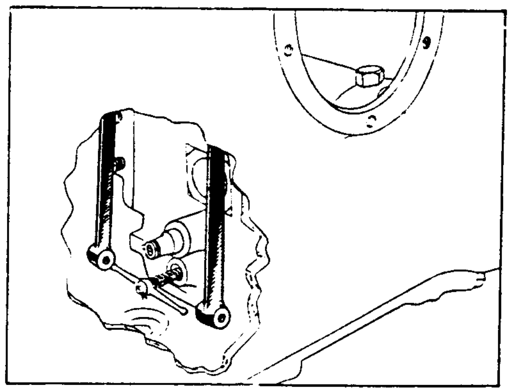
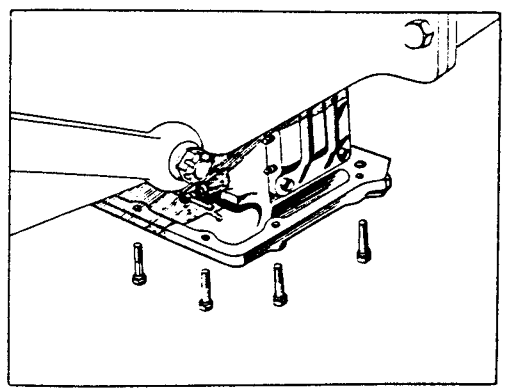


Fig. 11 D



TO DISMANTLE HYDRAULIC PUMP

(FIG. 12)

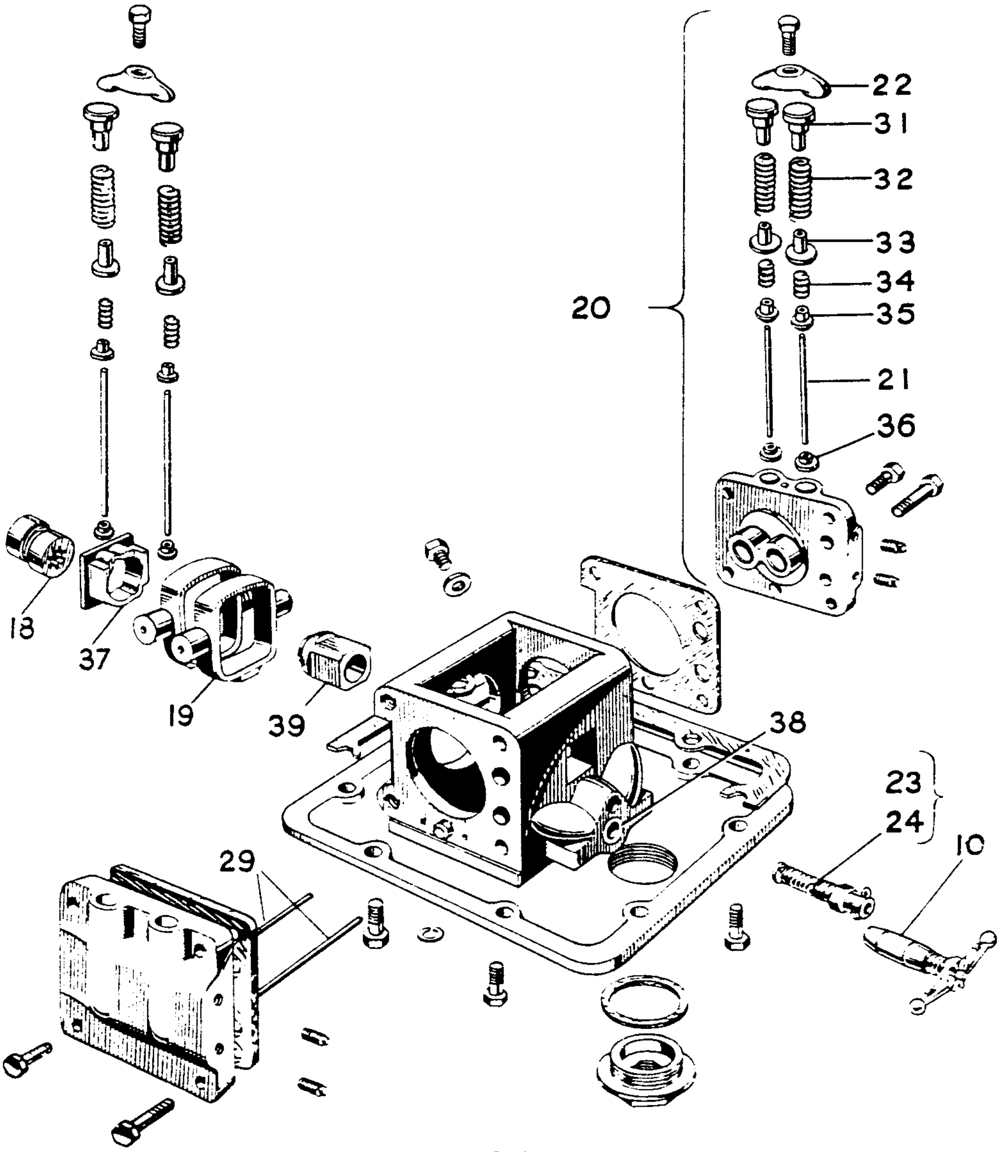
1. Remove valve chamber assemblies (20) and gaskets.

2. Withdraw piston steady rails (29).

3. From each assembly remove the clamp (22), plugs (31), outlet valve springs (32), outlet valves (33), inlet valve springs (34), inlet valves (35), valve guides (21) and valve guide sockets (36).

4. Lift out pistons (19) cams (18) and cam blocks (37).

5. Withdraw power take-off shaft bushing (39) from its square locating hole in the pump body.



As the safety valve assembly, comprising pressure relief valve (24) and check valve (23), and the control valve (10) will have already been removed, the final step in the dismantling of the hydraulic pump is the removal of the control valve bush (38).

TO REMOVE AND REPLACE CONTROL VALVE BUSH

FIGS. 13, 14 AND 15

REMOVAL.—The control valve bush is a press fit in its locating passage in the pump body, and can be removed by gently

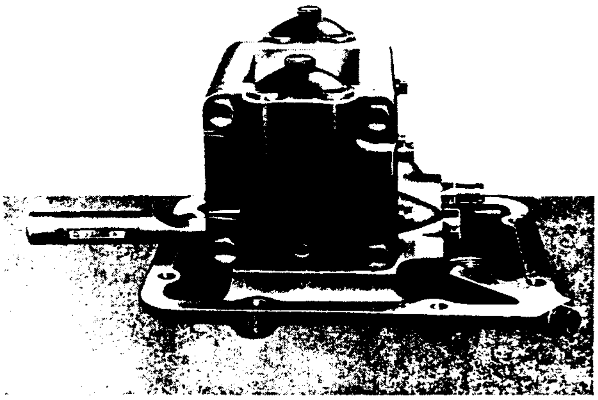


FIG. 13

driving out, using special tool FT.21A—Control Valve Bush Driver—as shown in Fig. 13.

REPLACEMENT.—The press fit of the control valve bush in its locating passage in

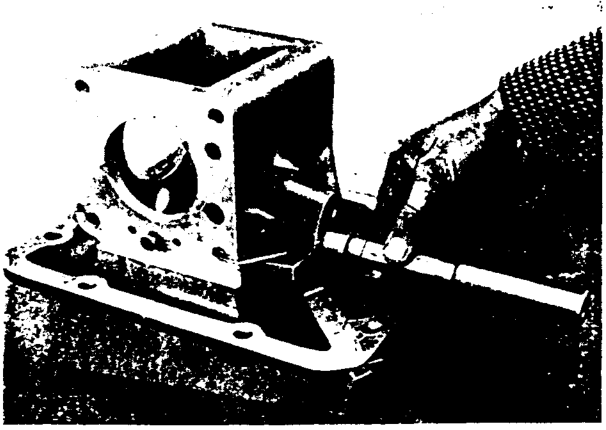


FIG. 14

the pump body must be tight enough to secure it firmly in position, yet not so tight that its bore is distorted sufficiently to cause sticking of the control valve.

Before replacing a control valve bush, or fitting a new one, the bore of the locating passage in the pump body must be checked, using the GO NO-GO gauge, as shown in Fig. 14.

(*a*) If the "GO" gauge only can be inserted, the bush may be fitted.

(*b*) If the "NO-GO" gauge cannot be inserted, the bore of the bush locating passage should be scraped until condition (*a*) applies. Engineers' blue should be applied to the gauge to indicate high spots.

(*c*) If the "NO-GO" gauge can be inserted, and is found to be a slack fit, the base assembly should be renewed.

(*d*) If, on the other hand, the "NO-GO" gauge is found to be a firm fit, the bush may be inserted, and the pump re-assembled.

Having checked the fit, replace the control valve bush, using special tool FT.21B—Control Valve Bush Replacer—as shown in

Fig. 15. The oil holes in the bush are correctly positioned when the flange of the bush replacer is hard against the machined face of the pump body.

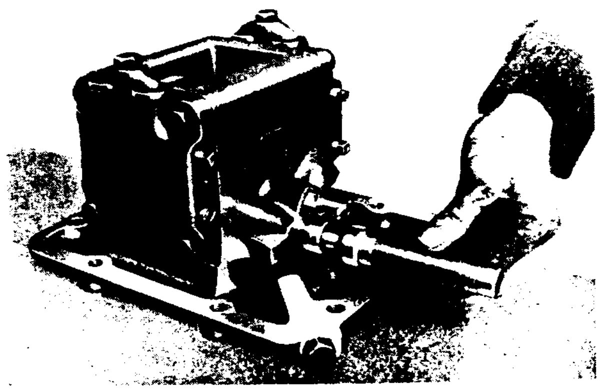


FIG. 15

TO RE-ASSEMBLE HYDRAULIC PUMP (*See Fig. 12*)

1. Insert piston steady rails (29), after checking for straightness.
2. Replace power take-off shaft bushing (39), cams (18), cam blocks (37) and pistons (19).

NOTES :—Place cam blocks together with the flanged sides adjoining and ensure that the pistons are correctly positioned on the steadies.

The steady rails are not fitted to earlier pump assemblies.

3. Replace control valve.
4. Replace safety valve assembly, comprising check valve (23) and pressure relief valve (24).

NOTE :—It is possible to carry out operation 3 and 4 after the pump assembly has been refitted to the tractor, before replacing the power take-off shaft.

5. Rebuild and replace valve chamber assemblies (20). These assemblies are rebuilt in the opposite order to that laid down in "To Dismantle Hydraulic Pump." Examine gaskets and renew where necessary.

TO REPLACE HYDRAULIC PUMP

Replace pump using reverse method outlined in "To Remove Hydraulic Pump."

After replacing the pump, insert control valve, reconnect the control fork to the control valve and check for freedom of movement by operating the hand control lever.

Replace inspection covers and refill with clean oil.

NOTE :—Care should be taken, when inserting the pump **with control valve in position,** to ensure that this valve is pushed fully home in its bush, thus preventing damage to the ball ended cross bar by the control fork or transmission casing.

TO REMOVE LIFT ASSEMBLY (FIG. 16)

It is not necessary to drain the transmission oil for this operation.

1. Withdraw the pins connecting the hydraulic lift arms (6) to the lift rods (7)

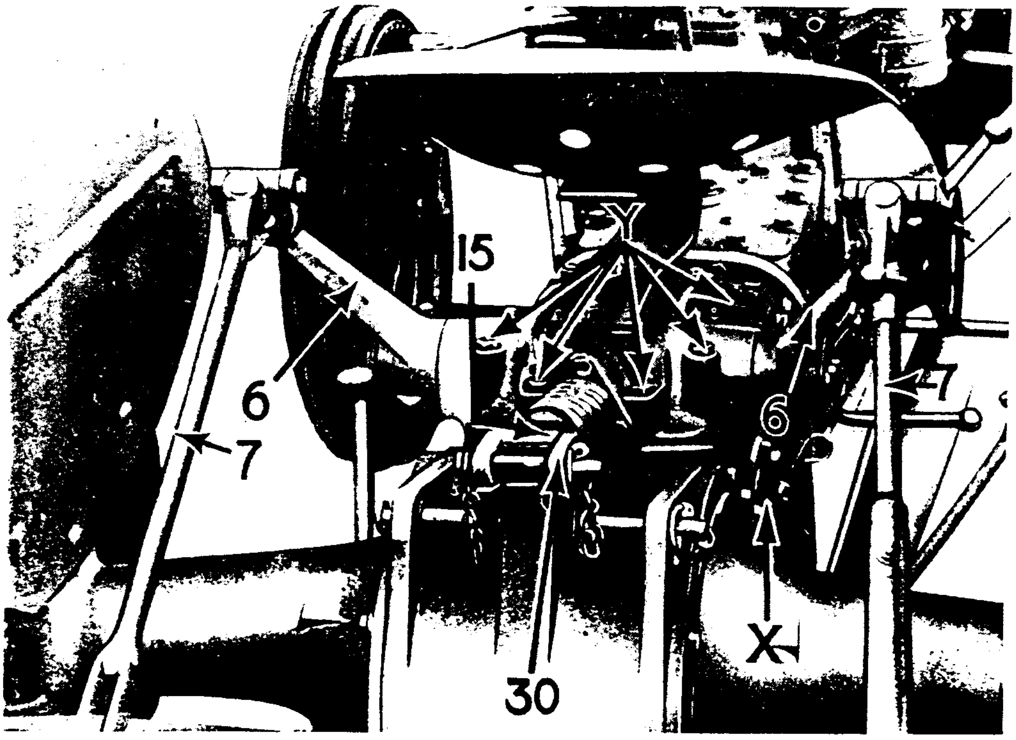


FIG 16

2. Withdraw the pin connecting the yoke (15), at the rear of the control spring, to the rocker (30) on rear axle casing.

3. Remove the inspection plate (X) from the right-hand side of the transmission housing.

4. Disconnect the hand control fork from the control valve—see "To Remove Hydraulic Pump."

5. Remove outer bolts (Y) securing the hydraulic cover to the transmission housing and lift off cover assembly.

NOTE :—It is not essential, but it is recommended that the drivers seat and seat spring assembly should be removed before lifting off the cover assembly.

TO REPLACE LIFT ASSEMBLY

Proceed in reverse order to the instructions given in "To Remove Lift Assembly."

Lubricate **all** screw threads before tightening.

TC REMOVE HYDRAULIC CYLINDER ASSEMBLY

(FIG. 17)

1. Remove lift assembly.
2. Disconnect fork retraction spring (26) from hand control fork (25) and cylinder casing.

NOTE :—The piston may be removed from the cylinder by carefully striking the open end of the cylinder on a piece of soft wood, or by holding a pressure air line against the oil inlet hole in the

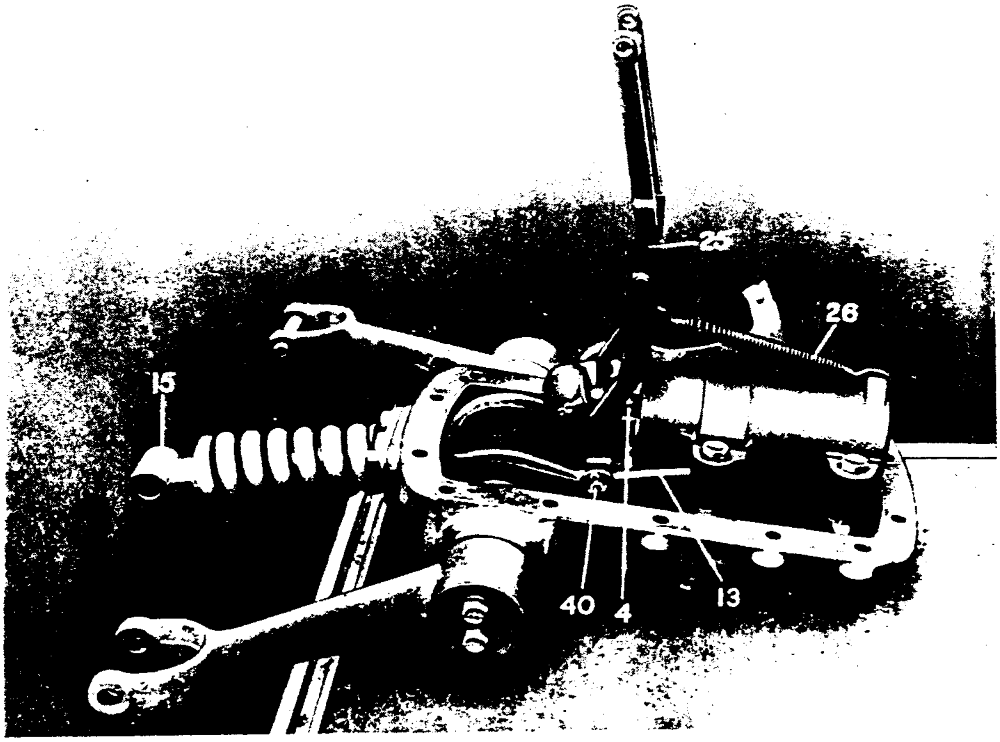


FIG. 17

3. Remove the four bolts securing the cylinder to the lift cover, and withdraw the cylinder from the ends of the control spring fork (13).

The cylinder and piston assembly can now be removed.

cylinder casing. If air is used, hold the assembly so that the piston points downwards, and increase the pressure gradually.

Clearance between cylinder and piston should be .0015"—.0025".

Piston ring gap, .010"—.017".

TO REPLACE HYDRAULIC CYLINDER ASSEMBLY

1. Carefully enter the control spring fork (13) into the holes in the cylinder casing.
2. Enter the ball end of the connecting rod (4) into the piston skirt.
3. Connect fork retraction spring (26) to hand control fork (25) and cylinder casing.
4. Replace lift assembly, lubricating **all** screws threads before tightening.

TO REMOVE LIFT SHAFT

(FIG. 18)

1. Remove lift assembly.
2. Remove the two screws (47) from one end of the shaft, and withdraw lock-washer (48) and washer (49).
3. Holding remaining lift arm (6), gently drive the shaft (28) through, disengaging the ram arm (5) and ejecting one bush (50).

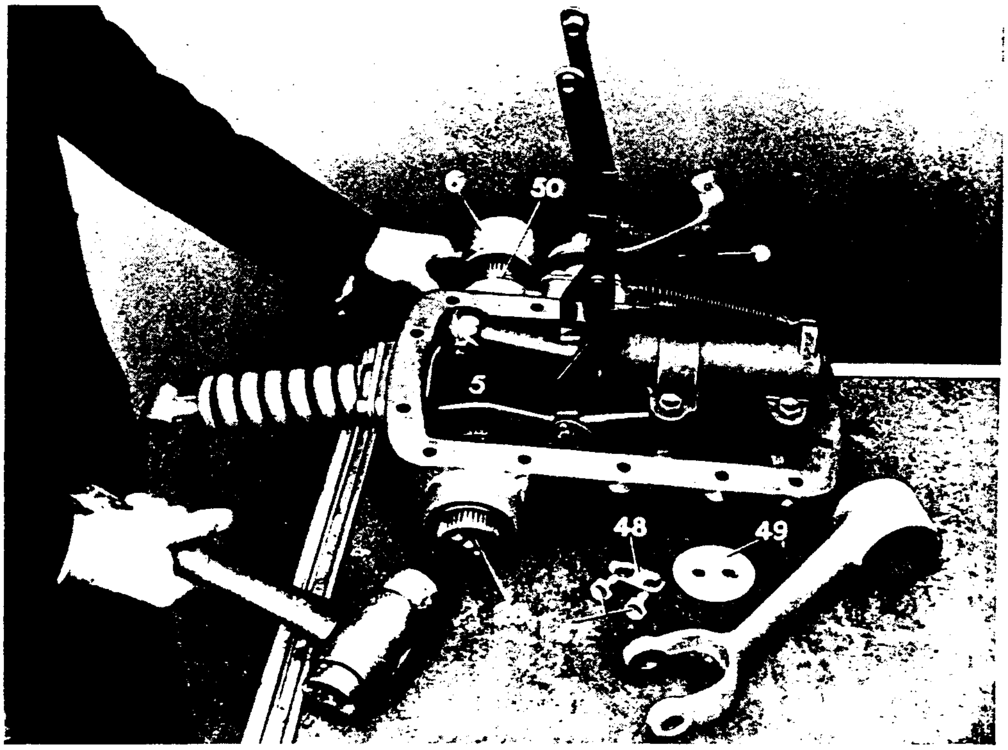


FIG. 18

4. Remove the other bush from the opposite end of shaft.

TO REPLACE LIFT SHAFT

NOTE :—The lift shaft has master splines.

1. Place ram arm (5) in position in lift cover and insert lift shaft (28)
2. Insert bushes from shaft ends.
3. Replace disc washers (49) and lock-washers (48) and tighten screws (47) evenly until the shaft is just tight.
4. Slacken screws until shaft moves freely.
5. Set lockwashers.

TO DISMANTLE FORK MECHANISM

(FIG. 19)

1. Remove lift assembly.
2. Disconnect fork retraction spring (26)

4. Detach hand control fork from control spring fork (13) by the removal of two pins (40).

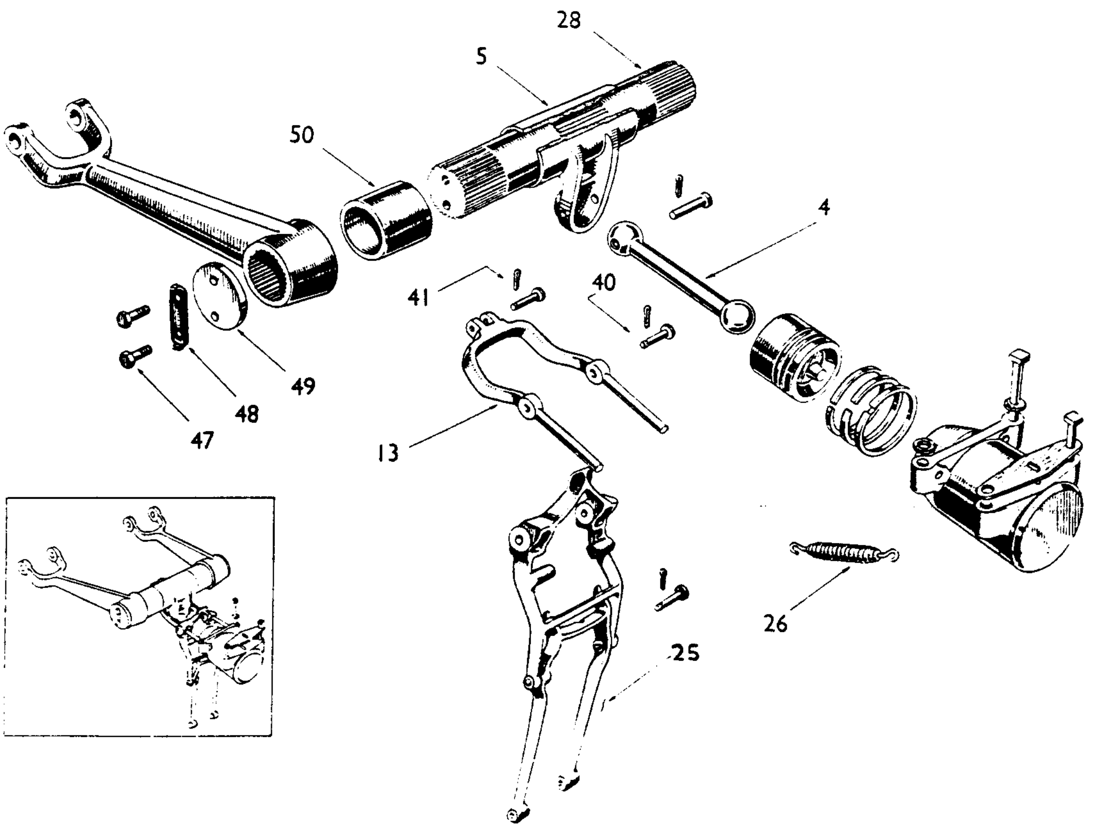


FIG. 19

from hand control fork (25) and hydraulic cylinder casing.

3. Remove hydraulic cylinder casing.

NOTE :—The control spring fork is connected by pin (41) at the rear, to the control spring assembly (see Fig. 20, item 42).

CONTROL SPRING ASSEMBLY

(FIG. 20)

The control spring plunger (42) projects through the rear of the lift cover, where a felt washer (43) is carried between the spring support (44) and cover plate (45). The support and cover plate are retained to the lift cover by three screws.

The control spring (14) is carried on the spring seat (46) and yoke (15). The control spring yoke and the plunger, on to which it threads, are supplied only as matched parts.

By unscrewing the yoke, the spring and spring seat may be withdrawn, exposing the screws retaining the seat support and felt washer.

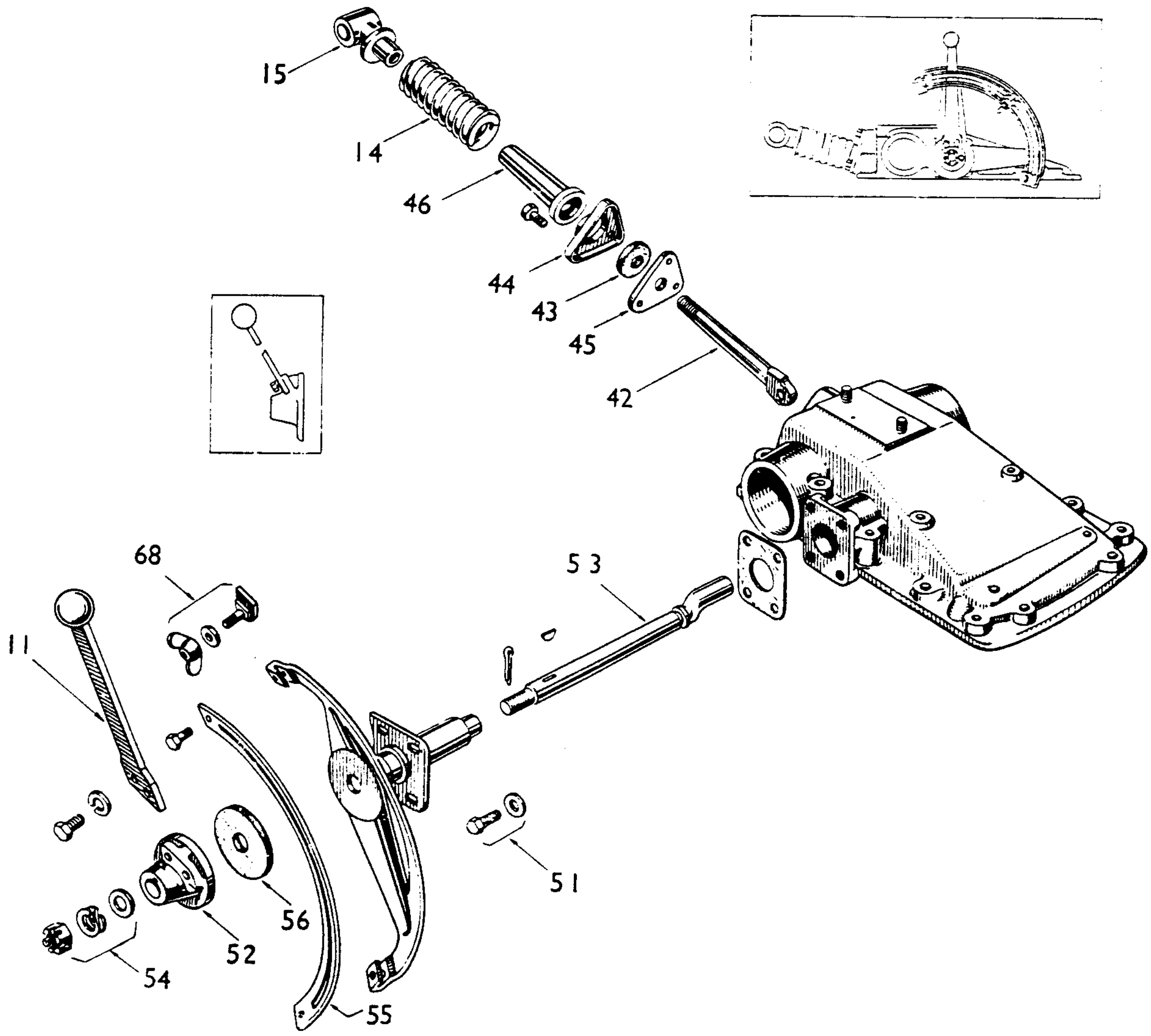


FIG. 20

CONTROL SPRING ADJUSTMENT

In all normal circumstances, it should not be necessary to dismantle the control spring assembly or to alter the delicate adjustment of the spring. If, however, the assembly has been dismantled, the spring should be reset and checked with an implement mounted and raised. Under these conditions, the spring must have not more than .020" end play.

If the amount of end play is incorrect, adopt the following procedure :—

1. Lower implement.
2. Disconnect top link.
3. Screw up yoke half a turn.
4. Reassemble top link.
5. Mount and raise implement.
6. Examine for end play.

Repeat this procedure until the correct adjustment is obtained.

TO REMOVE AND DISMANTLE QUADRANT ASSEMBLY
(FIGS. 20 AND 21)

Removal of the four screws (51) permits the complete quadrant assembly to be withdrawn.

3. Withdraw friction plate and lever.
4. Pick out Woodruff key and friction disc (56).

FIG. 21

The control lever (11) on friction plate (52) is keyed to shaft (53).

To dismantle :—

1. Remove slotted nut and washers (54).
2. Remove quadrant retainer (55).
5. Tap out shaft.

To replace :—

Proceed in reverse order, lubricating all screw threads before tightening.

CONTROL LEVER ADJUSTMENT (FIGS. 21 AND 22)

NOTE :—The settings of the control lever should be checked at intervals, with an implement mounted.

1. Mount and raise an implement.

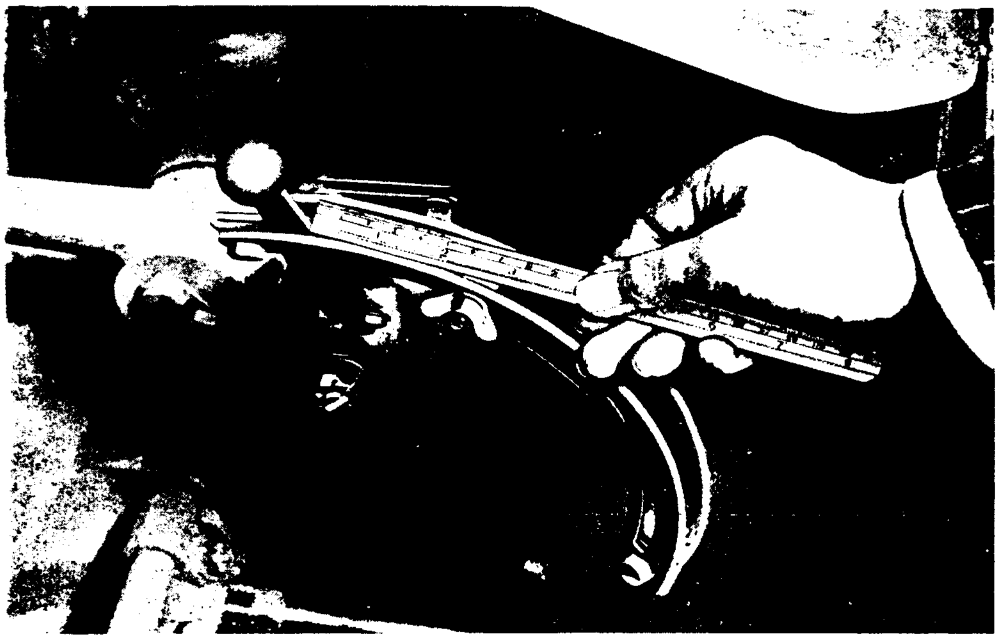


FIG. 22

2. Slacken the four screws (51) securing the quadrant to the lift cover. Note that the holes in the quadrant are elongated.
3. Set control stop (68) at exactly $2\frac{1}{4}$ inches from the rearmost setting of the control lever. (*See Fig.* 22).
4. Move the lever forward until the implement begins to lower.
5. It will probably be necessary to prise the quadrant assembly gently backward or forward until the lever is in contact with the stop at the point when lowering just commences.
6. Re-tighten screws (51) equally and re-check.

FRICTION DISC ADJUSTMENT

As friction disc (56) wears, it will become necessary to re-adjust in order that the hand control lever will remain in the selected position at work.

To adjust :—

1. Remove split pin from slotted nut (54).
2. Tighten nuts sufficiently to hold lever securely.
3. Replace pin.

If the friction disc needs to be replaced, proceed as in "To Dismantle Quadrant Assembly.

LINKAGE

LOWER LINKS

Ease of implement attachment and detachment is obtained by three point connection to the two lower links and the upper link assembly.

The lower links (8) illustrated in Figure 23 are mounted by ball joints to brackets cast on the rear axle casing and are retained by castellated nuts and split pins. They are raised and lowered by lift rods which, at the upper ends, are carried by universal joints on the hydraulic lift arms.

It is particularly important that the lower links are correctly mounted as shown in Fig. 23, with straight edges uppermost at the rear, and cut-away edges uppermost at the front. If lower links are not mounted in this manner, the upper edges may possibly foul the rear axle casing before hydraulic control valve, shut-off causing overloading of the hydraulic control mechanism.

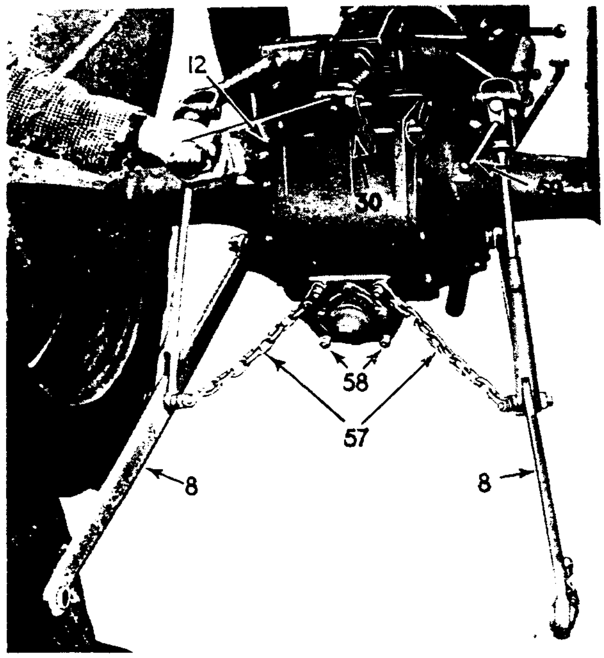


FIG 23

CHECK CHAINS

The check chains attached to each lower link and to chain anchors (58) bolted to the rear axle casing, prevent the implement from swinging sideways into the rear wheels. Twisting of these chains would limit the upward movement of the links, causing over-loading of the hydraulic mechanism. It would also restrict the ability of the implement to swing and could seriously affect its performance. Take care, too, that the chain anchors are assembled correctly, with the chain anchored above centre, as shown in Fig. 23.

LIFT RODS

The right-hand lift rod is adjustable for length, so providing control from the driver's seat of the horizontal setting of the implement. Adjustment is obtained by turning the levelling lever (59) which, through bevel gears, screws the lift rod into or out of the fork mounted at the lower end to the lower link. This lift rod is also grooved at a point, which, when in line with the top of the fork into which it screws, indicates that the two lower links are parallel.

UPPER LINK

The upper link assembly (12) mounts between the implement struts and the control spring rocker (30) above the rear axle casing. It carries to the hydraulic system a forward thrust developed by soil resistance at the implement point. Its function is, therefore, of the highest importance.

For normal operation the length of this assembly should be the minimum provided : *i.e.* 25″ (63.5 cms.) from ball centre to ball centre but it may be necessary on occasion to lengthen this slightly when certain implements are operating in difficult conditions. It is essential that this assembly is perfectly rigid and that the three bolts securing the two halves are dead tight.

The marks provided on the sections, as illustrated in Fig. 24 are in line when the link is at the minimum setting for length.

RACK (FIG. 24)

An implement adjustment rack is supplied with certain implements, such as mowers, disc harrows, etc., which is fitted to the upper link assembly. The rack is mounted as shown in Fig. 24 and it may be left in position when other implements are being used. When the top link is used on implements which do not require the rack, the link should be turned to prevent damage, so that the rack is underneath at the forward end.

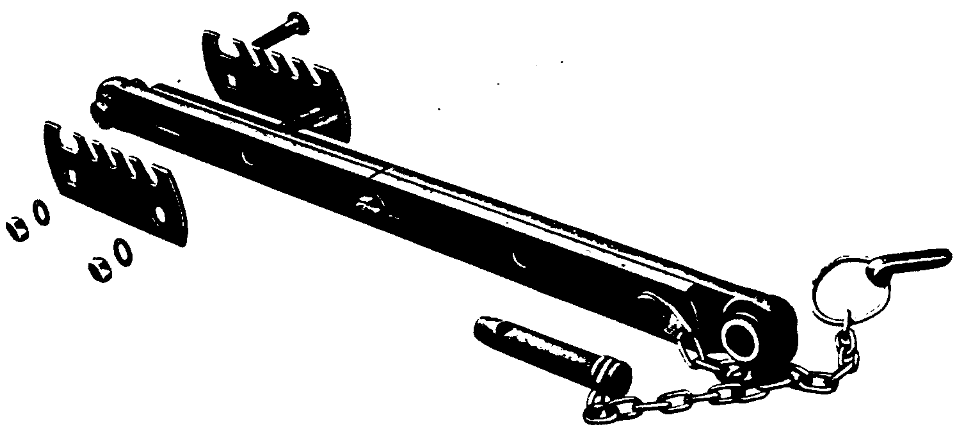


FIG. 24

LUBRICATION

Lubrication points are provided for the lift rod thread and the levelling lever gear assembly and require daily attention.

It is important that no grease or oil is applied to linkage ball joints.

TO DISMANTLE AND RE-ASSEMBLE LEVELLING LEVER ASSEMBLY (FIG. 25)

1. Unscrew right-hand lift rod from fork (60) on lower link by rotating the levelling lever (59).

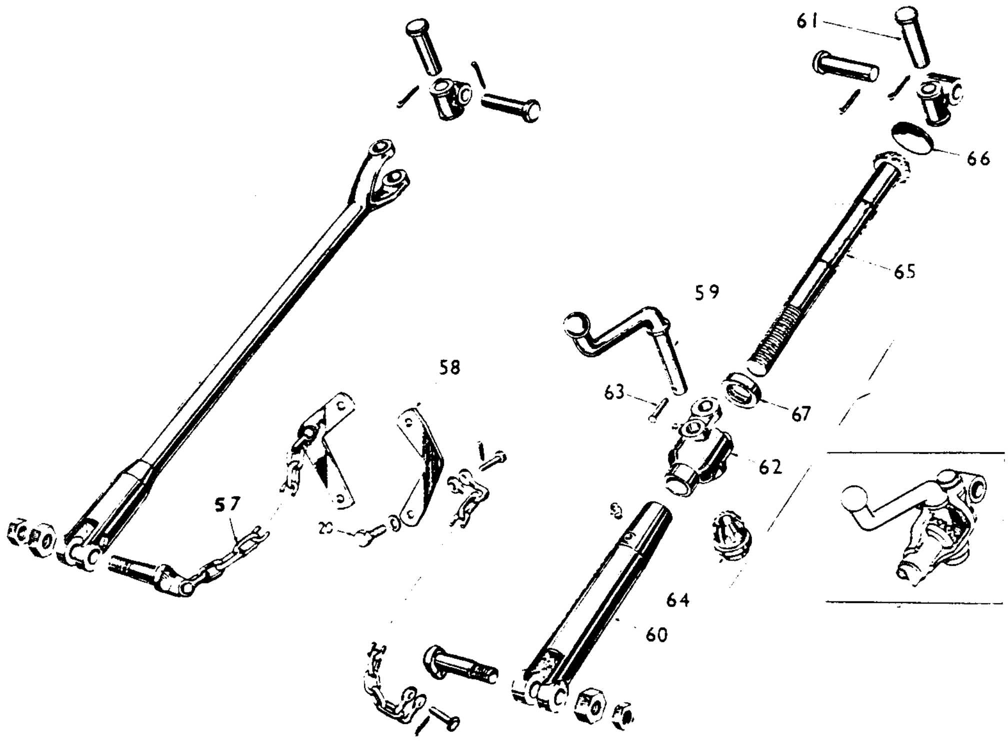


FIG. 25

2. Remove pin (61) from levelling gear box (62) and remove lift rod assembly complete.
3. Remove rivet (63) from levelling lever (59) and gently drive lever through gear (64).
4. Drive shaft (65) upwards, when the expansion plug (66) will be removed together with the bearing assembly (67).
5. Re-assemble in reverse order.

NOTE :—When servicing levelling shaft gears, care should be taken to ensure that the correct type of pinions is used. A change in gear form was introduced, and between tractors No. TE-6483 and TE-8701 both types were employed on assembly. The shaft (65) and gear (64) are supplied in sets and must be serviced only in that manner.

DRAWBAR (FIG. 26)

Figure 26 shows the adjustable drawbar (69) mounted to the tractor in the correct manner, with the stay assemblies (70)

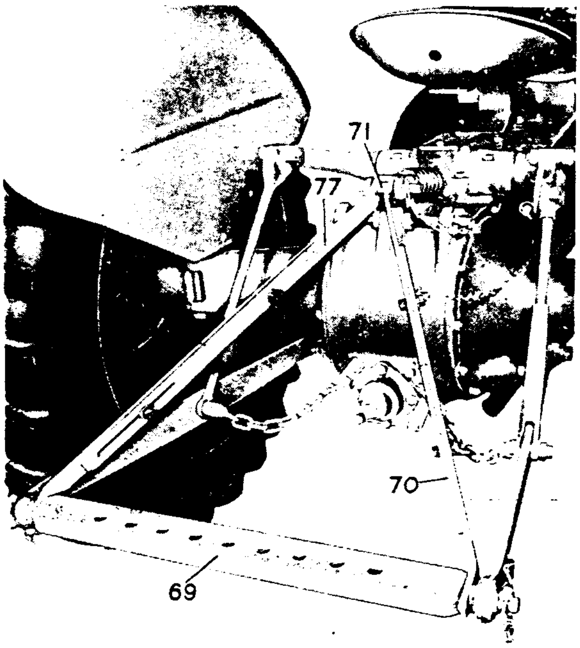


FIG. 26

mounted to the upper link pin (71). The height of the drawbar is governed by the length of the stay assemblies, and the normal setting of $17\frac{1}{2}''$ (44.55 cms.) above the ground is obtained when the notches marked on the two sections of each stay assembly are in line. Various heights may be particularly suited to different pull-type implements.

With the stay assemblies fitted, it is essential that the hydraulic lift is not operative, and a wedge assembly Fig. 27. is, therefore, attached by a chain to the right-hand stay. This should be fitted to the hydraulic control lever quadrant when the drawbar assembly is fitted, in the manner illustrated. The power take-off shaft should also be dis-engaged unless the

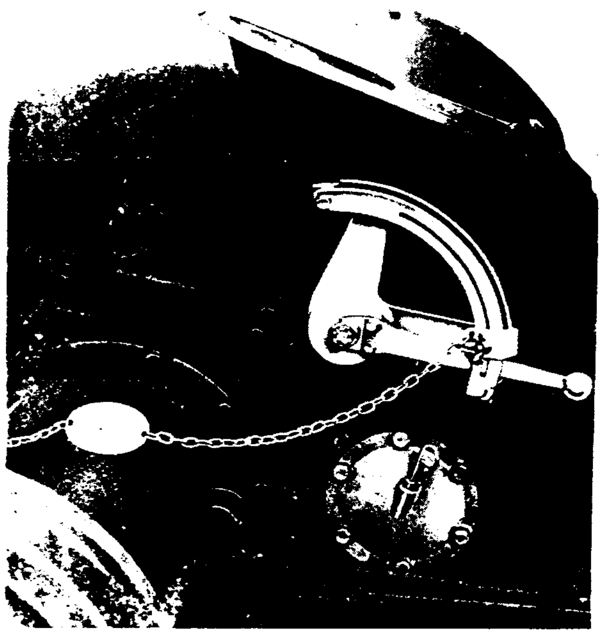


FIG. 27

implement being pulled requires power drive for operation.

The higher the attachment point from the ground, the greater the amount of weight transferred from the tractor front wheels to the rear wheels, increasing traction.

It is recommended therefore that the attachment point of any towed implement is so adjusted that this weight transference provides the maximum traction at the rear wheels while still retaining sufficient weight on the front wheels for efficient steering.

HYDRAULIC FAULT TABLE

The following recommendations assume that the oil employed is in accordance with that stated in the Tractor Instruction Book.

NOTES :—

1. No fault should be investigated until engagement of the Power Take-Off shaft and the correct setting of the Control Spring has been verified.

2. It is also advisable to work the control lever quickly through its full range two or three times.

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
1. Will not lift or drop.	(*a*) Sticking of control valve. (*b*) Sticking of piston in hydraulic cylinder.	(*a*) Remove inspection plate and free valve by moving in and out of bush. If trouble not cured in this way, change oil and ensure that control valve stem is not bent—if so, remove and straighten. Ensure that hand control fork is central. Check fit of control valve bush in its locating passage in pump body. (*b*) Remove and clean hydraulic cylinder assembly. Examine and adjust piston ring gap.
2. Will not lift.	(*a*) P.T.O. shaft not engaged. (*b*) Sticking control valve. (*c*) Sticking piston in hydraulic cylinder.	(*a*) Move control on left inspection plate to rear. (*b*) See 1a. (*c*) See 1 b.
3. Jerky or sluggish operation.	(*a*) Lift shaft locking screws too tight. (*b*) Tight piston in hydraulic cylinder. (*c*) Control valve travel reduced. (*d*) Control valve sticking. (*e*) Fork retraction spring weak. (*f*) Pump valves sticking. (*g*) Inlet and delivery valves incorrectly assembled. (*h*) Gasket(s) leaking.	(*a*) Reset locking screws. (*b*) See 1b. (*c*) Adjust hand control lever. (*d*) See 1a. (*e*) Examine and renew if necessary. (*f*) Dismantle pump and examine valves for freeness on guides. (*g*) Check for correct assembly. (*h*) Examine gaskets and renew if necessary.

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
4. Implement lifts at high engine speed, but not at idling speed.	Oil Leakage between pump and hydraulic cylinder.	Examine for oil leakage paying particular attention to gaskets between valve chambers and pump body, pump base and transmission centre housing, and hydraulic cylinder and cover. Examine oil tube between hydraulic cylinder and pump. Replace if damaged or split.
5. Implement falls when engine is stopped.	Oil draining from hydraulic cylinder due to :— (*a*) Damaged gaskets. (*b*) Bad scoring of cylinder walls. (*c*) Worn rings. (*d*) Control valve too slack in its bush. (*e*) Control valve too short on sealing surfaces. (*f*) Faulty check or relief valves.	(*a*) See 4. (*b*) Renew cylinder. (*c*) Renew rings. (*d*) and (*e*) Renew control valve or bush where necessary. (*f*) Renew where necessary.
6. Implement jerking when in fully raised position.	(*a*) Lower link chain twisted. (*b*) Check chain anchors wrongly fitted. (*c*) Lower links wrongly fitted. (*d*) Pressure relief valve not seating.	(*a*, *b* and *c*) Refit correctly. (*d*) Remove and clean valve assembly
7. Full working depth of implement not obtainable.	(*a*) Soil-engaging parts of implement worn. (*b*) Implement not adjusted correctly. (*c*) Hand control lever requires setting. (*d*) Control spring out of adjustment.	(*a*) Resharpen, or, if wear excessive, replace worn parts. (*b*) Refer to Implement Instruction Book. (*c*) Re-adjust hand control lever. (*d*) Re-adjust control spring yoke.
8. Implement depth irregular.	(*a*) Soil engaging parts of implement worn. (*b*) Implement not adjusted correctly. (*c*) Excessive suck of implement. (*d*) Control spring out of adjustment. (*e*) Soil of varying texture.	(*a*) Re-sharpen, or, if wear excessive, replace worn parts. (*b*) Refer to Implement Instruction Book. (*c*) Slightly lengthen top link assembly. (*d*) Re-adjust control spring yoke. (*e*) Regulate with hand control lever.

HYDRAULIC SYSTEM

The following modifications have recently been incorporated in the hydraulic system. In those instances where the alterations affect servicing procedure, further instructions have been added.

At Tractor Serial No. 134,001

OSCILLATING CONTROL VALVE.

An oscillating device for the control valve was introduced to minimise the possibility of the control valve sticking. It was incorporated without major modification to the hydraulic system and earlier and later type pumps directly interchange.

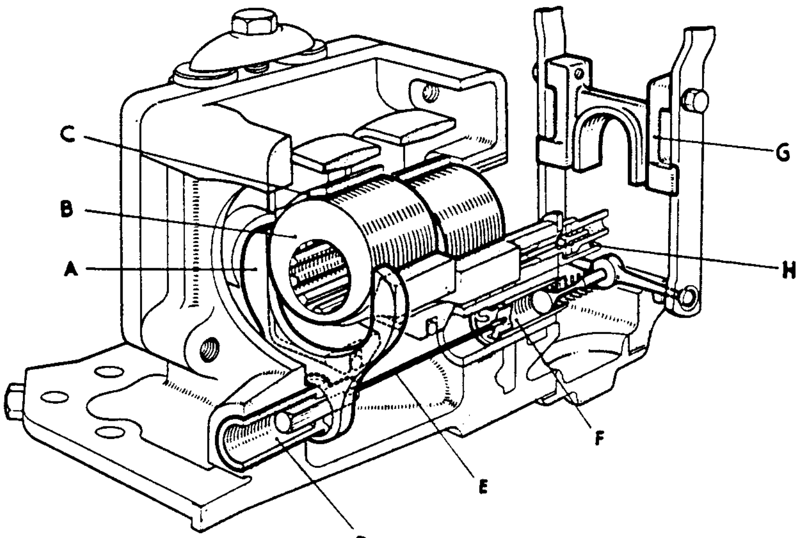


FIG. 28.
PUMP SHOWING OSCILLATING CONTROL VALVE MECHANISM

The oscillating mechanism operates as follows, refer to Fig. 28.

A fork (A) fits over the end of cam (B) which rotates inside the pump cam blocks (C). The lower end of the fork is splined to a bush (D) which turns in the pump body and has a square hole in it to receive a key rod and guide assembly (E) which connects to the control valve. Thus as the cam (B) rotates with the power take-off shaft, a rocking motion is imparted to the fork which, transmitted through the bush (D) and key rod assembly (E), oscillates the control valve (F).

The movement of the control valve by the control fork is unaffected.

The stabilizer (G) is fitted to prevent the twisting movement being imparted to the control fork, and should an old type pump be replaced by the later type, fitting the stabilizer is strongly recommended.

As a further precaution against the control valve sticking, the small shield (H) was fitted beneath the safety valve to prevent any sediment in the centre drain plug being stirred up around the control valve when the safety valve discharges. With the introduction of the oscillating control valve, the longitudinal grooves in the control valve bush were deleted.

TO REMOVE AND DISMANTLE HYDRAULIC PUMP.

The instructions given on pages L9 and L10 should be followed, with these additions :—

(*a*) Disconnect one side of the stabilizer (G. Fig. 28) before separating the hand control fork from the control valve.

(*b*) After removing the valve chamber assemblies, unscrew the bolt securing the oscillating fork bush (D. Fig. 28), remove tab washer and pull fork hard back against pump face before lifting out pistons, cams and cam blocks.

(*c*) Finally, after removing pistons, etc., and P.T.O. shaft bushing, withdraw the oscillating control valve fork and bush assembly.

TO DISMANTLE AND RE-ASSEMBLE OSCILLATING VALVE, FIG. 29.

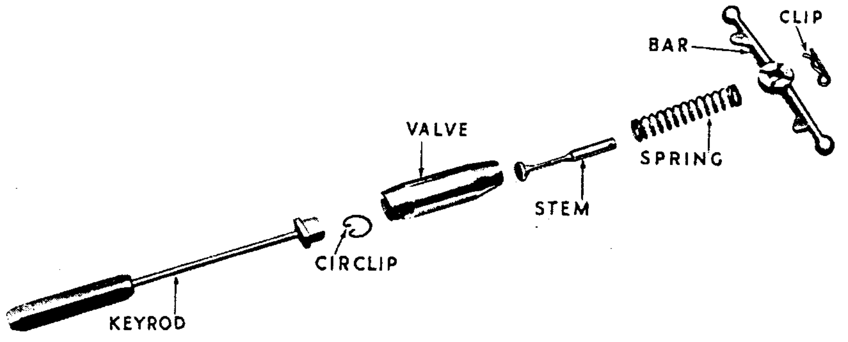


FIG. 29.
OSCILLATING CONTROL VALVE DISMANTLED

It is necessary for the pump to be removed from the transmission housing before the oscillating control valve can be extracted.

Dismantling :

1. Remove circlip and withdraw key rod assembly.
2. Compress spring, take out clip and remove spring and stem.

Re-Assembly :

Re-assemble control valve in reverse order to dismantling.

N.B. It is most important for the key rod circlip to locate correctly in its groove.

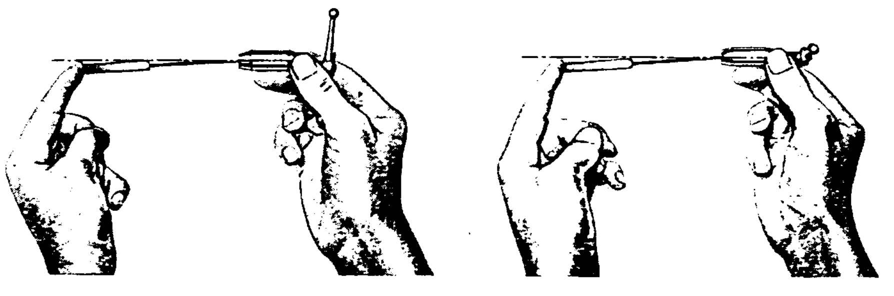


FIG. 30.
OSCILLATING CONTROL VALVE—SHOWING REQUIRED KEY ROD DEFLECTION

NOTE : There should be sufficient freedom in the key rod joint of the oscillating control valve for the end of the square guide to drop below the centre line of the valve at all angles (see Fig. 30). This allows the control valve to align itself in its bush.

TO RE-ASSEMBLE HYDRAULIC PUMP, REFER TO FIG. 10, PAGE L10.

1. Insert oscillating fork and bush.
2. Insert piston steady rails (29) after checking for straightness.
3. Replace power take-off shaft bushing (39), cams (18), cam blocks (37) and pistons (19), locating the oscillating fork round the extended rear end of the cams.

NOTE : Place cam blocks together with the flanged sides adjoining and ensure that the pistons are correctly positioned on the steady rails.

4. Rebuild and replace valve chamber assemblies. These assembles are rebuilt in the opposite order to that laid down in "To Dismantle Hydraulic Pump," page L10. Examine gaskets and renew where necessary.
5. Insert bolt securing oscillating fork bush, and lock tab washer.
6. Replace control valve, lining up guide and oscillating bush by means of a piece of wire inserted through bush, then push gently into place.
7. Replace safety valve assembly, comprising check valve (23) and pressure relief valve (24).

TO REPLACE HYDRAULIC PUMP.

Follow the instructions contained on page L12 taking care that :—

(*a*) The oscillating control valve is inserted before the pump is replaced.

(*b*) After re-connecting the control valve to the control fork, reattach the stabilizer.

(*c*) Before replacing the inspection cover, make sure the stabilizer cannot foul on the P.T.O. shaft. If necessary, file the corner of the stabilizer.

Between Tractor Serial Nos. 182,998-183,560 Inclusive

LEVELLING LEVER ASSEMBLY.

To guard against seizure when rolled type threads were first employed on levelling box shafts, a stop collar was introduced to prevent the threads of shaft and fork from coming into contact.

It is necessary to remove this collar before the shafts can be withdrawn, and to replace it by a similar collar on re-assembly.

At Tractor Serial No. 200,001

HYDRAULIC TAPPING POINTS.

Two additional oil pressure take-off points, (thread sizes $\frac{3}{8}''\times 18$ N.P.T.F.) with socket type sealing screws, were added in a gallery in the hydraulic lift cover.

VALVE CHAMBERS, FIG. 31.

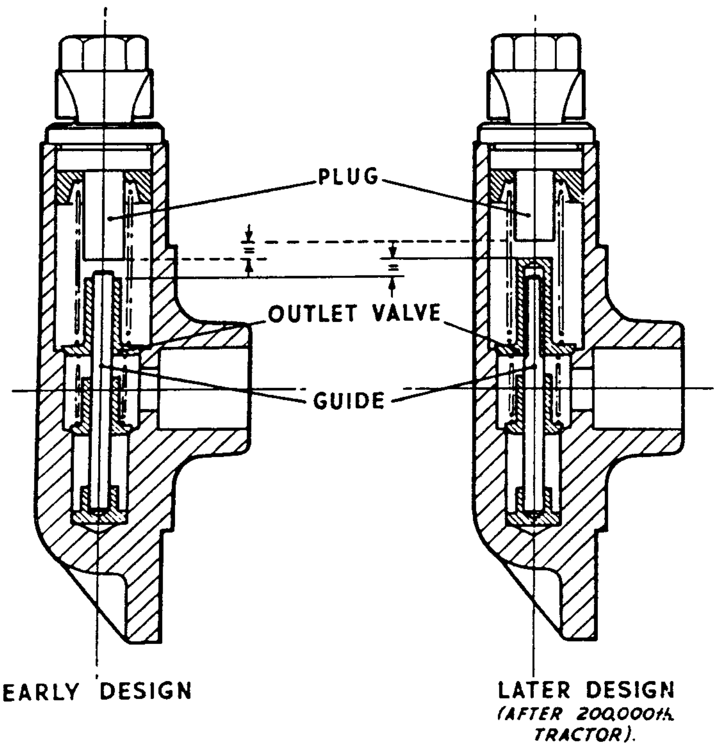


FIG. 31.
VALVE CHAMBERS

To eliminate the possibility of a pressure leak between guides and outlet valves, the through drilling for the guide in the outlet valve was modified to a blind hole. The guide and the stem of the plug were shortened and flats added to the guide for venting purposes.

The differences in the two designs are clearly illustrated in Fig. 31 from which it can be seen that the assemblies complete will interchange, but the modified parts, i.e., outlet valve, guide and plug will only suit the assembly for which they were designed.

UPPER LINK, FIG. 32.

The design of the upper link assembly, introduced at Tractor Serial No. 200001, provides for adjustment in length from $24\frac{1}{2}''$ — $26\frac{1}{2}''$ (62.2 — 67.2 cms). This is effected by locating the centre bolt in different pairs of holes in the two members.

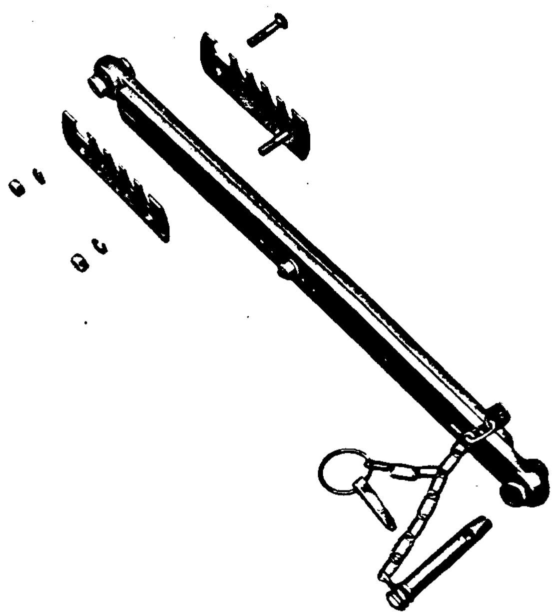


FIG. 32
UPPER LINK

The shortest adjustment should only be used with certain implements and in such cases a precise recommendation will be made.

QUADRANT ASSEMBLY — DIESEL TRACTORS, FIG. 33.

On diesel tractors, in order to afford adequate space for the battery position, the hydraulic control lever is connected by linkage to the control shaft, and the retaining nut and washers are mounted at the rear of the quadrant assembly.

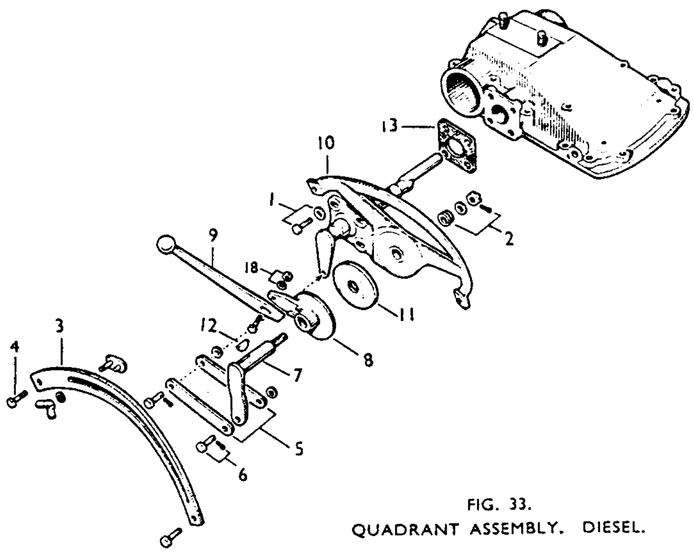


FIG. 33.
QUADRANT ASSEMBLY. DIESEL.

TO REMOVE QUADRANT ASSEMBLY, FIG. 33.

Disconnect and remove right hand battery.

Remove four screws with flat washers (1) and withdraw quadrant assembly complete with gasket (13).

TO DISMANTLE QUADRANT ASSEMBLY.

1. Remove slotted nut and washer (2).
2. Remove quadrant retainer (3) and screws (4).
3. Disconnect link (5) by removing clevis and split pins (6).
4. Detach shaft (7) friction plate (8) and lever (9) from quadrant plate assembly (10), and remove friction disc (11).
5. Tap out shaft (7) and remove Woodruff key (12).

TO REPLACE QUADRANT ASSEMBLY.

Proceed in reverse order, lubricating all screw threads before tightening.

At Tractor Serial No. 268,153

HYDRAULIC LIFT COVER AND CYLINDER ASSEMBLY.

The ram cylinder was re-designed and strengthened. The front end of the cylinder is secured to the lift cover by means of two special fitted bolts which also act as dowels. Loads are thereby transferred directly to the lift cover. The cylinder gasket was modified at the same time to suit the special bolts.

When fitting the strengthened ram cylinder, it is most important that the special bolts securing the front end are fitted first and that there is no binding on the rear bolts. Tighten the two front bolts to a torque wrench reading of 55—60 lb. ft. (7.6 — 8.3 kgm.) and then the rear to the same figure.

At Tractor Serial No. 286,543

HYDRAULIC PUMP.

'O' ring oil seals, mounted in grooves at the inlet and outlet oil transfer ports of the hydraulic pump, were introduced to improve the joint between the pump base and the valve chambers. These seals supersede the gaskets previously fitted. The deletion of the gaskets reduced slightly the distance between the two valve chambers, and the P.T.O. support was modified at the face adjoining the valve chambers from 5.028"/5.032" to 4.997"/4.999", to accommodate this. Earlier versions of the support can be modified accordingly to interchange.

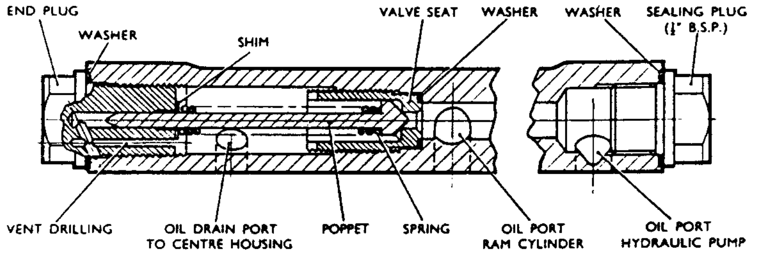
At this time also metal was added to the pump base casting and longer bolts introduced to suit.

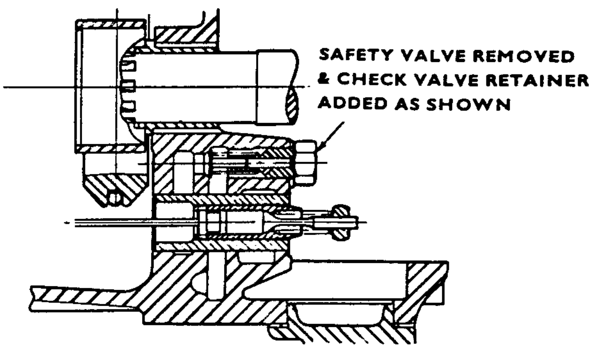
At Tractor Serial No. 330,044.

SAFETY VALVE, FIG. 34.

An improved safety valve was introduced and the safety valve (24) shown in Fig. 4., replaced by a check valve retainer. The shield, introduced at Tractor Serial No. 134001 and shown (H) in Fig. 28, was deleted.

ASSEMBLY-HYDRAULIC SAFETY VALVE IN TOP COVER.





LAYOUT OF CHECK VALVE WHEN SAFETY VALVE IS IN TOP COVER

FIG. 34.

The new safety valve assembly shown in Fig. 34, is positioned in the left-hand side of the oil gallery drilling in the hydraulic lift cover, deleting the oil tapping point. A feature of the valve is that, when it discharges, all the working parts of the valve are submerged in oil to eliminate possible corrosion from condensation. It is, therefore, desirable for the valve to be discharged at intervals.

Test Data.

The discharge pressure is unchanged and is adjusted so that the valve begins to open at a minimum static pressure of 1900 lb./sq. in. (133.6 kg. sq. cm.) The maximum pressure should not exceed 2400 lb. sq. in. (168.7 kg. sq. cm.) when by-passing $1\frac{3}{4}$ galls/min. S.A.E.50 oil at 110°—140°F. (43°—60°C.) and the valve must hold a static pressure of 1900-2100 lb./sq. in. (133.6—147.6 kg. sq. cm).

Adjustment is effected by the use of shims, each of which alters the pressure by 100 lb./sq. in. (7.03 kg. sq. cm.).

HYDRAULIC LIFT COVER AND CYLINDER ASSEMBLY.

The thread size of the right-hand take-off connection in the lift cover was changed from $\frac{3}{8}$" × 18 N.P.T.F. to $\frac{1}{2}$" B.S.P., and the socket screw replaced by a flanged type hexagon nut and sealing washer.

The lift cover was also strengthened around the ram cylinder attachment points. Four longer bolts are, therefore, required to secure the cylinder to the cover, the front pair being 'fitting' bolts with special nuts as before. The diameters of the bolts are unchanged.

The oil port in the top cover to the ram cylinder was under-cut to receive an 'O' ring which replaces the former arrangement of plain front gasket and two small compensating washers around the rear bolts retaining the ram cylinder to the lift cover.

At Tractor Serial No. 374,948.

CONTROL VALVE BUSH.

The longitudinal grooves in the control valve bush, deleted at Tractor No. 134001, were re-introduced. The new bush can be used in service to replace both types.

At Tractor Serial No. 407,102

OSCILLATING CONTROL VALVE MECHANISM, FIG. 35.

In order to counteract possible mal-alignment between the control valve and the oscillator bush, which may tend to result in the control valve sticking, the key rod was replaced by a metal drive strip. Compare Fig. 35 with Fig. 28.

of the bore which receive the end lugs of the metal drive strip. The slot for the grub screw is deleted and the grub screw replaced by a screw which simply retains a tab washer. This tab washer, of special design, is bent round across the end of the oscillator bush and prevents it from working rearwards.

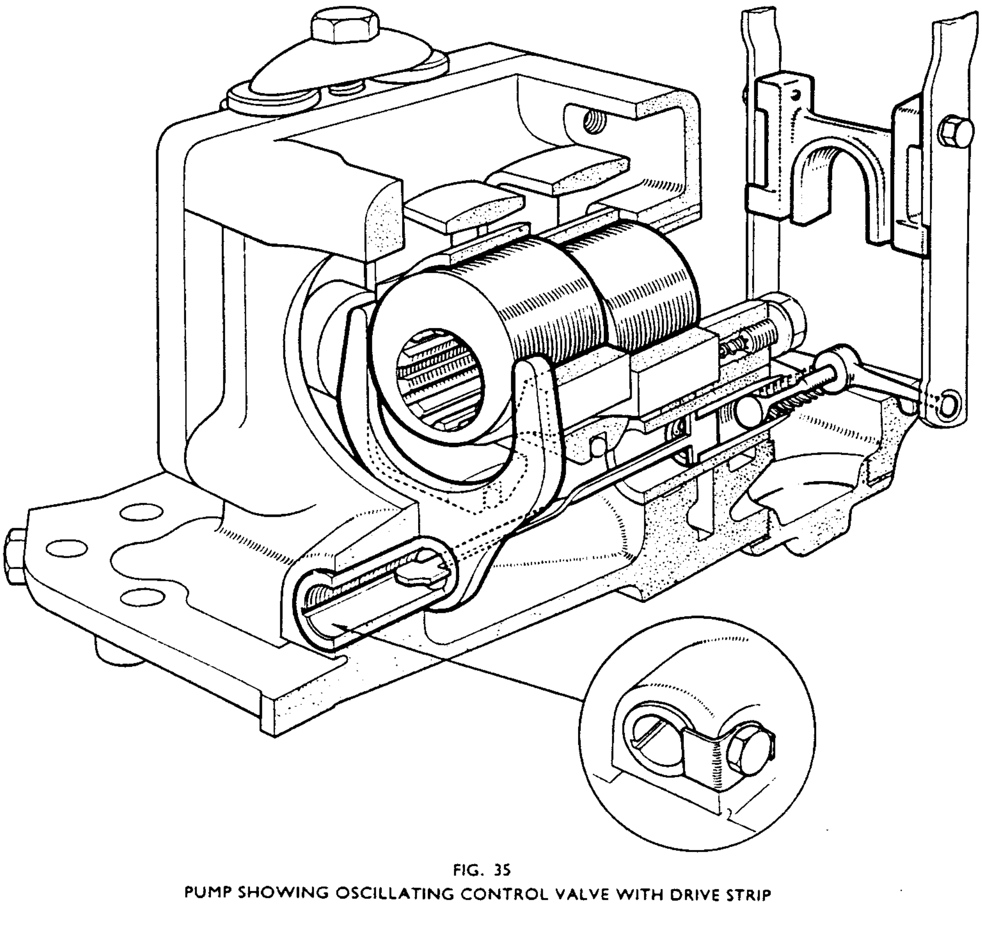


FIG. 35
PUMP SHOWING OSCILLATING CONTROL VALVE WITH DRIVE STRIP

The end of the metal drive strip is secured at the control valve by the circlip as originally fitted, the slot in the control valve being reduced in width.

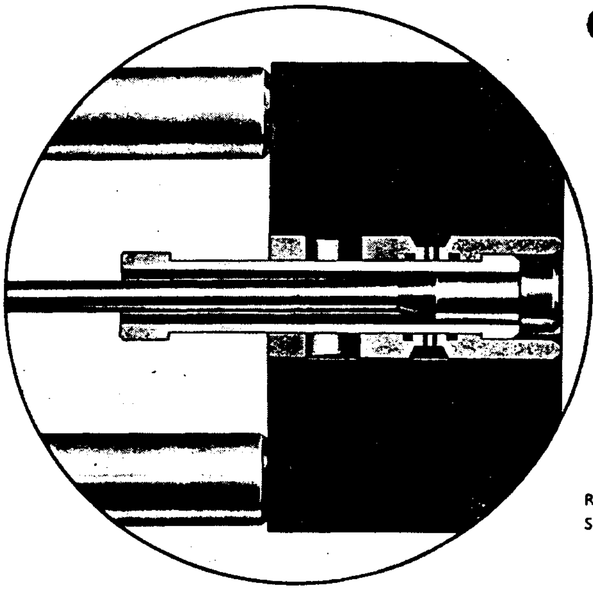
The square hole in the oscillator bush is replaced by grooves running the length

TO DISMANTLE PUMPS FITTED WITH THIS ASSEMBLY.

The instructions given for dismantling pumps fitted with the earlier type oscillating control valve should be followed (see page L.25).

CONTROL VALVE BUSH REMOVER FT. 98.

Service Tool FT.21A, which was designed for use on the early type pump assemblies, is unsuitable for those incorporating the oscillating control valve, unless the pump is dismantled.



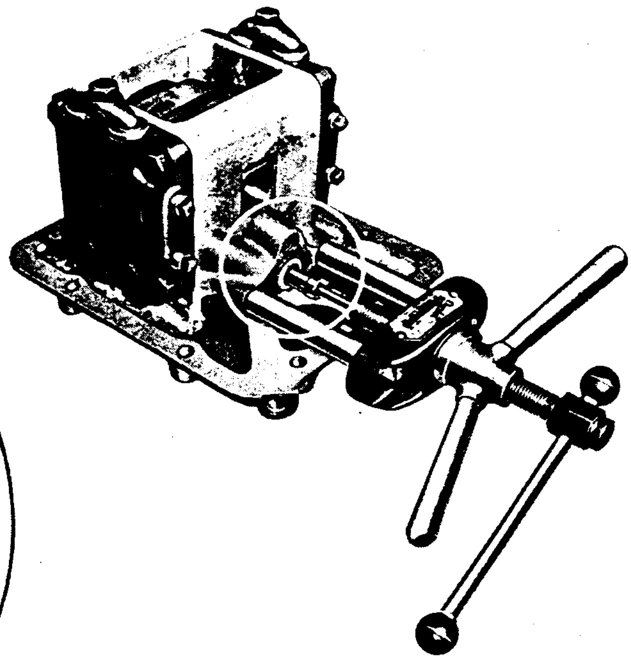


FIG. 36.
REMOVING CONTROL VALVE BUSH.
SERVICE TOOL FT.98.

Service Tool FT.98 has been introduced, and this can be used with both types of pump in their assembled state.

In operation, the three segments fit round the end of the tool shank and locate against the shoulder of the counterbore inside the control valve bush as shown (inset) ; the two legs seat against the pump base, and rotating the inner handle withdraws the bush.

CONTROL SPRING ROCKER BUSH REMOVER/REPLACER FT. 99, FIG. 37.

This tool has been designed to facilitate removal and replacement of the control spring rocker bush.

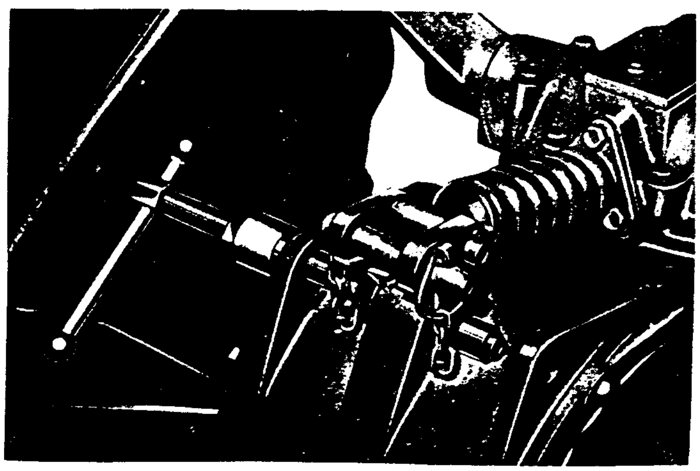


FIG. 37.
REMOVING CONTROL SPRING ROCKER BUSH.
SERVICE TOOL FT. 99

TO REMOVE CONTROL SPRING ROCKER BUSH.

First remove rocker pin assembly.

1. Insert stem of Service Tool through L.H. outer web with thrust bearing and nut outside web, as shown in Fig. 37, and screw cap on to end of stem.
2. By tightening on the nut withdraw the bush.

TO REPLACE CONTROL SPRING ROCKER BUSH.

1. Insert stem of Service Tool through R.H. outer web, with thrust bearing and nut on outside of web.
2. Insert replacement bush through L.H. web and mount on stem of tool. Screw cap on to end of stem.
3. By tightening on to the nut draw bush into position.

HYDRAULIC FORK SPREADER FT. 145, FIG. 38.

This tool has been designed for use when detaching the hand control fork from the control valve yoke as described in paragraph 3, page L9.

It is used to spread the lower ends of the hand control fork off the control valve yoke, and to hold them clear while the pump is lowered or the lift cover removed. The tool should be inserted, curved portion downwards, as illustrated.

A safety chain and clip, which should be secured to a suitable point outside the housing, are provided to ensure that the tool is removed on re-assembly.

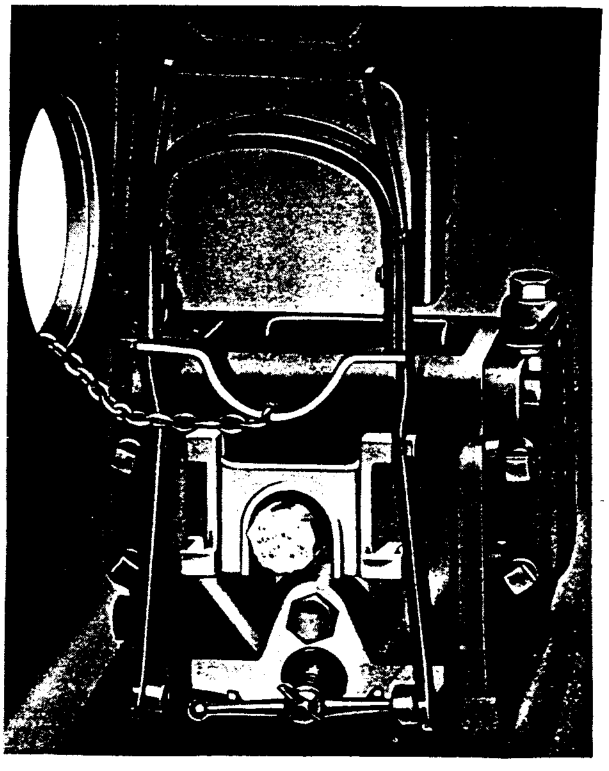


FIG. 38.
SPREADING HYDRAULIC FORKS
SERVICE TOOL FT.145

At Tractor Serial No. 429519.

HYDRAULIC SYSTEM SAFETY VALVE.

The poppet type safety valve in the Hydraulic lift cover was replaced by a steel ball type. To compensate for the difference in the thickness of the poppet head, the length under the head of the end plug is reduced from 1·03″ to ·97″. The diameter of the spigot portion of the valve seat has also been reduced from ·425″ + ·010″ to ·422″/·418″, to ensure that the valve seat does not bind in the oil gallery, as when binding occurs, oil will seep round the back of the valve seat.

Care must be taken to ensure that when removing the ball type valve assembly, the ball is not allowed to fall inside the lower drilling of the discharge port. When this happens, the ball cannot be retrieved until the lift cover and ram cylinder are removed. If the ball is left in the hole, it may be possible for it to be dislodged during the operation of the relief valve and for it to find its way into the centre housing which may result in damaged gears, etc.

When the ball type relief valve assembly is used to replace the earlier poppet type, the difference in head thickness will produce an additional loading on the spring resulting in higher pressure. It is necessary, therefore, to modify the end plug as already stated, or by adding a recess of 7/16″ diameter × ·06″ deep in the screwed end portion. If pressure is lower than the specified reading, then shims can be added, but if the end plug is not modified and the original shims not removed when changing over from the poppet type safety valve to the ball type safety valve, then it is possible for the valve spring to be almost solid in its closed position. If this happens the ball will be badly grooved, thus resulting in a permanent leak.

UPPER LINK.

Note that the upper link, which is now common to both MF-35 and TE-20 tractors, has had the boss at the link end extended slightly. When fitting a new upper link check to ensure that there is ample clearance at all angles when upper link replacements are made. It is permissible to remedy any fouling which is apparent by trimming the end of the upper link to obtain the clearance required. It may be necessary to remove up to ·040″ (1·18 mm) from the upper link, but excessive trimming which would weaken the link must be avoided.

HYDRAULIC SYSTEM AND LINKAGE

FAULT TABLE

The following recommendations assume that the oil employed is in accordance with that stated in the Tractor Instruction Book.

NOTES :—

1. No fault should be investigated until engagement of the Power Take-Off shaft and the correct setting of the Control Spring has been verified.
2. It is also advisable to work the control lever quickly through its full range two or three times.

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
1. Will not lift or drop.	(*a*) Sticking of control valve.	(*a*) Remove inspection plate and free valve by moving in and out of bush. If trouble not cured in this way, change oil and ensure that control valve stem is not bent—if so, remove and straighten. Ensure that hand control fork is central. Check fit of control valve bush in its locating passage in pump body. Check that there is sufficient freedom in the oscillating type control valve joint at all angles, for the valve to align itself squarely in its bush. Check that relief valve shield is not bent and fouling control valve.
	(*b*) Sticking of piston in hydraulic cylinder.	(*b*) Remove and clean hydraulic cylinder assembly. Examine and adjust piston ring gap.
	(*c*) When in transport position certain implements of non Ferguson design compress control spring to such an extent that vertical fork is forced outside control lever range.	(*c*) The forward thrust on the control spring must be removed gradually in stages, until, when the control lever is pushed slowly forward, the implement lowers. WARNING : If the load is removed with the control lever in ' drop ' position, the implement may ' crash ' to the ground.
2. Will not lift.	(*a*) P.T.O. shaft not engaged.	(*a*) Move control on left inspection plate to rear.
	(*b*) Sticking control valve.	(*b*) See 1 a.
	(*c*) Sticking piston in hydraulic cylinder.	(*c*) See 1 b.
	(*d*) Serious leak in system between pump and hydraulic cylinder.	(*d*) Confirm by checking control valve is in lift position. Examine for leakage at all gaskets, and ' O ' rings, cracked ram cylinder or valve chambers ; cracked or broken vertical tube.
	(*e*) Pump aerated e.g. when replacement pump fitted.	(*e*) Prime pump by loosening off clamps securing valve chamber plugs, and running tractor slowly with control valve in ' lift ' position until all air is expelled. Retighten clamps.
	(*f*) Safety valve stuck open or spring broken.	(*f*) Renew or service safety valve assembly as necessary.

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
3. Jerky or sluggish operation.	(*a*) Lift shaft locking screws too tight.	(*a*) Reset locking screws.
	(*b*) Tight piston in hydraulic cylinder.	(*b*) See 1b.
	(*c*) Control valve travel reduced.	(*c*) Adjust hand control lever.
	(*d*) Control valve sticking.	(*d*) See 1a.
	(*e*) Fork retraction spring weak.	(*e*) Examine and renew if necessary.
	(*f*) Pump valves sticking.	(*f*) Dismantle pump and examine valves for freeness on guides.
	(*g*) Inlet and delivery valves incorrectly assembled.	(*g*) Check for correct assembly.
	(*h*) Gasket(s) leaking.	(*h*) Examine gaskets and 'O' rings and renew if necessary. Check torque loading on securing bolts.
	(*j*) Control spring plunger plate badly bent or worn. Thereby altering the position of the top control fork in relation to control lever.	(*j*) Renew plate or adjust hand control lever.
4. Implement lifts at high engine speed, but not at idling speed.	(*a*) Oil Leakage between pump and hydraulic cylinder.	(*a*) See 2d.
	(*b*) Heavy load on linkage with hot oil in worn pump.	(*b*) Renew or recondition pump
5. Implement falls when engine is stopped.	Oil draining from hydraulic cylinder due to :—	
	(*a*) Damaged gaskets.	(*a*) See 4.
	(*b*) Bad scoring of cylinder walls.	(*b*) Renew cylinder.
	(*c*) Worn rings.	(*c*) Renew rings.
	(*d*) Control valve too slack in its bush.	(*d*) and (*e*) Renew control valve or bush where necessary.
	(*e*) Control valve too short on sealing surfaces.	
	(*f*) Faulty check or relief valves.	(*f*) Renew where necessary.
	(*g*) Cracked ram cylinder, valve chambers, or cracked or broken vertical tube.	(*g*) Renew where necessary.

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
6. Implement jerking when in fully raised position.	(*a*) Lower link chain twisted.	(*a*, *b* and *c*) Refit correctly.
	(*b*) Check chain anchors wrongly fitted.	
	(*c*) Lower links wrongly fitted.	
	(*d*) Pressure relief valve not seating.	(*d*) Remove and clean valve assembly
	(*e*) Implements such as Potato Planter or Weeder which incorporate balance spring may transmit fluctuations to control fork.	(*e*) Move control lever approx. 1" forward from fully lift position to reduce fluctuations.
7. Full working depth of implement not obtainable.	(*a*) Soil-engaging parts of implement worn.	(*a*) Resharpen, or, if wear excessive, replace worn parts.
	(*b*) Implement not adjusted correctly.	(*b*) Refer to Implement Instruction Book.
	(*c*) Hand control lever requires setting.	(*c*) Re-adjust hand control lever
	(*d*) Control spring out of adjustment.	(*d*) Re-adjust control spring yoke.
8. Implement depth irregular.	(*a*) Soil engaging parts of implement worn.	(*a*) Re-sharpen, or, if wear excessive, replace worn parts.
	(*b*) Implement not adjusted correctly.	(*b*) Refer to Implement Instruction Book.
	(*c*) Excessive suck of implement.	(*c*) Slightly lengthen top link assembly.
	(*d*) Control spring out of adjustment.	(*d*) Re-adjust control spring yoke.
	(*e*) Soil of varying texture.	(*e*) Regulate with hand control lever.
	(*f*) Upper link rocker bush or lift shaft bushes seizing.	(*f*) Renew bushes.

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Section M

POWER TAKE-OFF SHAFT

POWER TAKE-OFF SHAFT

DETAILS

Rear splines :—Six in number, 1.121/1.123" outside dia. × .922/.932" inside dia. (28.47/28.52 × 23.42/23.67 mm.)
Length of splines suitable for drive attachment :—1.92" (48.8 mm.)
Width of splines :—.275/.277" (6.99/7.04 mm.)
Dia. of hole :—21/64"(8.33 mm.). Distance from shaft end :—½" (12.7 mm.)
End cover, inside dia. :—2½" (63.5 mm.)

GENERAL DESCRIPTION (Fig. 1).

Supported by ball bearings (1) and (2), the power take-off shaft transmits the drive directly from the transmission countershaft through a sliding coupling to an attachment point, at the base of the rear axle centre housing, convenient for use with the Ferguson belt pulley and certain implements.

The splined forward end of the P.T.O. shaft also provides the drive for the hydraulic pump. A dust excluding cap (3) is screwed over the rear end of the P.T.O. shaft on to the cover (4) when the drive is not is use.

Note :

The continuous gear reduction of 2.75 to 1 between engine and transmission countershaft is also applicable to the P.T.O. shaft, *i.e.*

Engine	1,500 r.p.m.
P.T.O. Shaft	545 r.p.m.

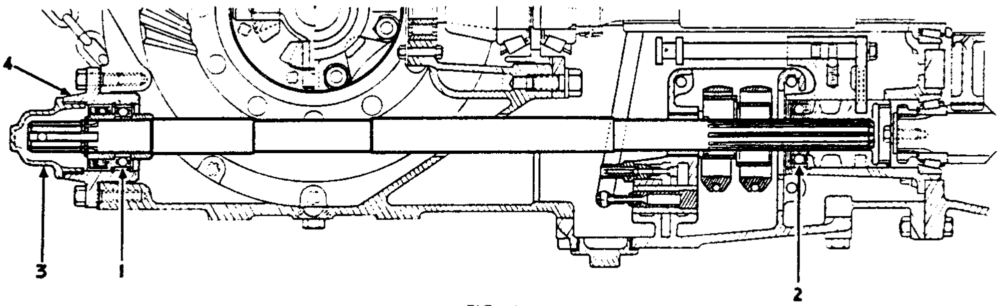

FIG. 1

To Remove P.T.O. Shaft.

1. Disengage shaft by forward movement of hand lever mounted on left hand centre housing inspection cover, as shown in Fig. 2.

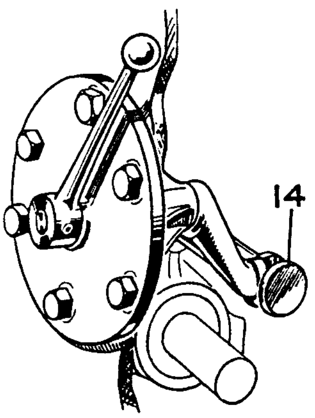

FIG. 2

2. Before removal of shaft either

   (*a*) drain oil from transmission and rear axle centre housing by removing all three plugs.

or :—

   (b) drop the tractor wheels 12 to 15 inches (30-40 cms.) into a depression and drain the oil sufficiently far forward to enable the shaft to be withdrawn without loss of oil.

Note :

It is advisable to unscrew the cap from the end cover before withdrawal of the shaft as the thread may be tight.

3. Unscrew and remove the four setscrews securing shaft end cover (4) and withdraw shaft assembly to the rear.

To Replace P.T.O. Shaft. (Figs. 3 and 6).

Before replacing shaft assembly, ensure that it is spotlessly clean and that the rear cover gasket (5) has not been damaged. A damaged gasket should be renewed.

1. With rear bearing assembly in position on shaft, insert the shaft from the rear through the hole at the base of rear axle centre housing.
2. Carefully enter the splined end through the bushing in the hydraulic pump, engaging the splines of the pump cams. Finally enter the shaft coupling sleeve (6).
3. Press home and tighten rear cover on to gasket (5).
4. Operate P.T.O. coupling lever to ensure correct functioning and meshing of coupling teeth, ensuring that shifter fork is correctly located in groove of shifter rail as shown in Fig. 2.
5. Replace right-hand inspection cover. Replace drain plugs.
6. Refill transmission and rear axle centre housing with clean oil of the correct grade, as laid down in Tractor Instruction Book.

P.T.O. Shaft Rear Bearing Assembly, Fig. 3.

Location of the P.T.O. shaft is obtained at the joint between the machined faces of the cover (4) and the flange on the rear axle centre housing, the ball race (1) being secured in position on the shaft between a shrunk-on collar (7) and a collar (8) retained by a circlip (9). The ball race is located between annular grooves in the inner bore of the cover by means of two snap rings (10) and (11), while an oil seal (12) fitting over collar (8) is a press fit in the cover bore.

To Dismantle Rear Bearing Assembly, Fig. 3.

1. Remove cap (3) and circlip (9).
2. Pull or tap off cover assembly with collar, bearing, snap ring and oil seal.
3. Remove snap ring (11), tap out collar (8) and bearing (1).
4. Push out oil seal (12) and remove snap ring (10).

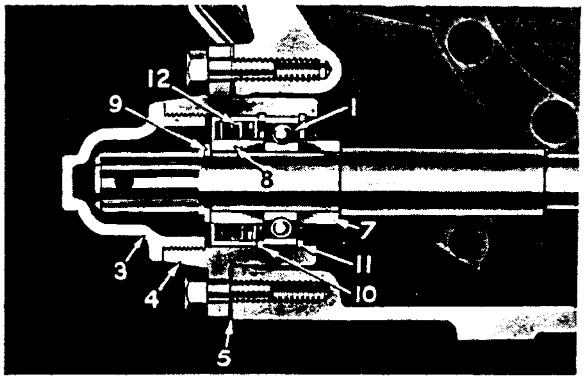

FIG. 3 REAR LAYOUT.

Note :

The remaining collar (7) is shrunk on to the shaft and should not be removed.

To Build Up Rear Bearing Assembly, Fig. 3 and 4.

1. Replace inner snap ring (10).
2. Using service tool FT.31B (Fig. 4), drive seal into position in cover (4) locating on snap ring.
3. Replace collar (8) in oil seal (12) from the rear, with large chamfer leading.
4. Replace bearing (1), locating on snap ring (10).
5. Replace snap ring (11).

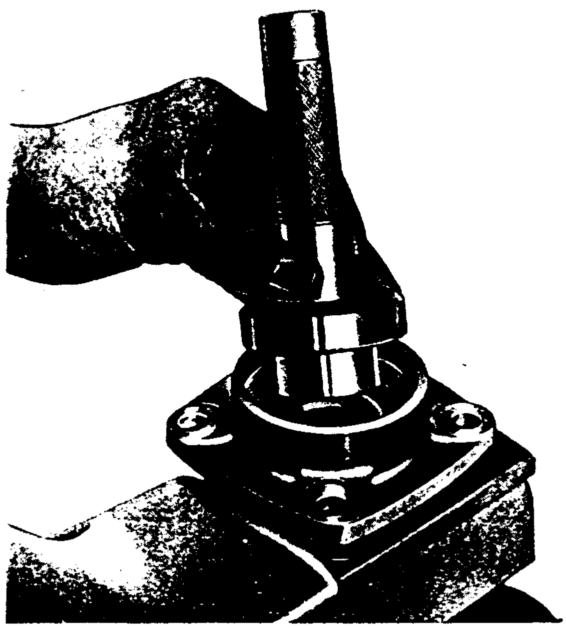

FIG. 4

6. Fit end cover assembly on shaft, locating inner journal of bearing (1) on collar (7). The outer section of service tool FT 25 can be located on collar (8) for the purpose of tapping into position.

7. To locate collar (8), place the inner portion of service tool FT25 over shaft splines, and on it mount circlip (9). Using the outer portion of the tool, push the circlip into position, as shown in Fig. 5.

8. Replace cap (3).

P.T.O. Shaft Coupling. Fig. 6.

When not required for the transmission of power, or for operation of the hydraulic system, the shaft can be disconnected from the transmission countershaft by forward movement of the hand lever pinned to the shifter fork as shown in fig. 2. As the shifter fork is engaged with the flanges at the rear end of shifter rail (14), rearward movement is imparted to the rail and stop (15) disengaging sleeve (6) splined to the shaft, from hub (16) splined to the transmission countershaft. The spring loaded ball (17) located in the shaft bearing support (18) engages annular grooves in the shifter rail and thus provides correct positive engagement between the teeth of the sleeve (6) and hub (16).

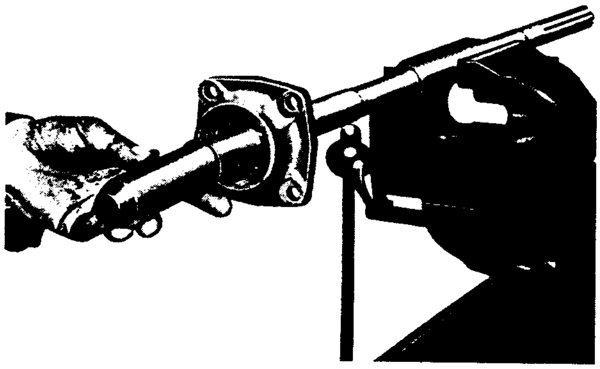

FIG. 5

Note :

The following operations entail the removal of the rear axle centre housing from the transmission case. Details of the correct procedure for this operation can be found under "Transmission, Section J."

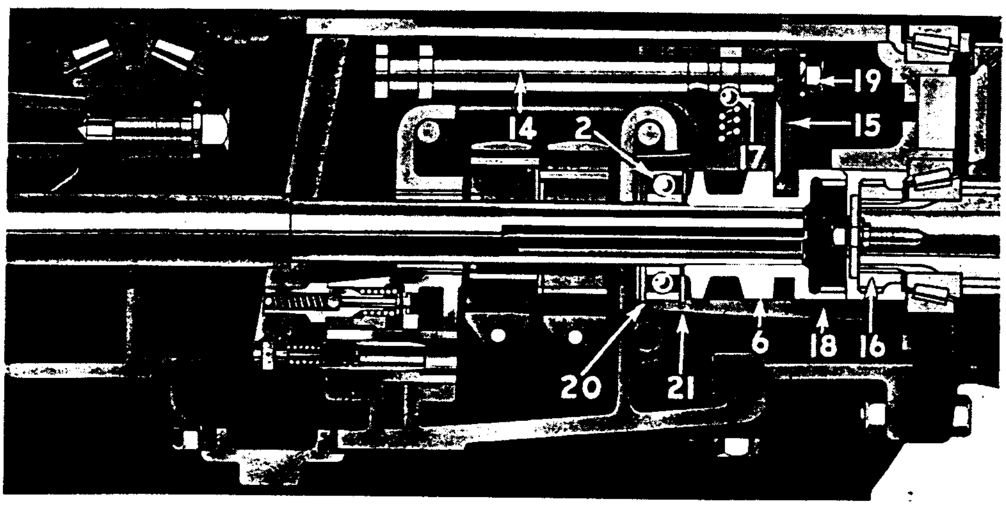

FIG. 6. FORWARD LAYOUT.

To Dismantle the P.T.O. Shaft Coupling Assembly.

Whenever possible, carry out dismantling and examination of coupling without removing the front bearing support and without disturbing the transmission countershaft.

1. Remove from the rear axle centre housing the left-hand inspection cover with hand lever and shifter fork. The lever is rivetted to the fork.

2. After removal of nut (19) with lock-washer, shifter rail (14) and stop (15) may be withdrawn, and locking ball (17) and spring may be examined. A weak spring should be renewed.

P.T.O. Shaft Front Bearing Assembly.

The front ballrace (2), which is a sliding fit over the splines of the P.T.O. shaft, is located by two snap rings (20) and (21) fitting in annular grooves in the inner bore of the bearing support (18).

To Remove P.T.O. Shaft Front Bearing.

1. Remove rear snap ring (20).
2. Withdraw bearing (2).
3. Remove front snap ring (21).

Note :

If a suitable extractor is not available the bearing support will have to be removed and the bearing tapped out. When removing the bearing support (18) take care not to damage or lose any of the shims fitted between its machined flange and the transmission casing. These control the transmission countershaft end float, and a re-check of end float would necessitate the complete dismantling of the transmission.

To Replace P.T.O. Shaft Front Bearing.

1. Insert front snap ring (21).
2. Insert bearing (2).
3. Insert rear snap ring (20).

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Section N

STEERING GEAR

STEERING GEAR

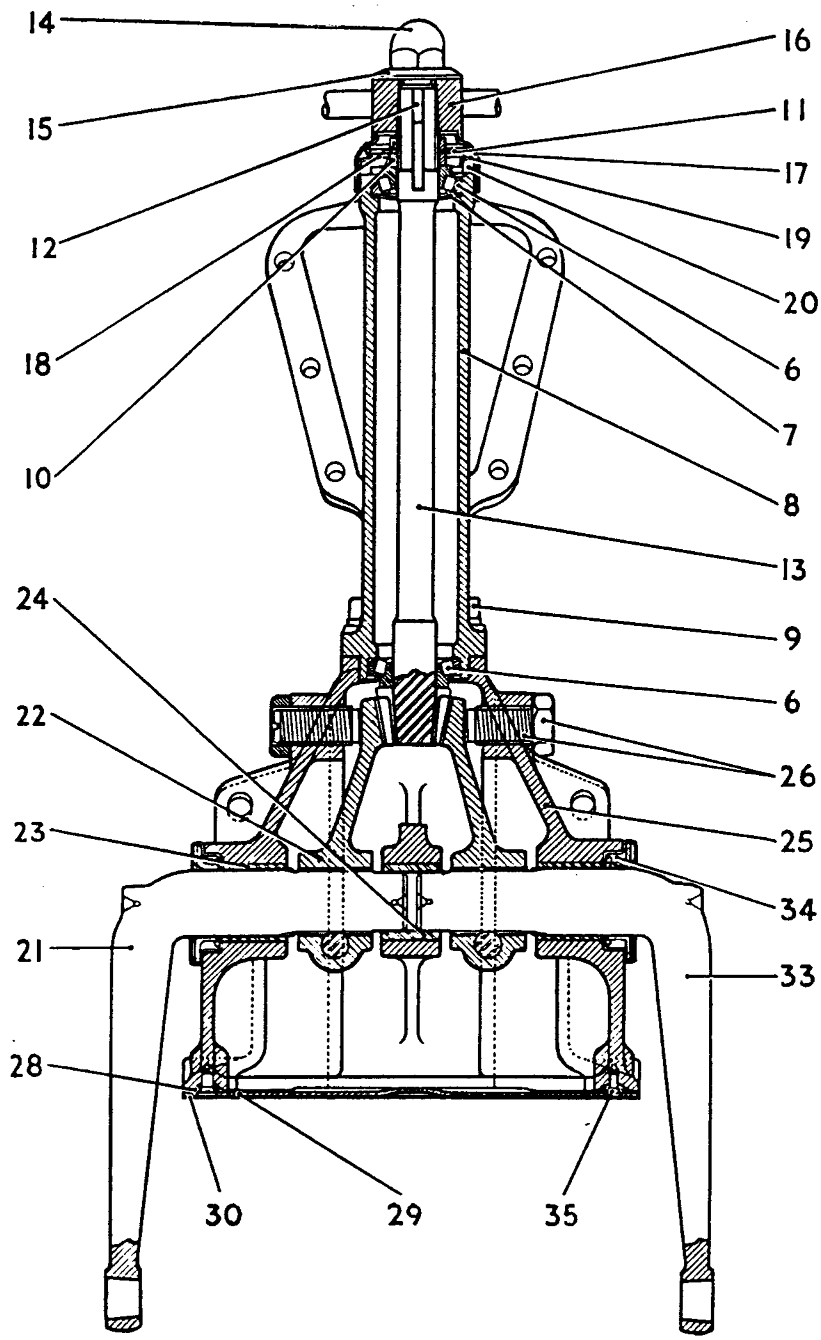


FIG. 1.

DESCRIPTION.

Figs. 1 and 2 show cross-sectioned and exploded views of the steering assembly which consists of a spiral bevel pinion and shaft (13) actuating two rack sectors (22) each being linked separately to a front wheel. The pinion shaft, mounted in two thrust roller bearings (6), is keyed to the steering wheel (16) and with housing (8) forms the upper assembly, while the lower assembly consists of sectors (22), splined to drop arms (21) and (33), mounted in bushes (23) in outer walls of lower housing (25) and in a common bush (24) in centre web. During dismantling, reference can be made to Figs. 1 and 2.

UPPER ASSEMBLY.

To Remove.

1. Disconnect link rod between arm of throttle hand lever (4) and throttle rod plate at connection (5) to arm.

2. Disconnect and remove battery.

3. Remove nuts (3) and lockwashers from the seven rib-neck carriage bolts (2) securing instrument panel (1) to upper steering housing (8). Remove battery earth strap which is attached to one of these bolts and tap out bolts using a hide faced hammer.

4. Remove the four set screws (9) with lockwashers securing base of upper housing to lower housing (25). Lift clear, if necessary turning steering wheel (16) to disengage pinion (13) from steering sectors (22).

To Replace.

1. Align front wheels in straight ahead position to centralise rack sectors, then proceed in reverse order to instructions given above.

NOTE : On replacing assembly, steering wheel should be turned slightly, as necessary, to engage pinion (13) with steering sectors (22).

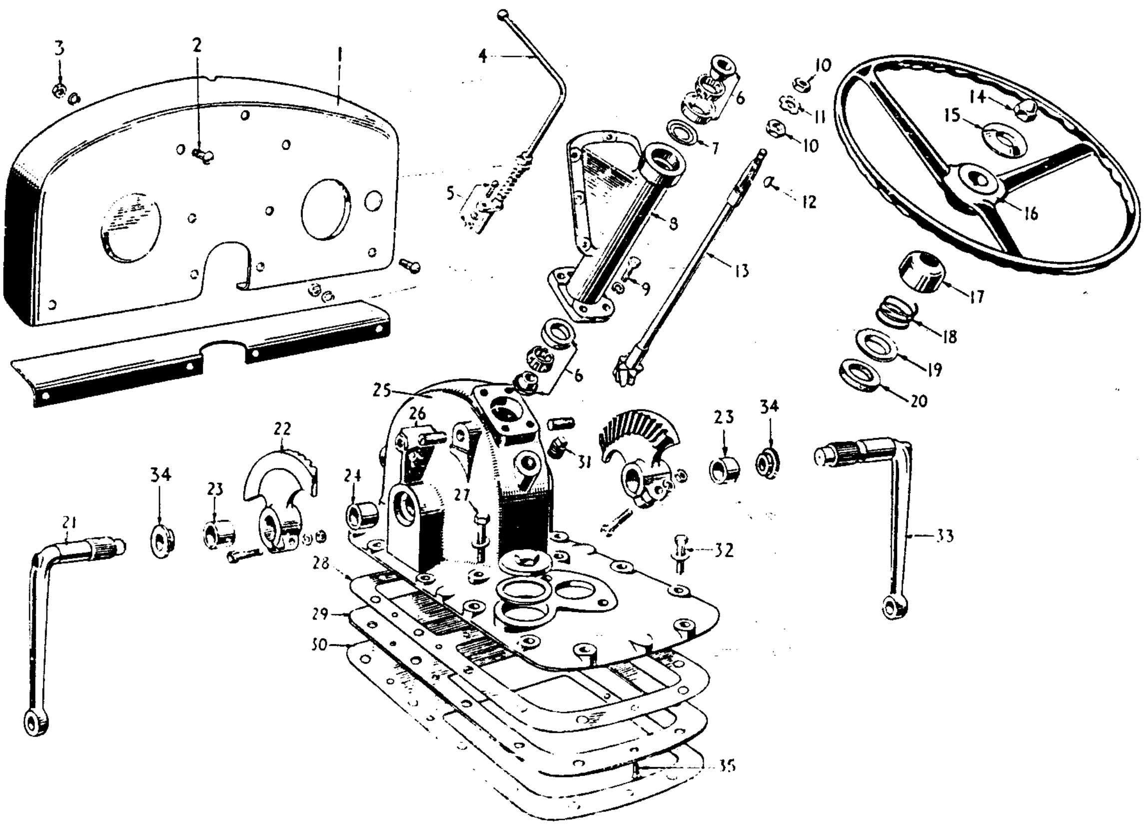


FIG. 2.

To Dismantle.

1. Using service tool FTB.8. Fig. 3, withdraw steering wheel (16) free from Woodruff key (12) in tapered

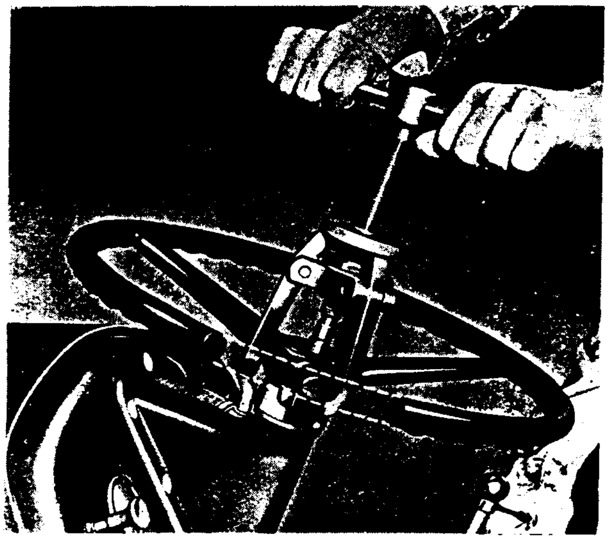


FIG. 3.
FTB.8 STEERING WHEEL EXTRACTOR.

shaft end after removal of nut (14) and washer (15), then remove cap (17) spring (18), seal retainer (19) and seal (20).

FIG. 4.
FTB.5 STEERING COLUMN LOCKNUT WRENCHES.

2. Remove retaining nuts (10) and tab washer (11), using wrenches FTB.5, as illustrated in Fig. 4. Tap out shaft downwards to release upper bearing (6) and its inner cone.

3. Remove cage of bottom bearing (6).

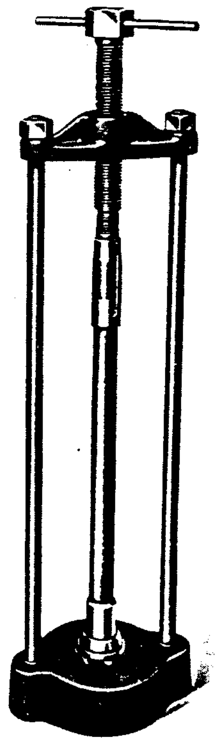


FIG. 5.
FT.36A STEERING COLUMN BEARING INNER CONE REMOVER.

4. Remove bottom bearing inner cone from pinion shaft, using puller FT.36A as shown in Fig. 5.

5. Tap out top and bottom bearing outer cups from housing.

   NOTE : Removal of upper bearing cup will damage retainer disc (7) which should be renewed on re-assembly.

To Assemble.

1. Mount bottom bearing inner cone on pinion shaft using Service Tool FT.36A with adapter FT.36B. Fig. 6.

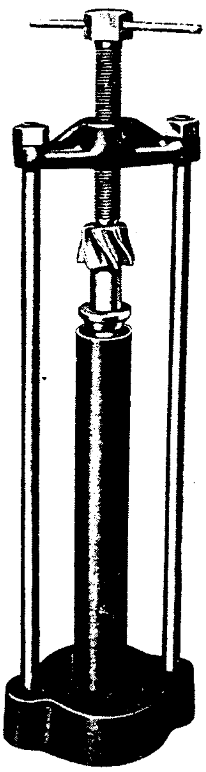


FIG. 6.
FT.36A and B REPLACING STEERING COLUMN BOTTOM BEARING INNER CONE.

2. Mount top and bottom bearing outer cups in housing, using Service Tool

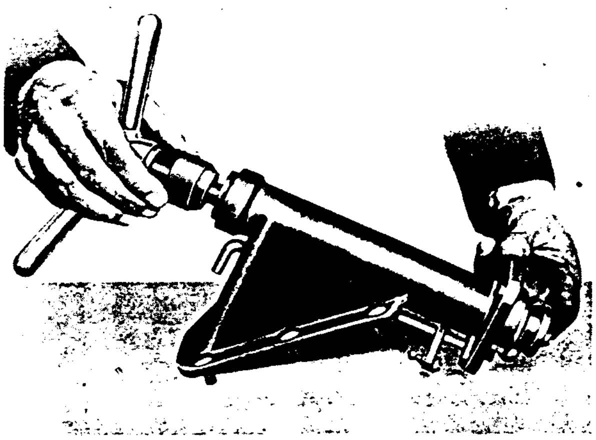


FIG. 7.
FT.13 STEERING COLUMN BEARING OUTER CUPS REPLACER.

FT.13, as shown in Fig. 7, locating retainer disc (7), concave upwards, below top cup.

3. Locate bottom bearing in its cone.
   NOTE : Top and bottom bearings (6) are identical.
4. Insert pinion shaft with bearing and inner cone in housing, and mount top bearing cage.
5. Locate inner cone over bearing cage and tighten retaining nut (10) until shaft is free to turn with no end float. Mount tab washer (11) and tighten upper lock nut (10), using wrenches FTB.5. afterwards bending back washer tabs over flats of nuts.
6. Locate steering wheel on Woodruff key (12) in tapered shaft end after fitting seal (20), retainer (19), spring (18) and cap (17) and mount top nut (14) and washer (15).

STEERING HOUSING ASSEMBLY.

To Remove Complete.

1. Remove hood stays and lower hood forward over radiator.
2. Remove fuel tank, battery and battery cradle (12-volt only).
3. Disconnect leads of electrical wiring harness at starter switch, coil and dynamo.
4. Disconnect oil pipe at gauge.
5. Remove air cleaner with hoses.
6. Remove tool box.
7. Disconnect link from hand throttle lever arm below dash.
8. Withdraw throttle rod to rear, after loosening nuts of "U" bolt at front end and clamp at rear—See Section F page F.5.

9. Disconnect choke control rod at carburettor lever and withdraw to rear.

10. Disconnect steering drag links at rear —See Section O page 0.2.

11. Remove securing set screws (27) and (32) and lift clear steering housing assembly complete with dash and battery platform.

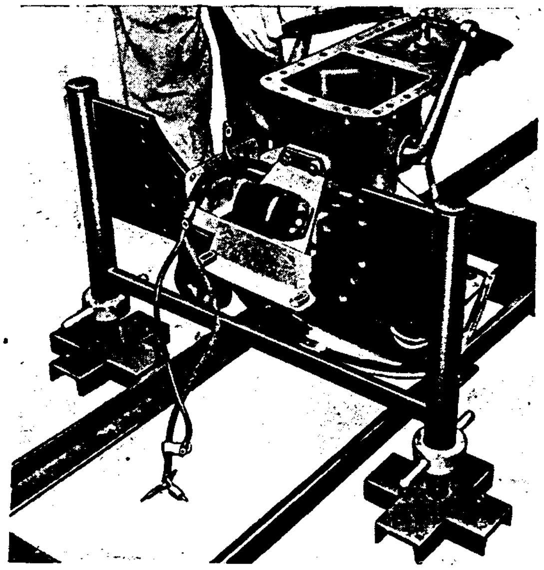


FIG. 8.
METHOD OF USING TRACTOR STAND TO SUPPORT STEERING ASSEMBLY.

NOTE : If steering wheel is removed, the assembly can be conveniently placed, base uppermost, on tractor chassis stand as shown in Fig. 8, for removal of base plate prior to draining oil from lower housing.

To Replace.

Procedure for replacement is a reversal of that given above for removal. However, the following points should be noted.

1. A new gasket (30) should be fitted between transmission housing and base plate (29) also if the plate, which is secured to housing (25) by ten screws (35), has been removed. A new gasket should be fitted between plate and steering housing. Gaskets (30) and (28) and housing screws (32) and (27) should be coated with "Titanine" before replacement.

2. Care should be taken when replacing assembly, not to disturb transmission shifter rail plunger springs and to locate gear shift lever end in selector grooves.

3. Should either of the rack sectors (22) have become disengaged from the pinion (13) their adjusting screws (26) should be slackened off (see page N.6) and the drop arm (21) or (33) connecting with the disengaged sector pulled outwards and rocked back so that the sector can be re-engaged. Trial and error should be employed for re-engagement until both drop arms are parallel when their lower ends are directly over foot rest brackets. This permits equality of left and right steering lock.

4. Refill steering housing after removal of plug (31). Capacity 5 pints (2.8 litres).

5. Reset and adjust governor. See Section F page F.7.

To Remove Sectors.

1. Remove steering assembly complete— See page N.4.

2. Remove pinch bolts and withdraw arms (21) and (33).

3. Pull out sectors (22) from engagement with pinion.

   NOTE : Oil Seals (34) can now be levered out and bushings (23) and (24) tapped out and similarly fitted.

To Replace Sectors.

1. Mesh sectors (22) with pinion, so that the splits in their bosses are in line at T.D.C.
2. Insert drop arms (21) and (33) through seals (34) into bushes (23) and (24) and sectors (22) with drag link bosses trailing towards gear shift lever location.
3. Tighten sector pinch bolts.

End thrust on sectors (22) is taken by adjusting grub screws (26) on either side of casing. Adjust for minimum back lash between pinion and rack sectors, without binding. Note master splines.

HYDRAULIC SYSTEM AND LINKAGE

FAULT TABLE

(File at end of Section L)

The following recommendations assume that the oil employed is in accordance with that stated in the Tractor Instruction Book.

NOTES :—

1. No fault should be investigated until engagement of the Power Take-Off shaft and the correct setting of the Control Spring has been verified.
2. It is also advisable to work the control lever quickly through its full range two or three times.

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
1. Will not lift or drop.	(*a*) Sticking of control valve. (*b*) Sticking of piston in hydraulic cylinder. (*c*) When in transport position certain implements of non Ferguson design compress control spring to such an extent that vertical fork is forced outside control lever range.	(*a*) Remove inspection plate and free valve by moving in and out of bush. If trouble not cured in this way, change oil and ensure that control valve stem is not bent—if so, remove and straighten. Ensure that hand control fork is central. Check fit of control valve bush in its locating passage in pump body. Check that there is sufficient freedom in the oscillating type control valve joint at all angles, for the valve to align itself squarely in its bush. Check that relief valve shield is not bent and fouling control valve. (*b*) Remove and clean hydraulic cylinder assembly. Examine and adjust piston ring gap. (*c*) The forward thrust on the control spring must be removed gradually in stages, until, when the control lever is pushed slowly forward, the implement lowers. WARNING : If the load is removed with the control lever in 'drop' position, the implement may 'crash' to the ground.
2. Will not lift.	(*a*) P.T.O. shaft not engaged. (*b*) Sticking control valve. (*c*) Sticking piston in hydraulic cylinder. (*d*) Serious leak in system between pump and hydraulic cylinder. (*e*) Pump aerated e.g. when replacement pump fitted. (*f*) Safety valve stuck open or spring broken.	(*a*) Move control on left inspection plate to rear. (*b*) See 1 a. (*c*) See 1 b. (*d*) Confirm by checking control valve is in lift position. Examine for leakage at all gaskets, and 'O' rings, cracked ram cylinder or valve chambers ; cracked or broken vertical tube. (*e*) Prime pump by loosening off clamps securing valve chamber plugs, and running tractor slowly with control valve in 'lift' position until all air is expelled. Retighten clamps. (*f*) Renew or service safety valve assembly as necessary.

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
3. Jerky or sluggish operation.	(*a*) Lift shaft locking screws too tight.	(*a*) Reset locking screws.
	(*b*) Tight piston in hydraulic cylinder.	(*b*) See 1 b.
	(*c*) Control valve travel reduced.	(*c*) Adjust hand control lever.
	(*d*) Control valve sticking.	(*d*) See 1a.
	(*e*) Fork retraction spring weak.	(*e*) Examine and renew if necessary.
	(*f*) Pump valves sticking.	(*f*) Dismantle pump and examine valves for freeness on guides.
	(*g*) Inlet and delivery valves incorrectly assembled.	(*g*) Check for correct assembly.
	(*h*) Gasket(s) leaking.	(*h*) Examine gaskets and 'O' rings and renew if necessary. Check torque loading on securing bolts.
	(*j*) Control spring plunger plate badly bent or worn, thereby altering the position of the top control fork in relation to control lever.	(j) Renew plate or adjust hand control lever.
4. Implement lifts at high engine speed, but not at idling speed.	(*a*) Oil Leakage between pump and hydraulic cylinder.	(*a*) See 2d.
	(*b*) Heavy load on linkage with hot oil in worn pump.	(*b*) Renew or recondition pump.
5. Implement falls when engine is stopped.	Oil draining from hydraulic cylinder due to :—	
	(*a*) Damaged gaskets.	(*a*) See 4.
	(*b*) Bad scoring of cylinder walls.	(*b*) Renew cylinder.
	(*c*) Worn rings.	(*c*) Renew rings.
	(*d*) Control valve too slack in its bush.	(*d*) and (e) Renew control valve or bush where necessary.
	(*e*) Control valve too short on sealing surfaces.	
	(*f*) Faulty check or relief valves.	(*f*) Renew where necessary.
	(*g*) Cracked ram cylinder, valve chambers, or cracked or broken vertical tube.	(*g*) Renew where necessary.

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
6. Implement jerking when in fully raised position.	(*a*) Lower link chain twisted. (*b*) Check chain anchors wrongly fitted. (*c*) Lower links wrongly fitted. (*d*) Pressure relief valve not seating. (*e*) Implement such as Potato Planter or Weeder which incorporate balance spring may transmit fluctuations to control fork.	(*a*, *b* and *c*) Refit correctly. (*d*) Remove and clean valve assembly (*e*) Move control lever approx. 1" forward from fully lift position to reduce fluxtuations.
7. Full working depth of Implement not obtainable.	(*a*) Soil-engaging parts of implement worn. (*b*) Implement not adjusted correctly. (*c*) Hand control lever requires setting. (*d*) Control spring out of adjustment.	(*a*) Resharpen, or, if wear excessive, replace worn parts. (*b*) Refer to Implement Instruction Book. (*c*) Re-adjust hand control lever. (*d*) Re-adjust control spring yoke.
8. Implement depth irregular.	(*a*) Soil engaging parts of implement worn. (*b*) Implement not adjusted correctly. (*c*) Excessive suck of implement. (*d*) Control spring out of adjustment. (e) Soil of varying texture. (*f*) Upper link rocker bush or lift shaft bushes seizing.	(*a*) Re-sharpen, or, if wear excessive, replace worn parts. (*b*) Refer to Implement Instruction Book. (*c*) Slightly lengthen top link as-assembly. (*d*) Re-adjust control spring yoke. (e) Regulate with hand control lever. (*f*) Renew bushes.

Ferguson

SERVICE MANUAL

Section O

FRONT AXLE
ASSEMBLY

INDEX

FRONT AXLE ASSEMBLY

The front axle assembly comprises three sections, the centre section pivoting on a trunnion mounted on the axle support bracket and forming the mounting for the outer sections. Due to the backward sweep of the centre axle section and the provision of suitable end float on the trunnion, track width can be altered without dismounting or adjusting track rods or steering drag links, which pivot on their rear ball mountings. However, when outer axle sections are extended to provide a wide track, their mounting bolts should be replaced at least 3 holes apart, never in adjacent holes—See Section Q, page 4.

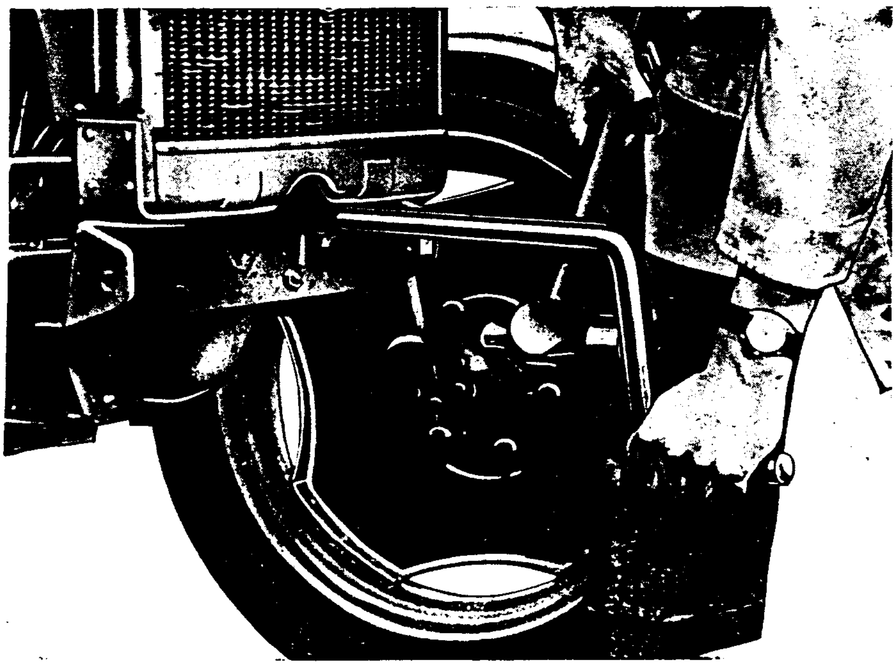


FIG. 1

Centre Trunnion.

The centre trunnion which is a press fit in the engine and radiator support bracket, can be removed without detachment of the bracket, using starting handle after first removing locating screw. With weight relieved from front wheels, insert starting handle, turn 90° to engage lugs behind trunnion and strike with hammer as shown in Fig. 1. Replace by tapping in position, afterwards inserting locating screw.

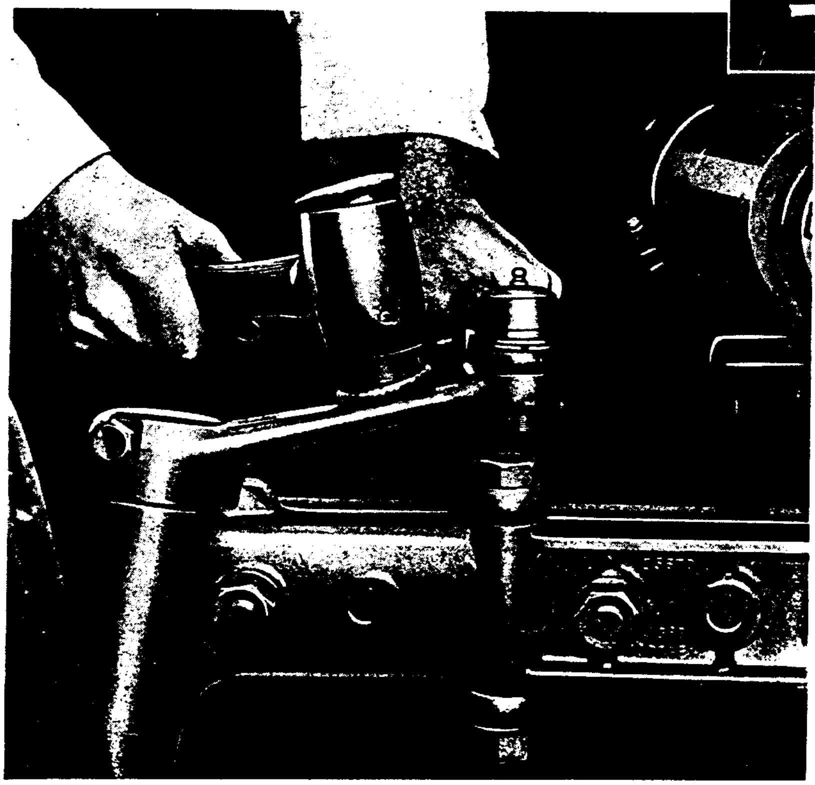
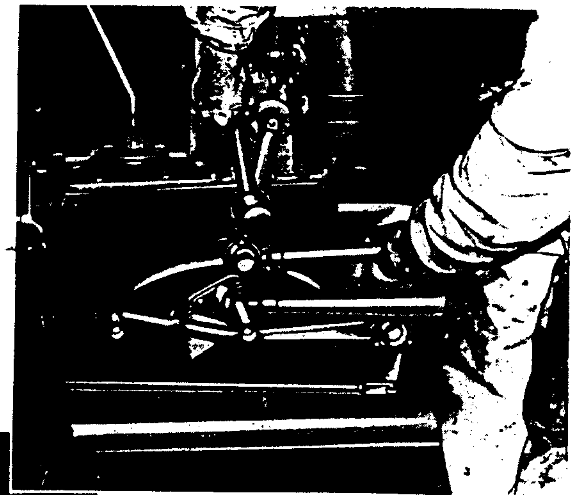


FIG. 2

To Remove Centre Beam.

1. Detach and swing clear axle outer section—2 bolts each.
2. Remove centre trunnion—See above.
3. Slide out centre section sideways.



Radius Rods.

Each bolted at forward end to outer axle section ; rear ball end supported in cup in footrest bracket. To detach, remove forward bolt and footrest.

Steering Drag Links.

Each assembly comprises a link rod with a spring-loaded, ball-ended taper pin mounted in a socket screwed into each end and secured by clamps. Provision is made for lubrication of ends through nipples located at top of sockets, grease being retained by rubber boots fitting over taper pins. Rear ball joints are not interchangeable from side to side or with front joints, because of the location of the grease nipples, and because shanks on front joints are right-hand, and rear left-hand, threaded. To detach, remove nuts and washers and free taper pins by tapping spindle arm and steering drop arm with hide-faced hammer, as shown in Fig. 2.

Removal of Front Axle Assembly.

It is convenient for access to certain engine components to remove the complete front axle and radiator assembly as follows :—

1. Drain radiator and cylinder block by opening their drain taps after having removed radiator filler cap.

2. Detach hood. This entails removal of two support attachment bolts from forward end of fuel tank and two shoulder screws from radiator support bracket.

3. Relieve load from front axle by trolley jack placed forward of sump drain plug.

4. Disconnect Steering drag links at rear. Until drag links are re-connected on assembly, care should be taken that the positions of drop arms or steering wheel are not altered.

5. Disconnect radius rods by removal of footrest.

6. Disconnect radiator hoses and stay to water outlet elbow.

7. Remove the four large and two smaller bolts securing front axle support bracket respectively to crankcase and sump.

8. Draw clear assembly comprising front axle radiator, radiator rods and track rods.

SPINDLE ASSEMBLY

To Remove.

For each spindle proceed as follows, referring to Fig. 3.

1. Support weight of engine by jack under axle support bracket.
2. Remove front wheel—six nuts.
3. Withdraw pinch bolt (2) and disconnect spindle arm (1) from spindle. Remove Woodruffe key and sealing ring (3) from spindle.
4. Withdraw from axle outer section (4) the spindle and hub assembly with bottom thrust bearing (6).

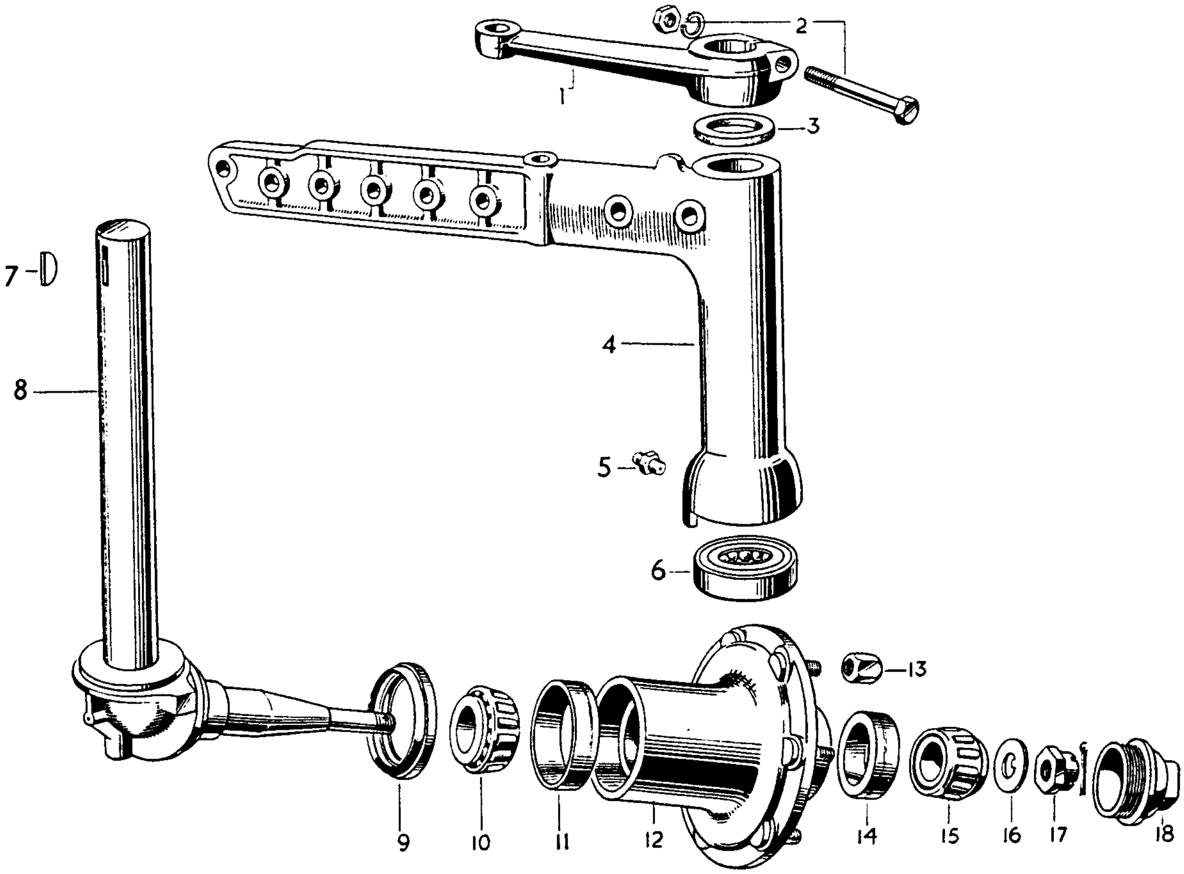


FIG. 3

To Replace.

1. Mount bottom thrust bearing (6) over spindle, seating on hub boss with casing uppermost.

2. Mount spindle in its bushes in front axle, replace sealing ring (3) and Woodruffe key ; replace spindle arm (1) and tighten pinch bolt (2).

   NOTE.—LH and RH spindle are not identical and should be mounted so that the keyway is parallel with axle beam when wheel hub is at right angles to tractor centre line.

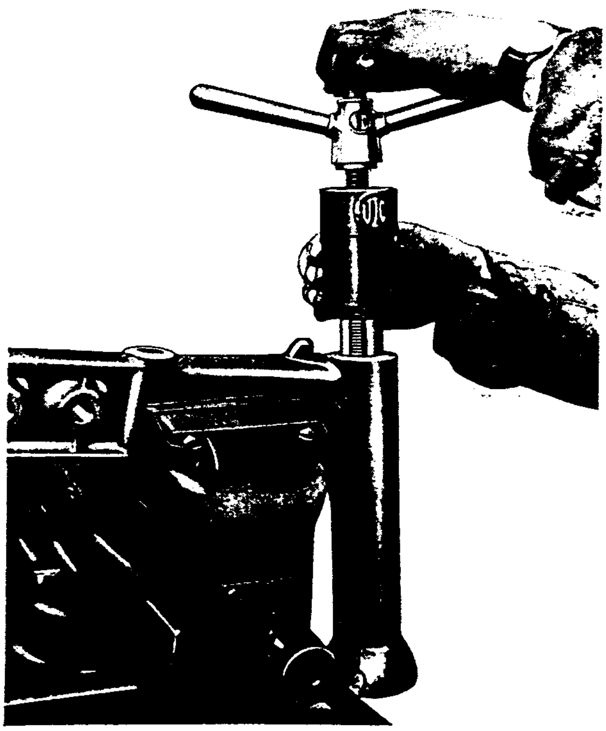


FIG. 4

Spindle Bushes.

Although these bushes can be removed, replaced and reamed with outer axle

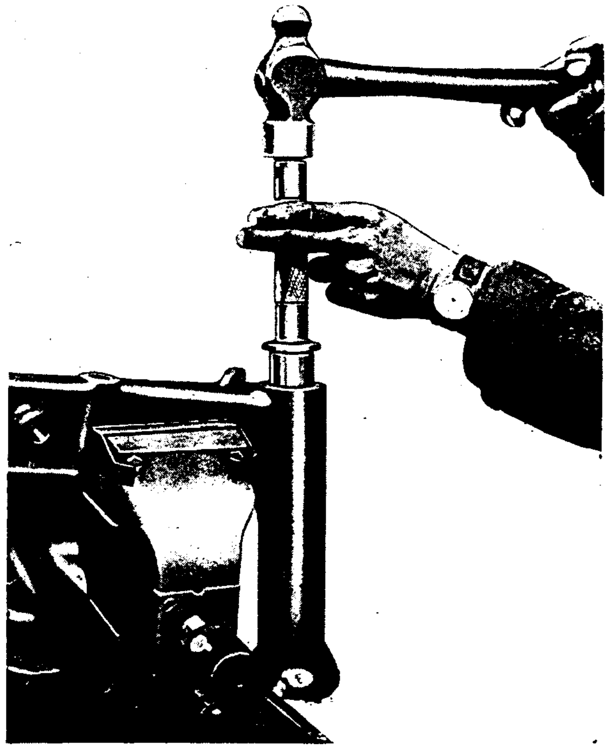


FIG. 5

section in position, the operation can be more conveniently carried out with this part mounted in a vice, as shown in the illustrations.

To Remove.

For each, proceed as follows :—

1. Remove swivel pin.
2. Treating upper and lower bushes in turn, mount bush remover, FT.17, as shown in Fig. 4, rotating smaller lever to enable tap to make a deep cut into bush, then turning larger lever to withdraw bush.

To Fit.

1. Remove lubricator (5, Fig. 3) and smear bush locating bores with oil.

FIG. 6

2. Mount bush on boss of replacing tool FT.18 and tap in position as shown in Fig. 5.

   NOTE.—To ensure correct fit of spindle shanks, bushes should be expanded and reamed after mounting, using reaming kit FT.19. as described in the following paragraph.

3. Place split boss of expanding tool supplied with the reaming kit on bush bore, as shown in Fig. 6 and tap through ball-ended rod. This corrects any compressive distortion which has taken place on inserting bush.

4. Ream bushes as shown in Fig. 7.

5. Wash with paraffin and blow out using compressed air, then fit lubricator.

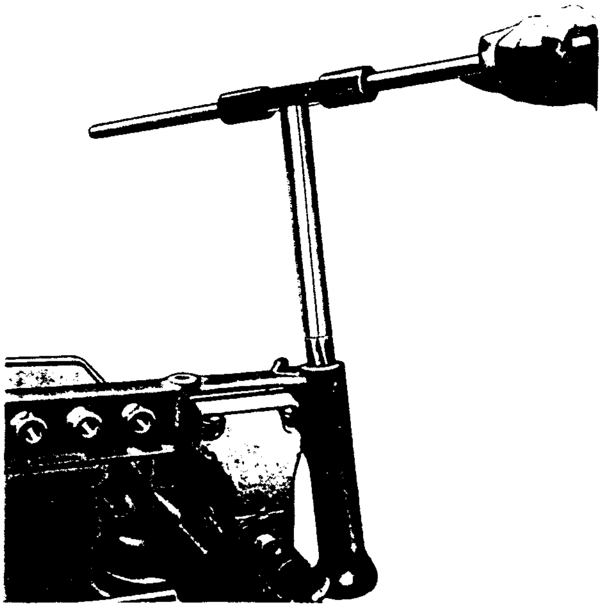


FIG. 7

O.

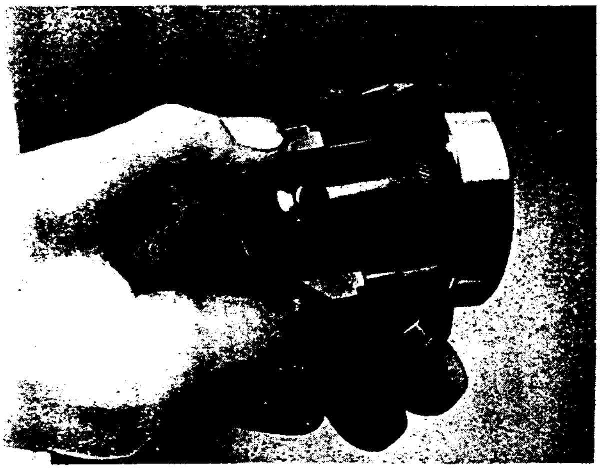
FRONT HUBS

Each mounted on two taper roller bearings (11) and (14) see Fig. 3, lubricated from oil reservoir of $\frac{5}{8}$ pint (.3 litres) contained in hub casing and retained by oil seal and gasket.

To Dismantle.

Support weight of engine by jack under axle support bracket, then for each hub, proceed as follows, with reference to Fig. 3.

1. Remove wheel—6 nuts (13).
2. Drain oil from hub, after removal of plug.
3. Remove hub cap (18).
4. Remove cotter pin, castellated nut (17),



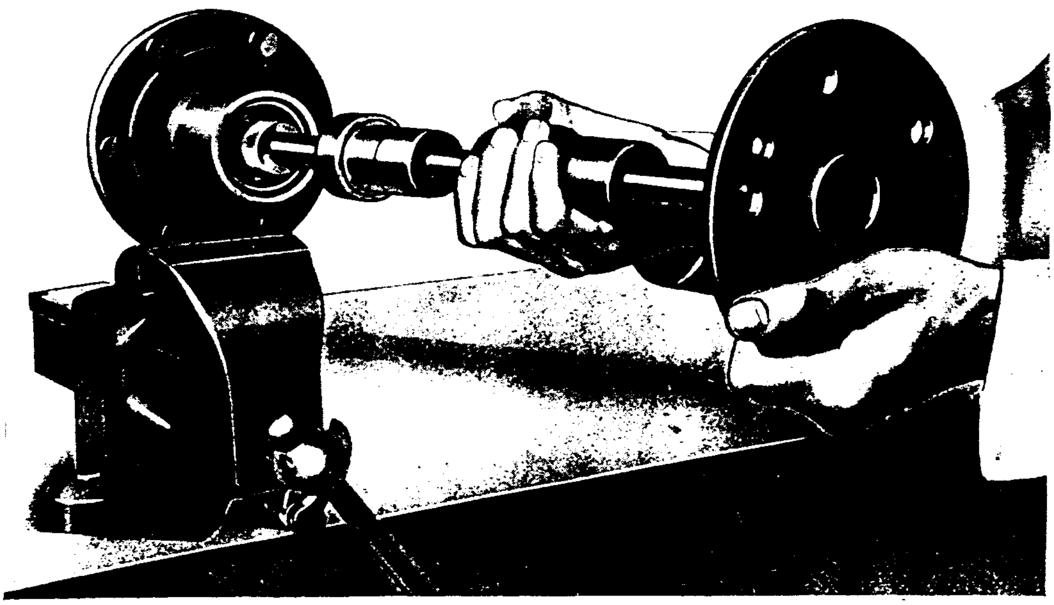


FIG. 8

retaining washer (16) and outer taper roller bearing (15).

5. Withdraw hub (12) from spindle (8)

lever oil seal (9) from its recess in hub, and remove inner taper roller bearing (10).

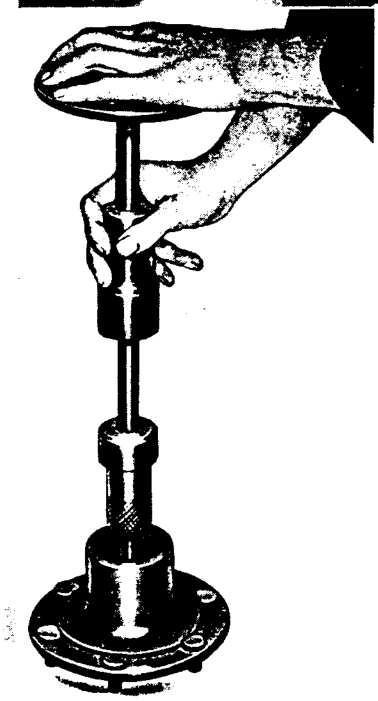
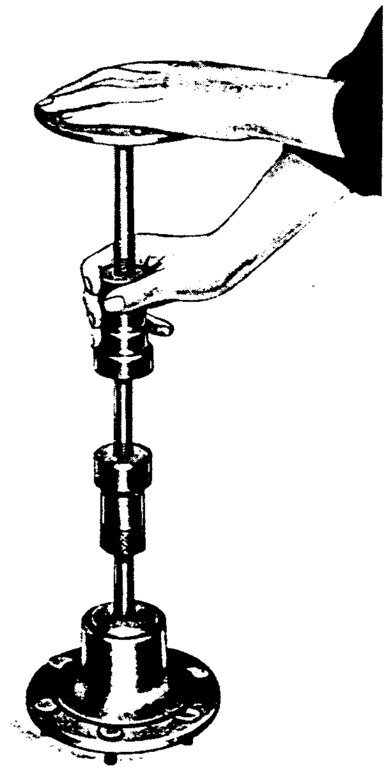


FIG. 9

6. Using service tool FTB.7 with connecting piece D and adaptor E remove inner

bearing cup 11 as shown in Fig. 8. With adaptor F in place of E tap out outer bearing cup, Fig. 9.



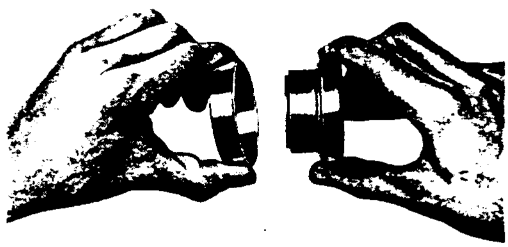


FIG. 10

To Assemble.

1. Tap in bearing cups using service tool FTB.7 with adaptor G as shown in Figs. 10 and 11 for inner and outer cups respectively.

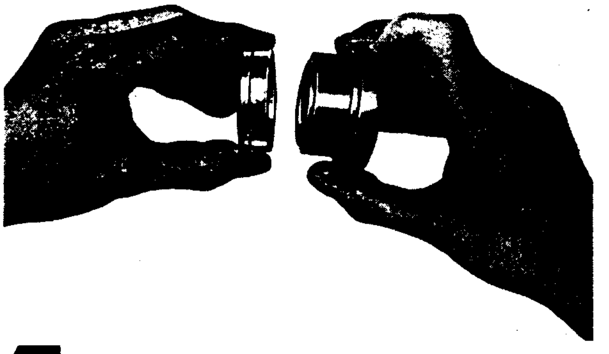


FIG. 11A

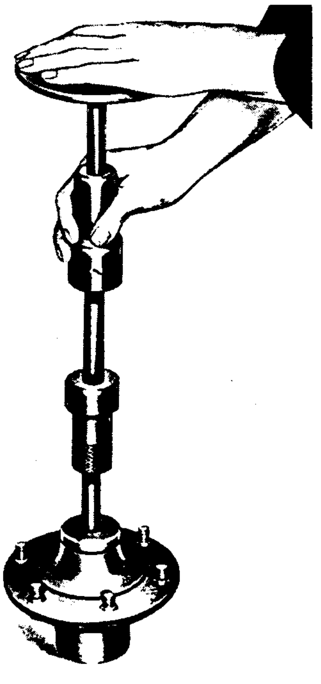


FIG. 11

2. Mount inner bearing in cup and tap in oil seal.

3. Mount hub on spindle and replace outer bearing with retaining washer, tighten castellated nut until hub locks, then unscrew one castellation before inserting cotter pin.

4. Mount hub cap with new gasket, fill hub with oil and attach wheel.

NOTE.—Oil should be poured into hub until it overflows from filler hole when positioned 45° from T.D.C.

SETTINGS AND ADJUSTMENTS

The following details of the principal factors governing front wheel alignment are given for reference, adjustment being provided only for toe-in.

Camber angle	2°
Spindle Inclination	9°
Castor Angle	$4\frac{1}{2}$°
Toe-in	$\frac{1}{8}$" (3.175 m.m.)

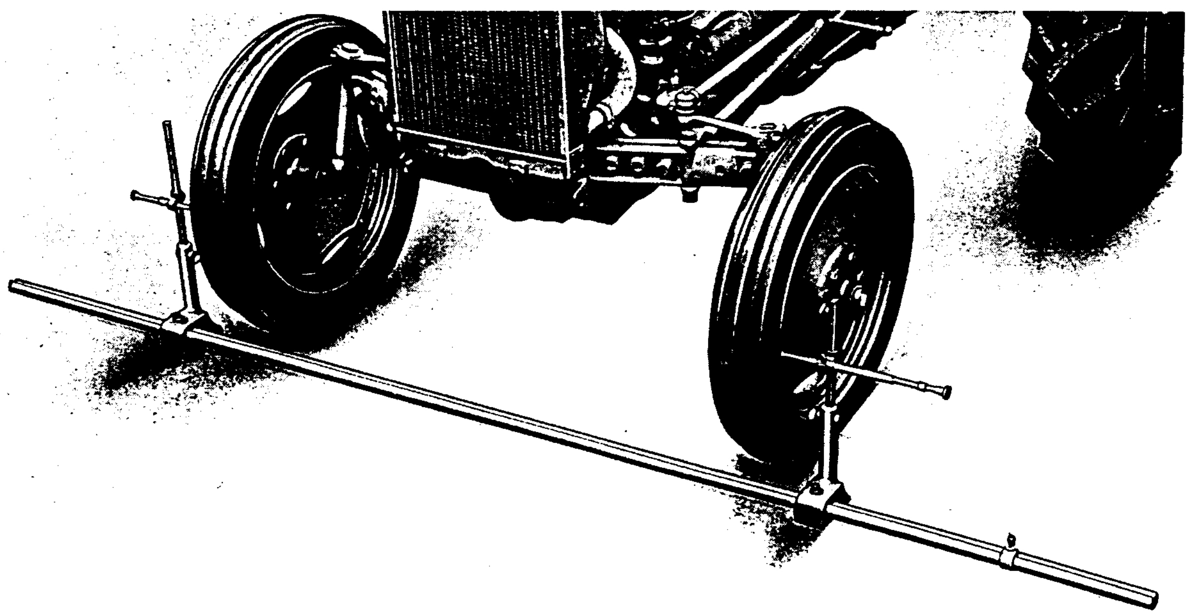


FIG. 12

Toe-in Adjustment.

This adjustment is facilitated if use is made of a fixture similar to the one illustrated in Fig. 12.

1. Align front wheels in straight-ahead position. This is indicated by equality of centre distances between forward drag link grease nipples and foot rest outer balls when rear drag link grease nipples are directly above footrests, and can be obtained by loosening end socket pinch bolts and turning link rods as necessary to shorten or lengthen until distance between grease nipple centres is approximately $37\frac{7}{8}$" (96.2 cms.).

2. Mount gauging jig as shown in Fig. 12 first in front, then behind front wheels, with points contacting outside of wheel rims.

3. Adjust lengths of both drag links so that distance measured in front of wheels is $\frac{1}{8}$" (3.175 m.m.) less than that measured behind.

Ferguson

SERVICE MANUAL

Section P

BRAKES

BRAKES

GENERAL

The brakes of the Agricultural Tractors are Girling internal expanding, 14″ × 2″, double anchor type fitted to the rear wheels only, providing 108 sq. ins. (697 sq. cms.) of friction area. They are specially designed for direct cross-shaft operation and may be applied together by means of a single pedal on the right-hand side of the Tractor or independently by pedals on either side. For normal braking purposes both brakes are applied together, but to assist turning the tractor in a small radius either left or right-hand independent brake can be applied.

Two types of brake will be found :—

(*a*) **Kidney-cam** operated—up to Tractor Serial No. 200,000 and between Serial Nos. 200928 to 201143 ; 201147 to 201156 ; 201618 to 201621 and 201625 to 204665.

(*b*) **Floating-cam** operated—Tractor Serial No. 200,001 and subsequent except as detailed in (*a*).

PRINCIPLE—FLOATING CAM TYPE BRAKES.

The shoes are fixed at the anchor pin end only, the adjuster unit being free to float within the confines of a centraliser spring mounted on the back plate.

The shoes are actuated by a cam formed integral with a shaft which is free to float within limits parallel with the line of operation. The shoes are held against the anchor pin by the action of return springs, the spring on the primary shoe being the weaker. Consequently, when the camshaft is rotated to open the shoes, the primary shoe having less resistance to movement opens first and the leading edge meeting the drum creates a servo-action which is transferred through the floating adjuster to the secondary shoe. The brake consists of a backplate on which is mounted the double anchor pin assembly securing one end of each shoe. Between the other ends of the shoe webs, is a barrel type adjuster operated by a crown wheel and pinion. A spring centraliser mounted on the backplate engages with a flange on this adjuster, and ensures that the shoes return to the central position after each operation. Between the shoe webs at the anchor pin end, is fitted the operating cam, formed integral with the shaft which has a guide in the anchor pin plate, and to which the foot pedal lever is directly connected. The shoes are kept square against the backplate by means of adjustable steady posts, spacer pins and washers.

ADJUSTMENTS — BOTH TYPES

1. Jack rear wheels clear of the ground.
2. Ensure that all shafts and pins work freely, and that when the brakes are " off " the brake pedals are against their stops.
3. Slacken off the centraliser nut B (next to the adjuster shank). Expand shoes fully in the drum by the adjuster A until the wheel is locked.

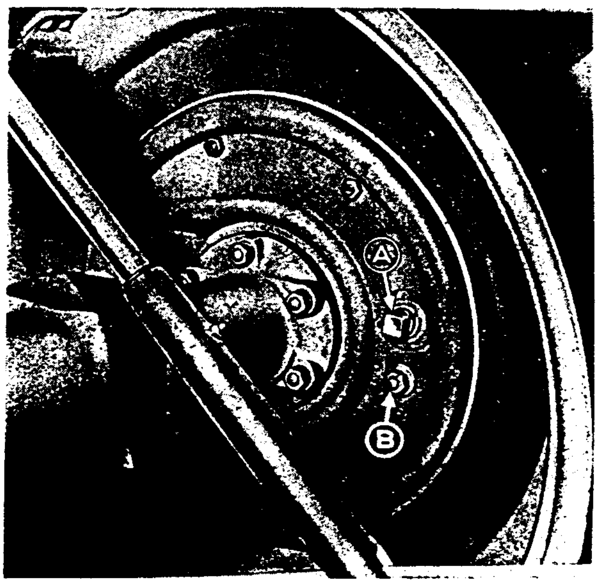


FIG. I
A. ADJUSTER. B. CENTRALISER NUT.

4. Tap lightly around the drum with a mallet to assist centralising and tighten centraliser nut.
5. Slacken adjuster until shoes are just

free in the drum. Six to eight clicks "off" is the recommended adjustment.

6. To test brakes for even balance engage 2nd gear and, driving at slow speed, apply the master brake firmly. Any tendency to veer off course should be counteracted by slackening off the adjuster for the brake on the side towards which veering takes place.

NOTE: The brake shoes can not be adjusted by altering the length of operating rods. The brake shoes themselves must be adjusted in the brake drums.

MAINTENANCE.

Independent brake linkage bush lubricators, introduced at Tractor Serial No. 225160 should receive attention every 10 working hours.

On no account must oil or grease be applied to the following bushes which are self lubricating :—

Combined brake shaft bushes (two) — transmission case.

Brake camshaft bushes (two) — rear axle housings.

SERVICING.

Wear or grease-fouling may make it necessary to replace brake linings. This is easily accomplished after removing the wheel and brake drum from the rear axle half-shaft flange. The wheel is attached to the axle half-shaft flange bolts by eight nuts and the brake drum to the flange by two cheese-headed screws. The brake shoes are then exposed and may be removed for service.

Examine brake linings. It is definitely not recommended that brake shoe relining should be carried out on the premises.

Replacement shoes should always be fitted if :—

(*a*) Excessive or uneven wear has taken place.

(*b*) Oil or grease has soaked into linings.

Note : Advantage should be taken of the Girling brake shoe reconditioning scheme for shoe replacements.

Shoes should always be replaced in pairs, i.e., both top or both bottom shoes—NOT SINGLY.

The ideal arrangement is for all linings of each brake to be of similar material. Failing this, the linings should be paired, i.e., both bottom shoes and both top shoes of each wheel should be of similar material. If linings are mixed it is possible to obtain a condition where the correct balance between right and left hand brake is very difficult to achieve.

BRAKE LININGS.

The materials can be identified by paint marks on each side of the lining and a complete list of linings which have been approved is given below for information :—

KIDNEY-CAM OPERATED TYPE.

Type.	Marking.
Ferodo VM23	4 powder blue marks equally spaced.
Don CM.	Red mark on left-hand edge.
Don LM	Red marks on left-hand and right-hand edge, and centre.
Chekko X14	Blue and red mark on left-hand edge and centre.
Mintex M.9	Green mark extending from left-hand edge to centre.

FLOATING-CAM OPERATED TYPE.

Don CM.	Red mark on left-hand edge.
Don R7.	Red mark on left-hand edge and centre.
Chekko XL3	Blue and Red mark on left-hand edge.
Chekko X14	Blue and Red mark on left-hand edge and centre.
Capasco HF6A	Black mark on left and right-hand edge and centre.

Note : Type **Chekko XL3** is the only lining recommended for the floating cam type brakes on 85 m/m bore and Diesel Engine Agricultural Tractors.

RECONDITIONING BRAKES

After a period of prolonged usage, and where for any reason the efficiency of the brakes has deteriorated, it is advisable to strip down and overhaul the braking system completely. To carry out this operation, in the minimum of time and with maximum results, proceed as follows :—

Detach front end of brake rods from cross-shaft levers then :

5. Inspect cam bush (D). Replace cam-plate and block assembly (2) if worn.

6. Smear cam, anchor pins on plate assembly (7), control shaft bearing bush, and cam pivot pin on control shaft crank with H.M.P. grease.

7. Replace brake control shaft with collar mounted but with set screw not tightened.

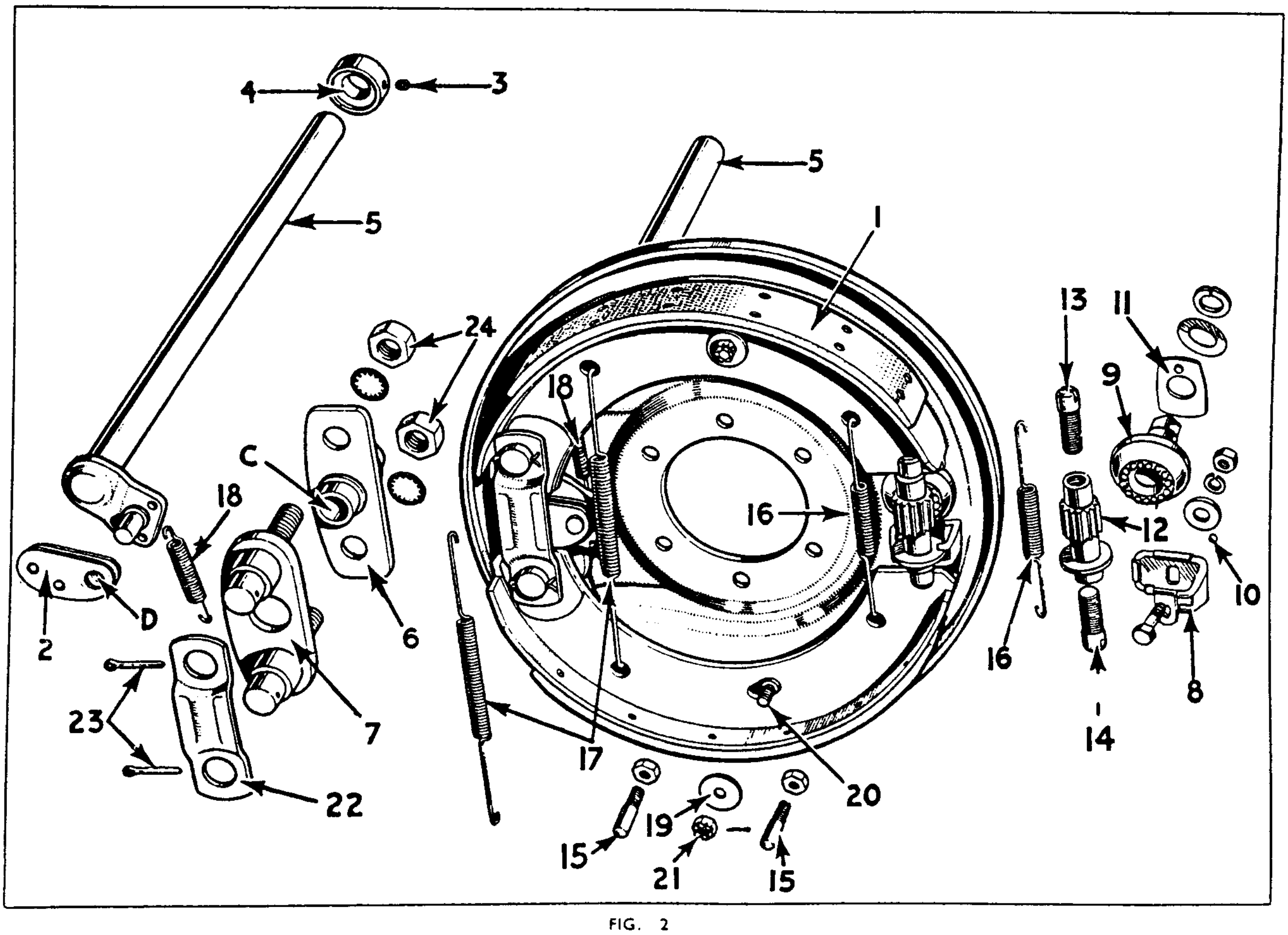


FIG. 2
KIDNEY CAM OPERATED BRAKE

(a) **KIDNEY—CAM OPERATED TYPE, FIG. 2.**

1. Jack up rear axle and remove wheels and brake drums.
2. Remove shoes (1) and Cam (2).
3. Loosen set screw (3) in collar (4) on brake control crankshaft (5) and withdraw shaft.
4. Inspect control shaft bearing bush (C). Replace bearing (6) if bush is worn.
8. Assemble kidney-shaped cam on control shaft crank ensuring that the straight edge is facing upwards.
9. Examine centraliser (8). Replace if spring is broken or distorted. Smear with H.M.P. grease and ensure that adjuster spindle is correctly located in centraliser (See Fig. 2.)
10. Examine crown wheel (9). Renew if teeth are worn. Examine clicker gear, ball (10) and retainer (11).

11. Clean and re-grease adjuster pinion (12) and screws (13) and (14).

12. Apply grease to steady posts (15).

13. Locate shoes on anchor pins and ensure that springs (16), (17), (18) are correctly positioned (See Fig. 2).

Note : Crank lever return spring (18) is connected to pin on backplate and nearer hole on control shaft assembly.

14. Apply grease to spacer pins (20) and washers (19).

15. Tighten slotted or self-locking nuts (21) on spacer pin washers until washers can just be rotated with fingers. Insert cotter pins as necessary.

16. Assemble strut (22) on anchor pins and fit split pins (23).

17. Fit drum to rear axle shaft flange and secure by tightening the two screws.

18. Reset shoes as instructed below.

(b) **FLOATING CAM TYPE FIG. 3.**

1. Jack up rear axle and remove wheels and brake drums.

2. Remove shoe return springs (1), (2) and (3), retaining washers (4) and strut (5).

3. Remove the castellated or self-locking nuts (6) and washers on both spacer pins. The shoes assembly can now be lifted off the backplate and easily taken to pieces.

4. Remove spring (7) and dust plate (8) from shaft, then remove camshaft (13).

5. Examine all moving parts (cam faces, adjuster pinion (9), crown wheel (10) etc.) and replace where worn or damaged. Particular attention should be given to the centraliser spring (11), which should always be replaced if broken or distorted.

6. Slacken steady post nuts (12) and screw the posts well back into the backplate.

7. Well grease control shaft (13) and anchor pins (14) using **only** Genuine GIRLING brake Grease. This grease is specially manufactured for the purpose and has a very high melting point to prevent it running under heat

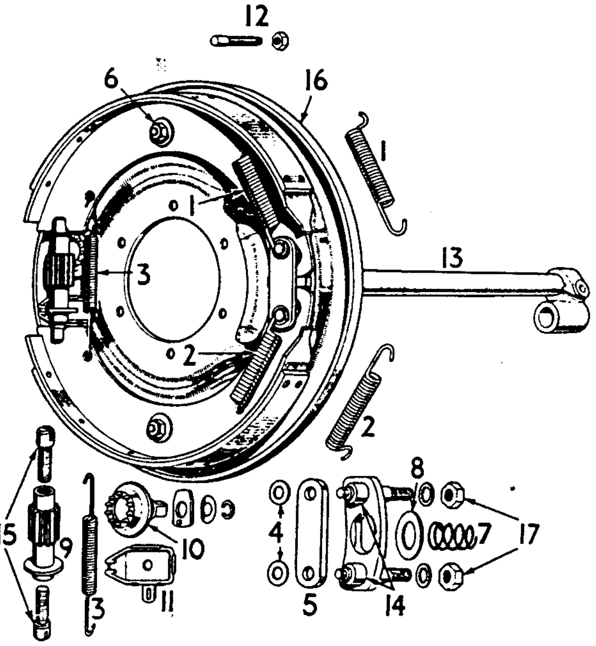


FIG 3
FLOATING CAM OPERATED BRAKE

8. Re-assemble shaft with spring (7) and dust plate (8).

9. Grease threads and flange of adjuster pinion (9) and spindles (15), grease centraliser spring (11) and steady posts (12).

10. Assemble shoes to back plate (16), engage nuts and washers (6) on first two or three threads and locate centraliser spring, and then position the holes in the shoe webs on the two anchor pins (14).

11. Replace anchor pin strut (5) and washers (4).

12. Fit the blue spring to primary shoe and red spring to secondary shoe, anchor pin end. It is advisable to fit

NEW springs when fitting replacement shoes.

13. Grease shoe webs around spacer pin holes and replace spacer pin washers and nuts (6). These nuts must not be excessively tight, it should be possible to rotate the washer by the fingers.

14. Before fitting brake drums, set shoes square to axle flange. This should be effected by clamping a straight edge under one wheel nut and checking the braking surface with a square against the straight edge.

    Adjustments should be made on the steady pins (12) and nuts (6), making sure that on completion the shoe web is free to move between these components and is not held tight by them.

Note : For lubrication of brake mechanism use only Girling high melting point brake grease. Lubricate all screw threads before tightening.

RESETTING SHOES—KIDNEY CAM AND FLOATING CAM OPERATED TYPES

1. Slacken off anchor pin nuts and centraliser nut one to two turns. The shoes must now be set to obtain the correct clearances between lining and drum. This operation is most important as the ultimate efficiency of the brake depends upon the accuracy with which the shoes are centralised and set.

2. Fully expand the shoes in the drum by means of the adjuster. With a hide or copper hammer, tap anchor pin nuts and centraliser nuts to ensure that they settle in their correct positions. Ensure that the shoes are still fully expanded in the drum by tightening on the adjuster. If this will tighten further repeat tapping procedure.

3. Tighten up centraliser nut and anchor pin nuts using a 16″ (400 mm.) spanner for the latter. THESE MUST BE VERY TIGHT.

4. Kidney Cam Type Only : Position the collar on the brake cranked shaft so that the shaft is free to turn with no end float. Tighten set screw.

5. Screw in steady posts until they are in light contact with the shoe webs and tighten locknut.

6. Slacken off adjusters.

7. Fully expand shoes in drum prior to reconnecting linkage, see below.

RE-CONNECTING LINKAGE

Both brake rods, being detached from cross-shaft and brake shoes fully expanded in the drum proceed as follows :—

Adjust yoke ends of brake so that clevis pins can be inserted without difficulty, with the cross-shaft arms one spline back from the vertical position, meanwhile pulling on rods to remove excessive play in fork ends and clearance between cam and shoe tips. Insert cotter pins.

Slacken off adjuster 6 to 8 clicks.

Test brakes as instructed in " Adjustments."

BRAKE FAULT TABLE

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
Insufficient stopping power.	(*a*) Shoes incorrectly adjusted. (*b*) Brake rods incorrectly adjusted. (*c*) Grease or oil on linings. (*d*) Incorrect lubricating grease which melts and fouls linings. (*e*) Centraliser spring distorted or broken. (*f*) Bush of linkage seized, due to grease having been applied.	(*a*) Adjust as instructed. (*b*) Adjust as instructed. (*c*) Fit replacement shoes. (*d*) As above, use High Melting Point Grease. (*e*) Renew. (*f*) Remove and wash in petrol.
Application of combined brake pulls tractor to one side.	(*a*) Brakes balanced incorrectly. (*b*) Check for item (*a*) to (*e*) in section "Insufficient Stopping Power." (*c*) Linings not of same material.	(*a*) Adjust as instructed. (*b*) As instructed. (*c*) Fit shoes with correct and matched linings.
Brakes bind.	(*a*) Adjustment too close. (*b*) Brake pedals not returning to their stops in OFF position. (*c*) Shoe return springs weak.	(*a*) Adjust as instructed. (*b*) Check for free movement of pins and shafts. Ensure that brake rods are adjusted to correct length. (*c*) Renew.
Brakes harsh in action.	(*a*) Uneven wear on linings due to incorrect adjustment. (*b*) Anchor pins not dead tight.	(*a*) Reset brakes as instructed. (*b*) Tighten anchor pin nuts.
Brake squeal.	(*a*) Vibration between steady posts, spacer washers and shoes. (*b*) Linings worn to rivets.	(*a*) Lubricate these parts as instructed. (*b*) Renew shoes.
Independent brake linkage not operating.	(*a*) Grease may have been applied to self-lubrication bush, with result that stop assembly shaft sticks.	(*a*) Remove linkage and wash in petrol.

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SERVICE MANUAL

Section Q

WHEELS AND TYRES

WHEELS AND TYRES

		Front Tyre	Rear Tyre
Standard Size	—	4.00-19	10-28
Normal Pressure	—	26 lb. sq.in. (1.8 kg./sq. cm.)	12 lb. sq. in. (.85 kg. sq. cm.)

Rear Wheel

Wheel disc (1) is mounted to lugs (2) on wheel rim (3) by six bolts with washers

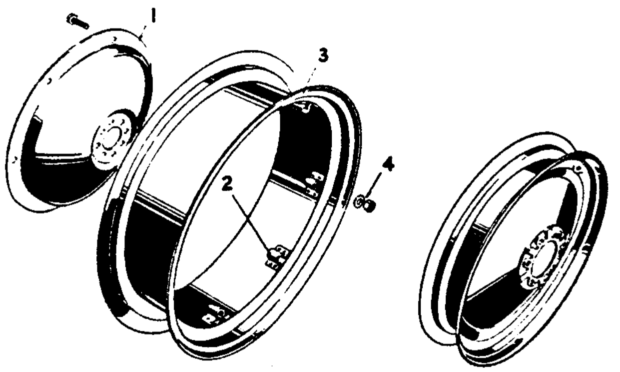


FIG.

and nuts (4). The disc is attached by eight bolts to the rear axle half shaft flange.

NOTE : (i) If it should be necessary to fit replacement rims or discs, care should be taken to use the appropriate lug bolts.

i.e. Part No. 1385—Short bolt for use with discs of tapered section.
Part No. 2184—Long bolts for use with discs of uniform section.

(ii) Wheel removal and replacement is made easier by the use of twin wheel nut wrench—service tool No. FTB18. Fig. 2.

Front Wheel.

The rim is not detachable from the wheel, which is mounted on six bolts in the front axle hub flange.

Tyres

The inflation pressures given above have been found suitable for all general work. Certain special conditions necessitate

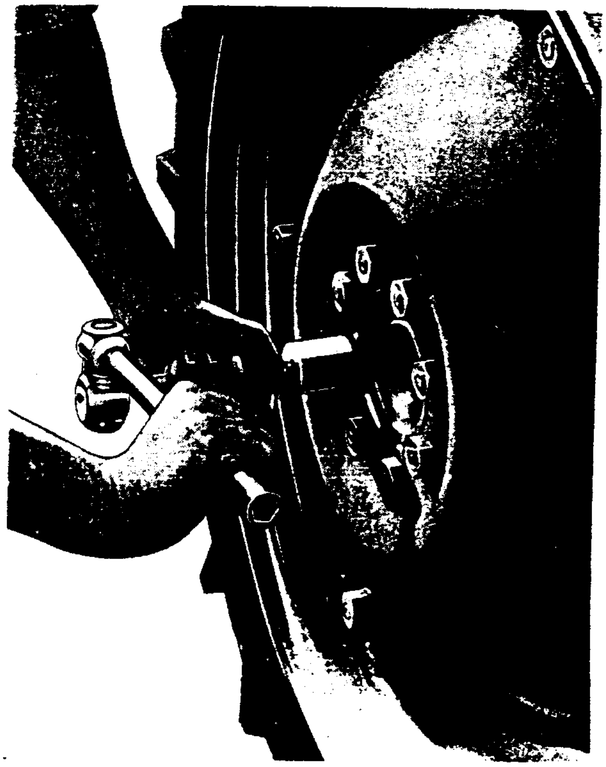


FIG. 2

the following adjustments of rear tyre pressure.

Trailer work – – –	15 lb. sq. in. 1 kg. sq. cm.
Very soft soil conditions	10 lb. sq. in. .7 kg. sq. cm.

It it most important that inflation pressures should be adjusted to normal as soon as suitable working conditions exist.

The employment of water ballast in rear tyres is not recommended.

NOTE : When fitting or removing tyres be **quite sure** that the beads are carefully adjusted into the rim well.

FITTING TYRES

Front Tyres—Inflation pressure 26 lbs. per sq. inch (1.8 kilos per sq. cm.).

1. Place cover eccentrically over the rim and press the lower bead as much as possible into the well of the rim.
2. Lever bead over flange.
3. Inflate tube until just rounded out (i.e. without stretching it).
4. Insert tube in cover with valve through hole in wheel rim, taking care that valve, fitted to side of tube, is on correct side of rim.
5. Press upper bead into well of rim diametrically opposite the valve and insert lever as closely as possible to the position where the bead passes over the flange.
6. Starting from this position, complete levering bead over flange.
7. Push valve inward to ensure that the tube adjacent to the valve is not trapped under the bead. Pull valve firmly back into position and inflate. If, during inflation, the valve does not protrude squarely from the rim, deflate the tyre and adjust the position of the cover and tube on the rim.
8. Re-inflate and check the concentricity of the fitting line on the cover with the top of the flange.
9. Remove valve core to deflate the tube completely, but do not disturb the beads of the cover.
10. Re-inflate to recommended working pressure of 26 lbs. per sq. inch. (1.8 kilos per sq. cm.). The object of double inflation is tc permit any stretched portions of the tube to re-adjust themselves in the cover, and relieve any strains in the tube.

Rear Tyres—Inflation pressure 12 lbs. per sq. inch (.85 kilos per sq. cm.).

1. Inflate tube until just rounded out (i.e. without any stretch) and fit into cover.
2. Lie wheel on floor with valve hole upwards. Place cover and tube, valve pointing upwards, eccentrically over rim. Pass valve through hole in rim and screw rim nut lightly on to valve (Fig. 3).

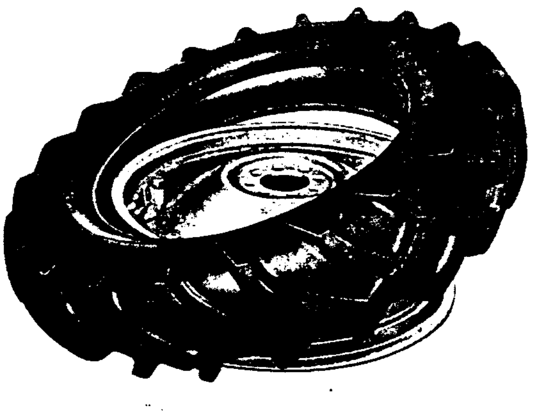


FIG. 3

3. Press lower bead as much as possible into well of rim.
4. Insert a 20″ (50 cm.) spoon lever as closely as possible to the point where the bead passes over the flange and lever bead over. Repeat until bead is completely over flange.
5. Press the upper bead into the well of the rim diametrically opposite the valve. Insert a spoon lever as closely as possible to the point where the bead passes over the flange and lever bead over. Repeat until the bead is completely over flange, finishing at the valve position (Fig. 4).
6. Push valve inwards to ensure that the tube adjacent to the valve is not trapped under the bead. Pull valve firmly back into position and inflate. During inflation, see that the valve protrudes squarely from the rim. If it does not do so, deflate the tyre and adjust the position of the cover and tube on the rim. Tighten rim nut.

7. Inflate to a pressure of 30-35 lbs. per sq. inch (2—2.5 kilos per sq. cm.) and then reduce to 12 lbs. per sq. inch (.85 kilos per sq. cm.). The object of this operation is to ensure that the beads are pressed fully home on their seats, so preventing any tendency towards tyre creep.

8. Ensure that the fitting lines on the cover are concentric with the top of the flange and check valve fitting for tightness.

FIG. 4

REMOVING TYRES

Front and Rear Tyres.

1. Remove valve cap and core, (in the case of rear tyres, remove also

FIG. 5

rim nut) to deflate tyre. Place these parts where they will be free from dirt and grit.

2. Using suitable levers press each bead in turn off its seat on rim (see Fig. 5). Two or three circuits of the tyre may be necessary to free bead completely.

3. Insert a lever at valve position, and while pulling on this lever, press the bead into the well of the rim, diametrically opposite the valve position (Fig. 6).

4. Insert a second lever close to the first and prise the bead over the rim flange, holding the removed portion of the bead with the first lever. Proceed in the usual manner until the bead is completely off the rim.

FIG. 6

5. Remove tube from cover.

6. Stand the wheel upright, and insert a lever between the remaining bead and the rim flange. Pull cover back over flange.

If cover is difficult to remove, maintain the pressure on the lever and tap the bead with a rubber mallet where it passes over the top of the flange.

Levers suitable for use when removing and fitting tyres are available from Messrs. Dunlop, Limited, under part Nos :—

Small lever (front tyres)—TL. 12
Large lever (rear tyres)—TL. 20
Cranked lever —TL. 14

TRACK WIDTH ADJUSTMENT

The track of the rear wheels can be adjusted in 4″ (10.16 c.m.) steps between 48″ (122 c.m.) and 72″ (183 c.m.) assembling

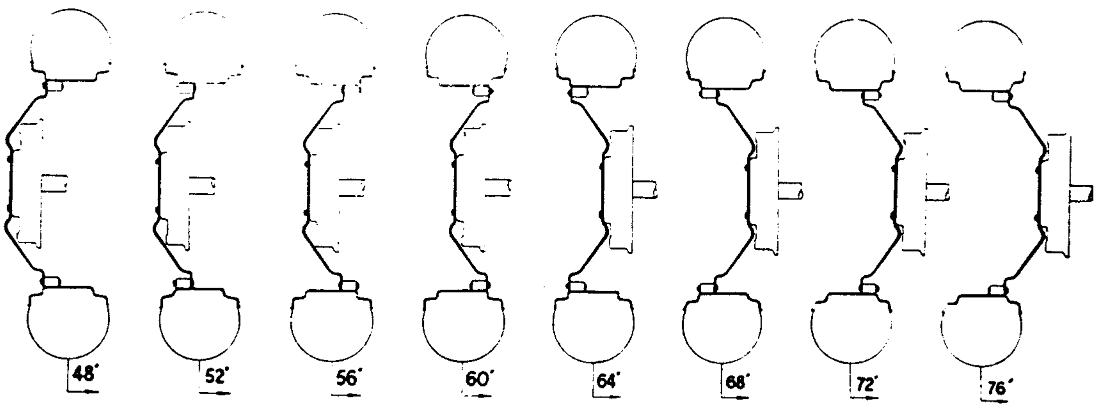


FIG. 7

the disc and rim in different positions as shown in Fig. 7. Track changes from a setting of 48″ to 52″, 64″ and 68″ (122 c.m. to 132 c.m., 162.5 c.m. and 172.7 c.m.) are made without changing the wheels to the opposite side of the tractor, whereas tracks of 56″, 60″, 72″ and 76″ (142.25 c.m., 152.5 c.m., 183 c.m. and 193 c.m.) necessitate moving wheel to the opposite side. This is indicated by the arrow on the side wall of the tyre, which, to obtain maximum traction, must always point in the direction of forward rotation.

The front axle is made in three parts which may be assembled to give the track width desired. This gives settings from 48″ (122 c.m.) to 72″ (183 c.m.). Widths of 76″ or 80″ (193 c.m. or 203 c.m.) are obtainable merely by reversing the wheels with the axle at the setting of 68″ or 72″ (172.7 c.m. or 183 c.m.).

Loosen the vertical bolt through radius yoke, remove bolts securing axle and spread as desired.

No change in steering connections is necessary. Always assemble axle with one hole between bolts holding axle together and never in adjacent holes.

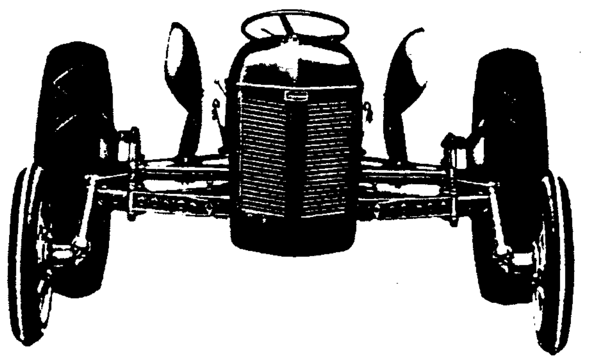


FIG. 8

Fig. 8 shows a tractor with wheels set to wide track.

STEEL WHEELS

Ferguson steel wheels have been designed for obtaining extra traction under particularly difficult conditions without using excessive weight.

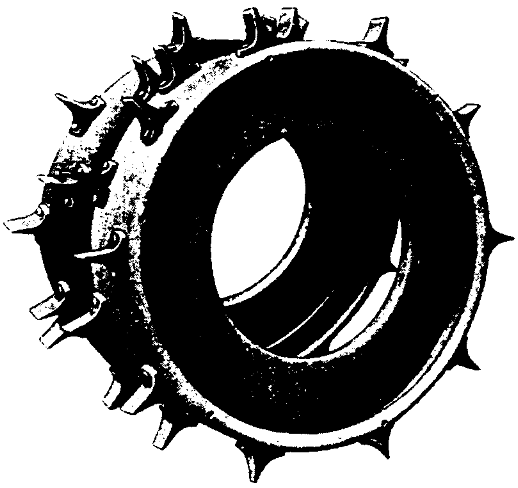


FIG. 9

Type ATE.1100 (Fig. 9) of 40″ (101.6 cm.) dia. 10″ (25.4 cm.) wide and with 20 detachable lugs is suitable for all general work.

As steel wheels are mounted to wheel discs in exactly the same way as tyre rims, instructions given for rear track width adjustment apply when steel wheels are in use.

WHEEL GIRDLES

Assembly.

Each wheel girdle comprises five rigid stirrups connected and held to the tyre by tension links. It is shipped in two unequal lengths which must first be bolted together

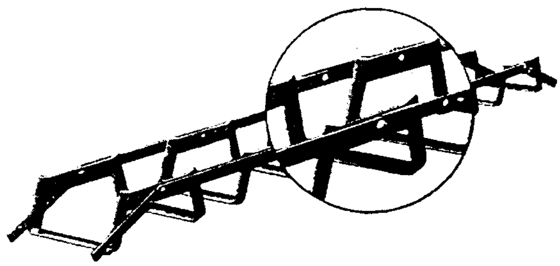


FIG. 11

as shown in Fig. 11. The tapped holes in the stirrups used for attachment of spade lugs must all be on the outside of the girdles when fitted. Although there is provision for the fitting of ten lugs, not more than five should be required on each girdle.

Fitting

1. With girdles positioned behind tractor, reverse tractor so that rear wheels stand on second stirrup. Fig. 12.

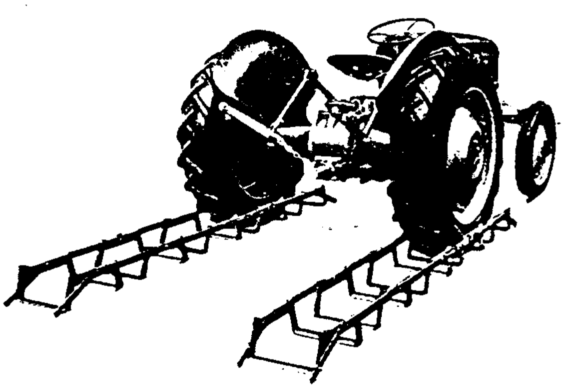


FIG. 12

2. From the rear, guide the girdles over the tyre until all the stirrups are in contact, Fig. 13.

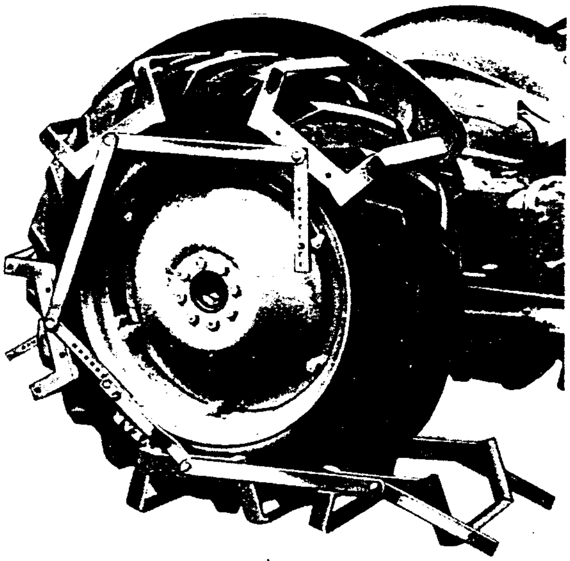


FIG. 13

3. Draw the end stirrups together with the hand tool, in turn, on both sides of each girdle. Engage pin on link attached to lower stirrup with a hole in link from upper stirrup, Fig. 14. Secure with bolt.

NOTE : Girdles cannot be fitted to wheels at 48″ (122 cm.) track. When operating with a 10″ (25.4 cm.) plough it is recommended that a girdle is used on land wheel only, which should be set to 52″ (132 cm.) track. The furrow wheel remains at 48″ (122 cm.) setting.

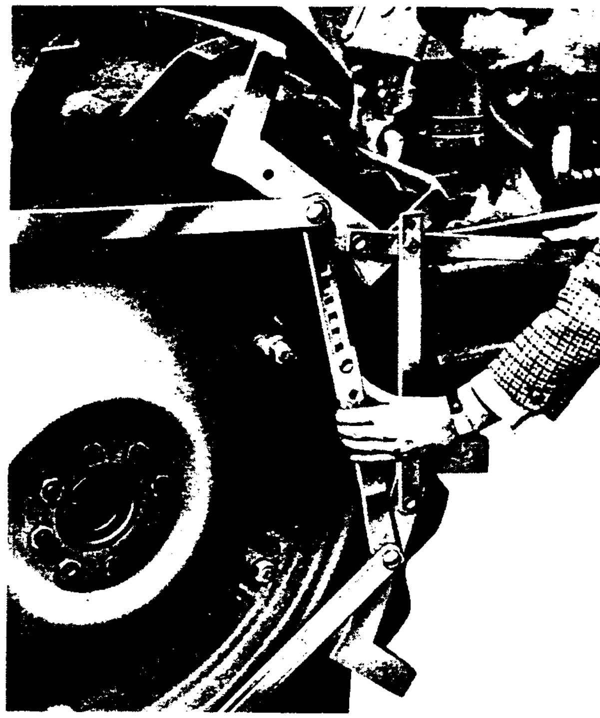


FIG. 14

Adjustment.

Correct degree of tightness allows slight freedom of movement of each stirrup and, properly tightened, the girdle will ' creep ' relative to the tyre, which makes it self-cleaning, gives resilience, and increases ' bite.'

Holes along two of the connecting links provided tightness adjustment for the girdles to suit condition of tyre ; as tyre wears, take up part adjustment at second set of adjustable connecting links to maintain even spacing of stirrups.

The FERGUSON SYSTEM
TRADE MARK

Ferguson

SERVICE MANUAL

Section R

SEAT, HOOD AND FENDERS

SEAT, HOOD AND FENDERS

DRIVER'S SEAT

This is secured by two nuts to studs located in hydraulic lift cover. A choice of three positions of seat on seat spring can be obtained by re-positioning securing bolt, nut and lockwasher.

HOOD

It is strongly recommended that suitably shaped formers, felt-lined to protect paint-work, are used to enable the hood top panel to be rested upside down for assembly. During assembly, paint should be removed from all screw threads by running through a suitable tap or die as necessary.

Assembly

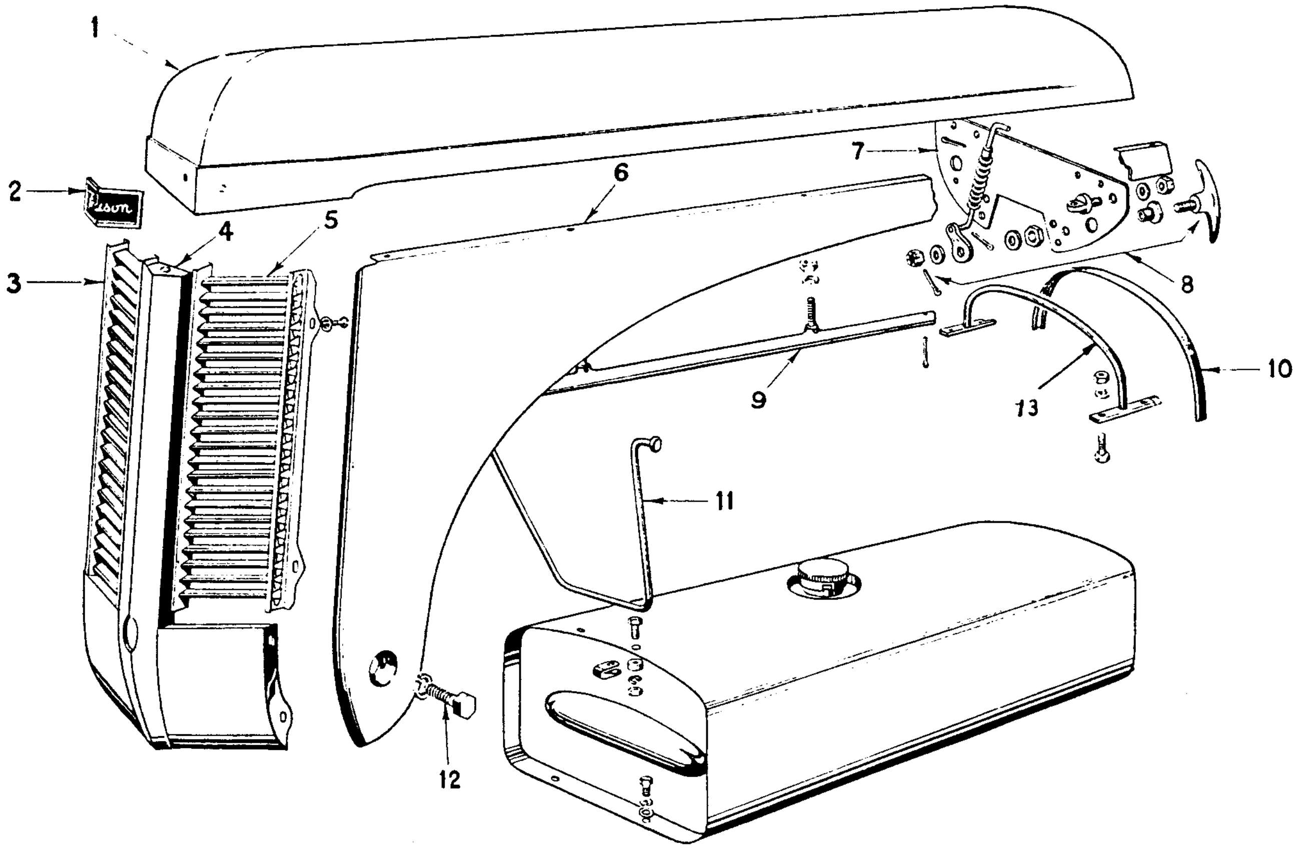
1. Secure name plate (2)—two screws.
2. Attach lower panel and centre bar assembly (4) to hood top panel (1) inserting screw below name plate, and setting back panel (4) so that none of the top edge of the centre bar is projecting.
3. Tap runners of head stiffening strap (13) into locating channels inside hood top panel, with cut-away slots to rear.
4. Insert split pins in end holes of hood side runners (9) and locate runner securing studs through the blank holes of side panels (6) and hood top panel, so that split pins are to rear. Secure with nuts and lock washers.
5. Insert bolts through the four remaining holes (backed by stiffening plates) in each side panel and secure to top panel by nuts and lockwashers.
6. Lever square the welded-on lugs of side panels before attachment of front grilles (3) and (5) by four round headed screws, each with lock-washer.
7. Attach bottoms of side panels to lower front panel (4) by four bolts with nuts and lock washers, first having removed burrs from front panel pressing.

Should there be clearance between grilles and side panels, the grilles should be tapped into place using a suitably shaped wood block.

Mounting

1. Place hood in position over radiator and engine.
2. Place suitable guides through holes for shouldered pivot screws (12) into the tapped holes of retained nuts in engine and radiator support assembly, then pivot hood forward.
3. Insert and tighten each pivot screw (12) on lock washer.
4. Slide hood support bracket (11) into runners (9) and attach on front of fuel tank by means of nuts and bolts through clips.

NOTE.—Rubber mounting strip (10) is riveted to the instrument panel of all tractors except those of very early manufacture, in which case it is riveted to the hood.



Hood Catch

The hood catch assembly, comprising detail (8) in the illustration, is mounted on the bulkhead (7). When the catch assembly is in the position shown, the hood is secured ; anti-clockwise movement of the handle is necessary to pivot the upper cranked end of the catch inwards, releasing the hood.

FENDERS

Each fender is secured to the rear axle housing by two bolts and nuts. However, should these bolts be too short to accommodate the hydraulic linkage stabiliser assembly, they should be replaced by longer ones.

Section T

NARROW WIDTH TRACTOR

INDUSTRIAL TRACTOR

THE FERGUSON NARROW WIDTH TRACTOR

TE-C20 Petrol Engine Version
TE-E20 V.O. Engine Version
TE-J20 L.O. Engine Version

Specification

Overall Dimensions

Wheel Track : Front — Adjustable in 4" steps (102 mm.) from 44" (1117 mm.) to 60" (1524 mm.).

Rear — Adjustable in 4" steps from 42" (1066 mm.) to 66" (1676 mm.).

Turning Circle Diameter (with track 42" rear, 44" front) with independent brakes : 18′ (5486 mm.), without brakes : 20′ (6096 mm.)

Weight (dry) TE-C/E/J20
Up to Serial No. 32500 : 2327 lbs. (164 kg.)
Serial No. 325001 and future : 2397 lbs. (168 kg.).

For all other Data refer to General Specification, Page B.1.

GENERAL

The Narrow Width Tractor is designed for use in orchards, plantations and closely planted areas where the employment of the normal width model is not practicable.

It is in all essentials the standard Ferguson Tractor and its efficiency and performance are unimpaired. The overall width, however, is 4′ 6" instead of 5′ 4" and the minimum track widths are : front 42", rear 44".

To obtain the narrow width, certain modifications have been made. The components affected are shown in Figs. 2 and 3.

FRONT AXLE

A narrow front axle is fitted and radius rods and steering drag links altered to suit.

The front wheels are fitted with hub caps which prevent damage to growing crops by parting them aside, out of the track of the rear wheels.

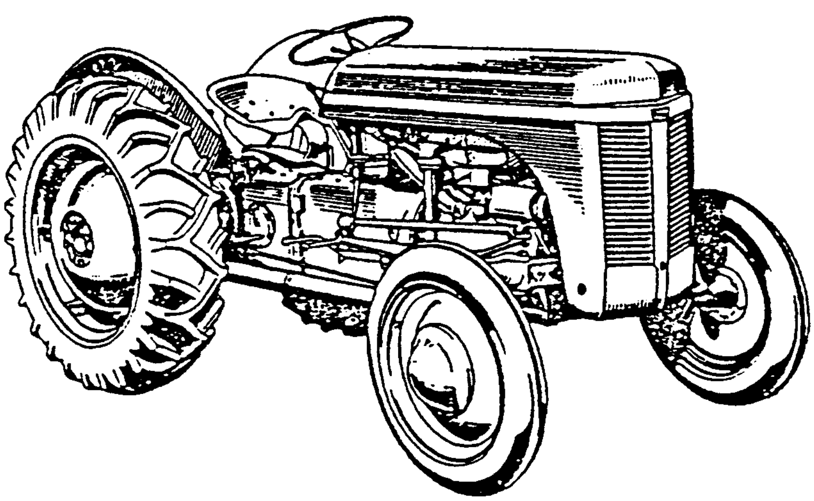


FIG. 1. NARROW WIDTH TRACTOR

REAR AXLE

The rear axle shafts and housings are shortened, necessitating the use of modified brake pedal and a shorter brake camshaft.

HYDRAULIC LINKAGE

The lower links of the hydraulic lift are formed to clear the narrow wheel track and the check chains and anchors are also modified. A loose tommy bar replaces the cranked lever fitted on standard models for levelling box adjustment, to accommodate the reduced clearance.

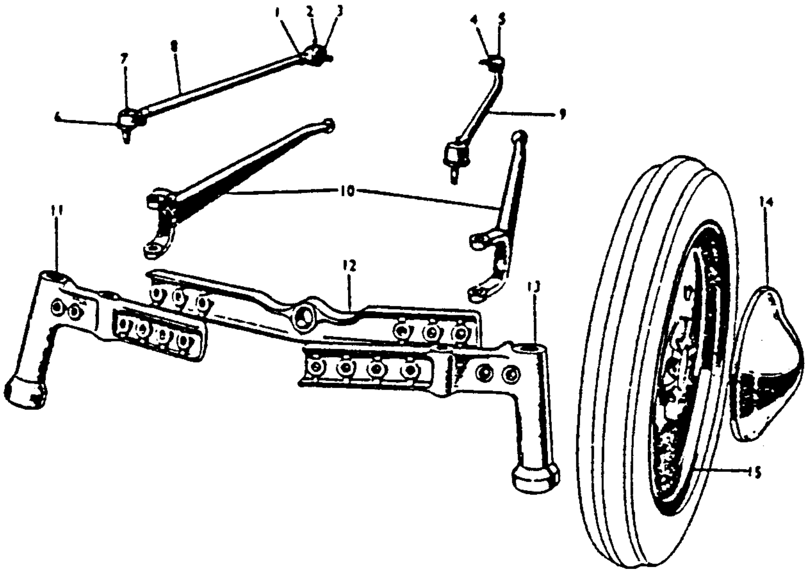


FIG. 2. FRONT AXLE AND RELATED PARTS

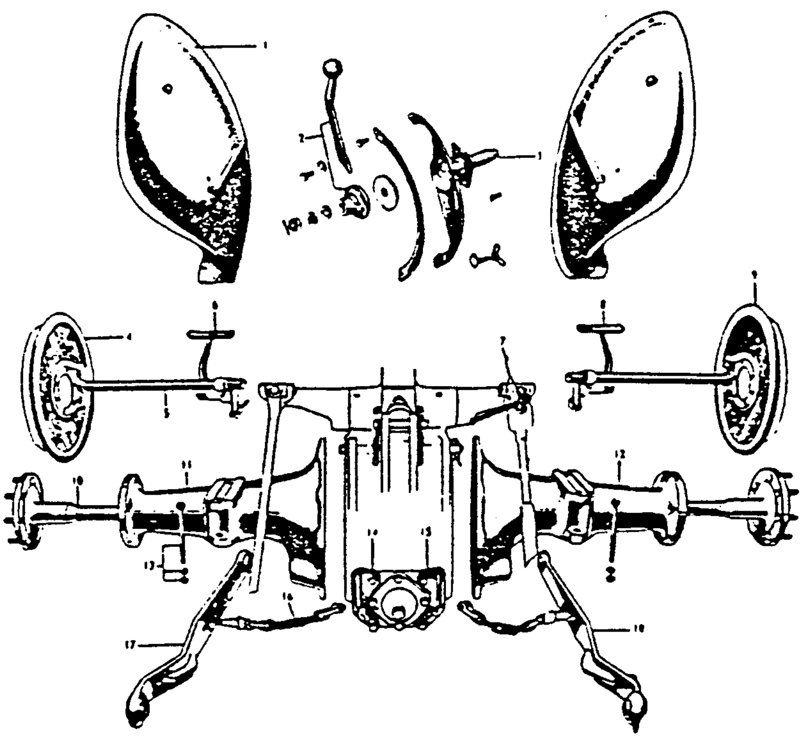


FIG. 3. REAR END DETAILS

SERVICING PROCEDURES

When servicing these modified components, the information given in relevant sections of this manual will be found to be generally applicable.

Servicing Rear Axle

When removing the hub bearing and bearing retainer assembly using Service Tool FT 26 or FT 26R (see Section K page K4), an additional distance piece, FT 26S-17, is required to compensate for the difference in length between the standard and narrow width half-shafts.

STABILISER ASSEMBLY

When attaching the standard stabiliser assembly to narrow width tractors, it is necessary to adopt the following procedure, owing to the reduced dimension between mudguard attachment fronts.

Fit the right-hand bracket, Part No. A-TE-9635 under the rear axle by the bolts securing the left-hand bracket, Part No. A-TE-9651, in a similar manner to the right-hand side. The anchor pins Part No. A-TE-9661 are now pointing out instead of inwards.

By reversal, the offset of the bracket bolt holes relative to the pins compensate to within $\frac{3}{8}$" of the amount the mudguard bolts are moved inwards on the narrow tractor. If necessary, the pins may be packed out by this amount to eliminate the error completely.

IMPLEMENT SUITABILITY.

In most cases the standard size implements can be attached without revision, but in other slight alteration is necessary. Before fitting these implements it will be found necessary to interchange the right and left-hand anchor brackets and to pack the pins (ATE 9661) $\frac{3}{8}$" **outwards.**

The following implements fit normally :

Mouldboard Ploughs
Disc Plough
Subsoiler
Tandem Disc Harrow (Trailing)
Spike Tooth Harrow
Spring Tine Harrow
Tiller
Ridger
Spring Tine Cultivator
Rigid Tine Cultivator
Winch
3 ton and 30 cwt. trailers.
Hammermill
Potato Spinner
Potato Planter
Blade Terracer
Post Hole Digger
Tractor Jack (A-TE-A70)
Trailer Hitch
Multi-Purpose Seed Drill
Weeder
Side Delivery Rake
Manure Spreader
Earth Scoop
Multi-Purpose Blade
60 cfm compressor and hedgecutter
25 cfm compressor
Reversible Heavy Duty Disc Harrow

The following standard sized implements require slight modification before they can be hitched.

Mower

The following modifications are necessary :

1. A new lug, having an agle of 20°, replaces AEEA 7004.

2. The housing assembly AEEA 7002 is reversed to point towards the centre line of the tractor, and the pullbar reset through an angle of 20°.

3. The tilt link, AEEA 7976 is given a 20° twist in order that it may register in the tilt lever yoke.

4. The balance spring end rod, AEEA 9510, must be turned over to crank outwards keeping the balance spring assembly clear of the lift lever.

5. The lift lever chain 6AEE 1505 should be shortened by one link.

6. The wheel track should be set as stated in the Mower Instruction Book, i.e. Rear 52", Front 48".

Manure Loader L-UE-20

Track Settings to be 54" (or more) rear, and 52" front. Axle brackets must be fitted in line with radius rods and secured on inside with longer bolt (supplied) passing through 4th hole from inner ends of outer axle members and 2nd hole from outer ends of centre axle member and with bolt of normal length through 5th hole from inner end of outer axle members. In addition, axle members must be bolted together securely with a normal length bolt passing through the innermost holes.

Steerage Hoe

Modifications are required to steering bracket to accommodate crank in R.H. Lower Link.

Transport Box

Hooks (TJE 8832-3) do not fit correctly over lower links.

Soil Scoop

Modifications needed to lower attachment assembly.

Pulley

Appropriate check chain must be removed and head of eyebolt (ATE 1033) ground down to clear pulley.

Woodsaw

Both fenders fouled seriously in transport position.

Reversible Plough

With coulters set low and narrow, stems foul lower links.

Mounted Tandem Disc Harrow

Slight modification to weight box required to clear lower links. Fit normally without weight box.

Earthmover

Tension rods rub on thrust bars but do not necessarily prevent use of this implement.

Low Volume Sprayer and Medium Pressure Sprayer

Proceed as follows :

1. Extend the wheel track to 46 inches or more.

2. In place of the cranked type lower links used on narrow width tractors fit the the lower links used with normal width tractors.

3. Remove the mudguards.

The following implements cannot be fitted to the Narrow Width Tractor :

High Lift Loader

Dump Skip

Potato planter fertiliser attachment.

THE FERGUSON INDUSTRIAL TRACTOR

SPECIFICATION

Brakes : **Two independent pairs of shoes acting on Rear Wheels**

INNER : 14" × 1½" mechanically operated — independently to assist turning or by handbrake. Internal expanding servo-action type, floating cam ; individual adjustment.

OUTER : 14" × 2" hydraulically operated, internal expanding, two leading-shoe design. Individual shoe adjustment.

Wheels : FRONT : Steel Disc with 6·00 — 16 triple rib pneumatic tyre on drop centre rim. Tyre pressure 26 lbs. (1·8 Kg.)

REAR : Steel Disc with 10 — 28 industrial tread pneumatic tyre on drop centre rim. Tyre pressure 12 lbs. (0·8 Kg.)

Horn : High Frequency type.

Dimensions :

Full Industrial Tractor :

Overall Length : 124" (3150 mm).

Minimum Overall Width : 69" (1753 mm).

Ground Clearance : 14½" (368 mm) under front bumpers

Weight approx : (With fuel, oil, and water)

Models TE-P/R/S20 : 3070 lbs. (1392 Kg.)
Models TET-20 : 3320 lbs. (1506 Kg.)

Basic Industrial Tractor : (complete with accessories)

Overall Length : 124½" (3163 mm).

Minimum Overall Width : 68" (1727 mm).

Ground Clearance : 14½" (368 mm) under front bumpers.

Weights approx : (complete with accessories, less wheel weights ; and including fuel, oil and water).

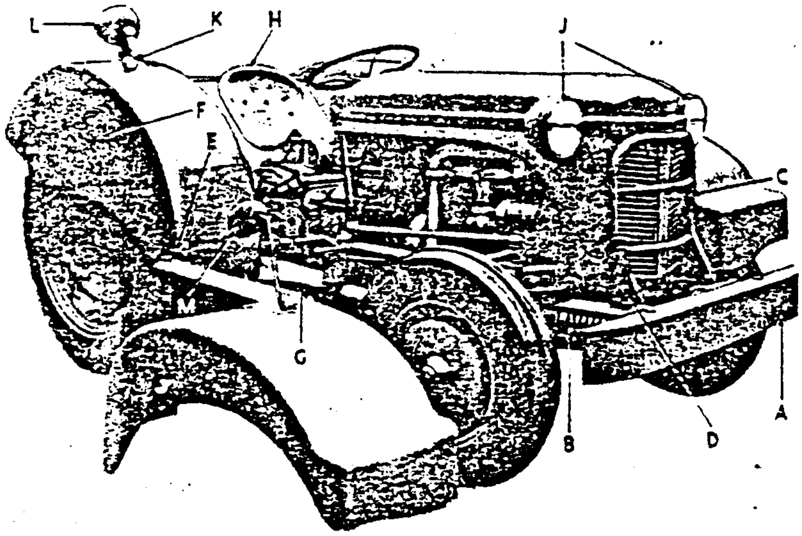
TEP-ZE 3030 lbs. (1384 Kg.)
TET-ZE 3280 lbs. (1488 Kg.)

For all other items see appropriate Agricultural Tractor Instruction Book.

The Industrial Tractor is designed for use in the industrial world, for work in factories, docks and on public highways. All of the features of the Agricultural Tractor have been retained and it is capable of using a range of Ferguson equipment.

Several versions of the Industrial Tractor have been marketed.

Fundamentally, these machines are identical with the agricultural tractors, employing the same engine, transmission, gears and hydraulic system, with additional equipment incorporated to make them suitable for work under industrial conditions and to comply with legal requirements for the public highway.



A Front Bumper
B Bumper Spring
C Radiator Grille Guard
D Pivot — Front Mudguard
E Mudguard Catch
F Detachable Side Cover
G Footboard
H Tipping Seat (shown tipped)
J Headlamps
K Side Lights
L Rear Floodlight (optional extra)
M Driving Mirror

FIG. 12. FULL INDUSTRIAL TRACTOR.

FULL INDUSTRIAL TRACTOR

The first version of the Industrial Tractor was marketed under codes :

TE-P20	Petrol Engine
TE-R20	V.O. Engine
TE-S20	L.O. Engine
TE-T20	Diesel Engine

and incorporated exterior modifications to conform with the requirements of Industrial work : as follows :—

Industrial type dual brakes, front bumper and radiator grille guard with special starting handle, industrial type fenders, lighting system, rear number plate, industrial tyres, tipping seat and footboards as shown in Fig. 12.

INDUSTRIAL—COUNCIL TYPE

This conversion was developed to avoid interference between the lighting system and Front End Loaders and provides an alternative lighting arrangement.

The new arrangement consists of a single headlamp located centrally on the top of the bonnet and a R.H. headlamp situated within the radiator grille.

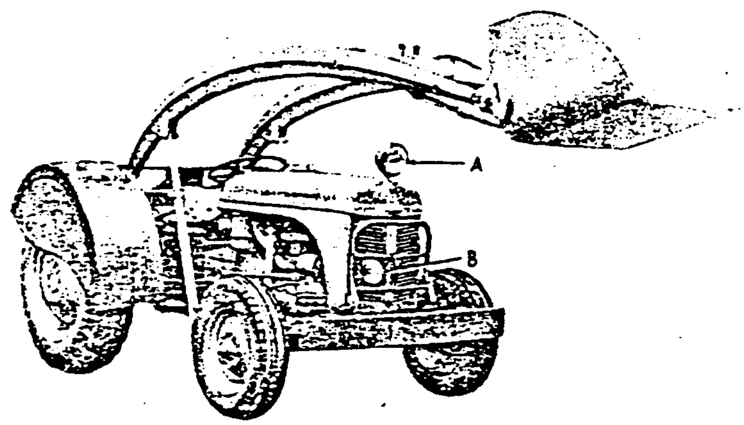


FIG. 13. COUNCIL TYPE TRACTOR

SEMI-INDUSTRIAL TRACTOR

A semi-industrial tractor was also marketed at this time, designed for use in circumstances which did not justify the complete outlay. These were available under Code Numbers :—

TE-P20-T	Petrol Engine
TE-R20-T	V.O. Engine
TE-S20-T	L.O. Engine
TE-T20-T	Diesel Engine

and consisted of an Agricultural Tractor fitted with industrial type dual brakes, industrial tyres, and front bumper and radiator grille guard, which are identical with those fitted to the Full Industrial Tractor.

BASIC INDUSTRIAL

Later the Basic Industrial Tractor was introduced and marketed under th following code numbers :—

With agricultural type rear fenders :

TEP-ZD	Petrol Engine
TET-ZD	Diesel Engine

Without rear fenders :

TEP-ZE	Petrol Engine
TET-ZE	Diesel Engine

These units are fitted with Dual Brakes, Industrial Tyres and Horn and mirror, as standard equipment.

For these basic models, the hinged seat and step-board assembly, front bumper with radiator grille guard and front and rear fenders of revised pattern are available accessories. These are supplied separately, and fitting instructions are appended in this section.

The Basic Industrial Tractor, fitted with all these accessories, is shown in Fig. 15.

ALL INDUSTRIAL TRACTORS :— GENERAL

INDUSTRIAL TYRES

Front : 6·00 — 16 triple rib pneumatic tyre.
Tyre pressure 26 lbs. (1·8 kg.)

Rear : 10 — 28 Industrial Type pneumatic tyre.
Tyre pressure 12 lbs. (0·8 kg.)

Special heavy duty industrial tyres are fitted to all industrial and semi-industrial tractors and recommended for use on roads, hard surfaces, in gravel pits and similar places.

For field work, however, they have not the same power grip or the self-cleaning action of the normal agricultural type.

For fitting and removal instructions refer to page Q.2.

DUAL BRAKE ASSEMBLY

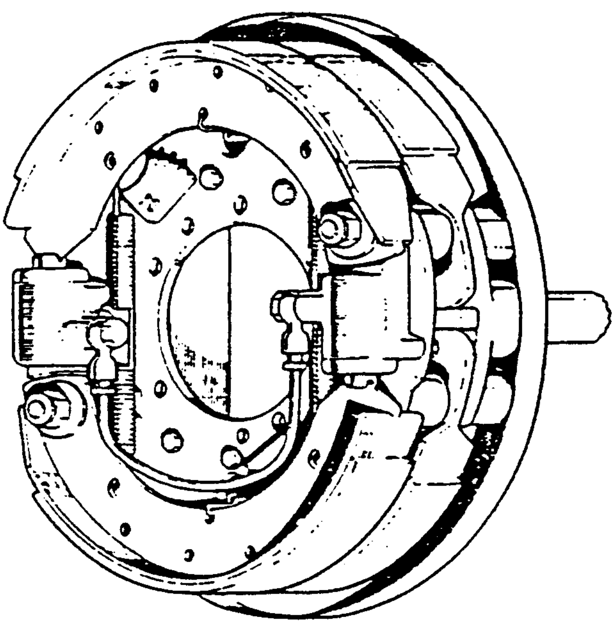


FIG 16A HYDRAULIC BRAKE

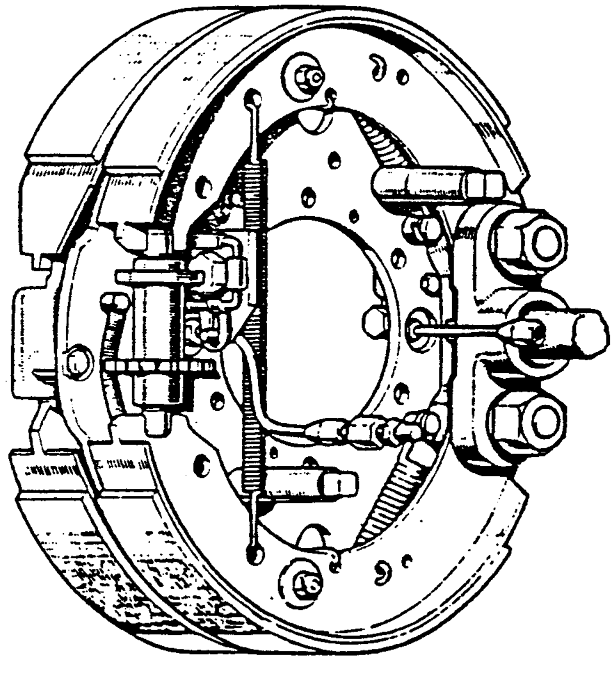


FIG. 16B. MECHANICAL BRAKE

It is a legal requirement in Great Britain and many other countries that Tractors used for haulage on public highways must be fitted with two completely independent braking systems. All Industrial and Semi-Industrial Ferguson Tractors are, therefore, fitted with a dual brake assembly.

General

The Brakes fitted to the Industrial Tractor are the Girling Dual Type, providing two independent braking systems in both rear wheel Brake Drums. Each brake consists of a torque plate upon which is mounted (on the outside face) a Girling 14" × 2" Hydraulic Leading Shoe Brake, and fitted to the inside face is a Girling Bendix type 14" × $1\frac{1}{2}$" Floating Cam brake.

In operation, the Hydraulic two Leading Shoe Brakes follow the normal hydraulic procedure of a pedal coupled to a master cylinder in which the hydraulic pressure of the brake fluid is originated. Both brakes are applied with equal force by means of a single pedal on the right-hand side of the tractor.

The Girling Bendix type Floating Cam brakes are specially designed for direct cross shaft operation, and may be applied together by means of the hand brake on the left-hand side of the Tractor, or independently by pedals on either side of the Tractor. For normal braking purposes the single pedal operating the two hydraulic brakes is used, but the two leading shoe brake is not self energising in reverse. It is therefore recommended that when the tractor is stopped on a slope or while reversing, the hand brake should be used at the same time. To assist in turning the vehicle in a small radius, either left-hand or right-hand the mechanical brake can be applied independently.

THE HYDRAULIC BRAKES

These brakes are 14" × 2" Girling Hydraulic Two Leading Shoe type, which are operated by two hydraulic cylinders of simple construction which are located at opposite sides of the outside face of the torque plate and are interconnected by a bridge pipe. Each wheel cylinder consists of a cast iron body containing a spring base, spring, seal, steel piston, and rubber dust cover. The pistons are situated so that following the rotation of the brake drum in the forward direction they give Two Leading Shoe action. Situated at the base of each cylinder is a pivot pin upon which is located the fulcrum end of the shoe. A flat washer and nut retain the shoe in position. The operating end of each brake shoe locates in the slot of the wheel cylinder piston, and the web of the shoe rests upon an adjustable steady post fitted to the torque plate.

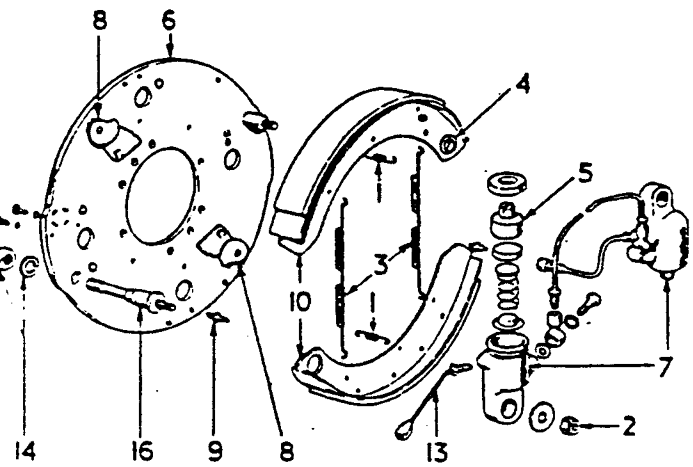


FIG. 17. HYDRAULIC BRAKES

The shoes are held in position by two springs from shoe to shoe also two steady springs are fitted, from a point at the centre of each shoe web, and pass through holes in the torque plate to locate on the webs of the mechanical shoes.

A bleed valve is situated on the outside of the dust plate, being interconnected by a pressure pipe to the rear wheel cylinders. A rubber cap is fitted to exclude dust, etc.

Adjusters

Adjustment for lining wear is by two snail cam adjusters, each operating against a post, at the actuating end of each shoe. The snail cams are connected by a gear and quadrant to a spindle which protrudes through the dust cover. On the end of the spindle there are four flats machined to enable a spanner to be used.

Fitting replacement brake shoes to the hydraulic leading shoe brake (Fig. 17).

Always fit Girling "Factory lined" replacement shoes.

When fitting replacement shoes always fit a new set of shoe return springs.

The following procedure should be adopted :—

1. Jack up the tractor, place chocks under the front wheels and remove rear road wheels and brake drums.

2. Remove steady rest springs (1) also nuts and washers (2) from pivot end of shoes. Lift one shoe out of the piston slot, then remove shoe from abutment pivot. Remove the shoe return springs (3). (To prevent the wheel cylinder pistons (5) from expanding it is advisable to place a rubber band round each cylinder).

   N.B. A loose collar (4) is fitted on the abutment pivot pin of the rear cylinder. Take care to retain this for re-assembly.

3. Clean down the torque plate (6) check wheel cylinders (7) for leaks and freedom of motion.

4. Check adjusters (8) for easy working and turn back (anti-clockwise) to the full " off " position. Lubricate where necessary with Girling (White) Brake Grease.

5. Smear the tops of the steady posts (9) and the operating and abutment ends of the new shoes with Girling (White) Brake Grease.

   Girling (white) brake grease must not be allowed to contact hydraulic pistons or rubber parts.

   Keep all grease off the linings on new replacement shoes and do not handle linings more than necessary.

6. Pair the new shoes (10) which must be fitted with Mintex NMT (A2 Woven) linings (identified by whole edge painted green). Fit new shoe return springs (3).

7. Refit the operating end of the shoes into their respective piston slots. Ensure that the loose collar (4) is replaced to the rear cylinder pivot, then ease the abutment ends of the shoes on to the pivot pins. Replace washers and pivot nuts (2) and tighten firmly. Replace steady rest springs (1).

8. Refit drums after making sure that they are clean and free from grease etc.

9. Adjust brakes as described below.

10. Refit road wheels and jack down.

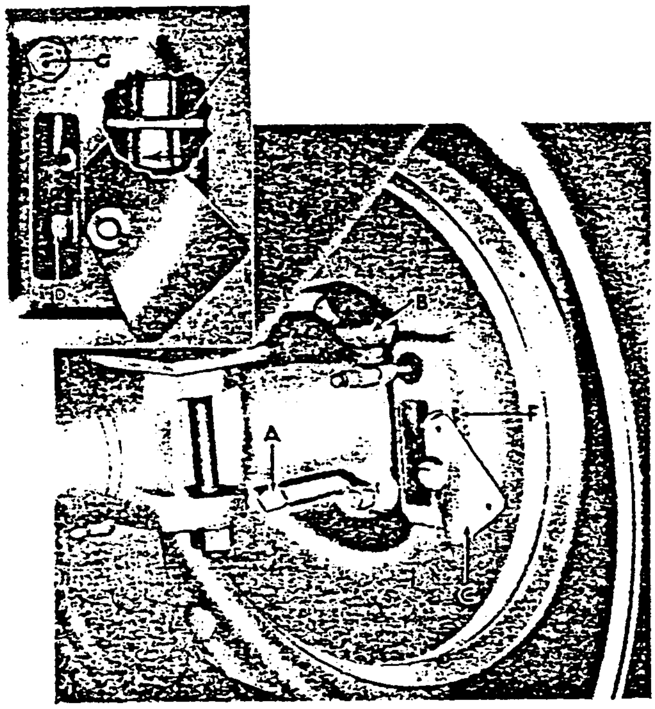


FIG. 18. BRAKE ADJUSTMENT

A Bottom Shoe Adjuster — Hydraulic Brake
B Top Shoe Adjuster — Hydraulic Brake
C Cover Plate
D Centraliser Nut — Mechanical Brake
E Clicker Adjuster — Mechanical Brake
F Hole for Clicker Adjuster
G Bleed Screw

Running Adjustments

Girling hydraulic brakes are adjusted for lining wear at the brakes themselves **ONLY.** On no account should any alteration be made to the Master cylinder linkage for this purpose.

Before commencing, check that the brake fluid supply tank is filled to the correct level and that the system does not require ' bleeding.' The rear wheels must be quite free, with no shoes binding.

A separate snail cam adjuster is provided for each shoe. Jack up the tractor until the rear wheels are clear of the ground then fully release both square head adjuster bolts on outside of the dust cover.

Turn one of the adjuster bc'ts (shown A and B Fig. 18) clockwise until the brake shoe concerned touches the brake drum, then release the adjuster until the shoe is just free of the drum. Repeat the process for the second adjuster and shoe.

Spin the wheel to ensure that the brake shoes are quite free of the drum. Repeat the whole procedure for the second rear wheel.

Testing (Hydraulic Brakes)

To test brakes for even balance, engage second gear and, driving at a slow speed, apply the master brake firmly. Any tendency to veer off course should be counteracted by slackening off the adjusters on the side towards which the veering takes place, taking care that both adjusters A and B are slackened off by the same amount.

Supply Tank

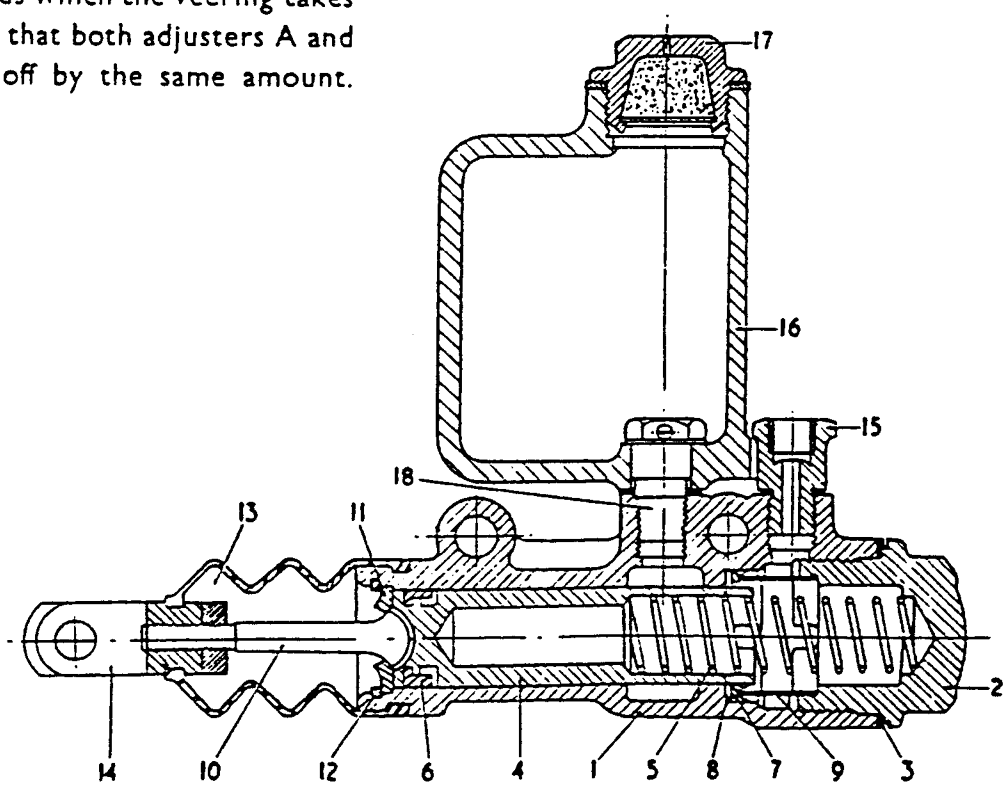
The type fitted consists of a light alloy container (16) with a screwed metal cap (17) pierced with a breather hole, (which must always be kept clear) also a cap washer. The tank is fitted directly on to the master cylinder, being held in position by a union (18) located through the tank and into the inlet port of the master cylinder.

Master Cylinder

This is of the Girling Compression (CB) Type where the operation of the brake pedal pushes the plunger into the compression chamber.

The cylinder is attached to the side of the tractor by two securing bolts.

FIG. 19. MASTER CYLINDER WITH SUPPLY TANK



Description

The assembly consists of a cast iron body (1) with a highly polished bore, a screwed end cap (2), a gasket (3) and a polished steel plunger (4).

A plunger return spring (5) fits between the end cap and the plunger and on the rear of the plunger a rubber end seal (6) is located in a groove. A rubber recuperating seal (7) (formed with two internal diameters) is fitted inside the body, protected by a steel shim (8) and supported by a special form of recuperating seal support (9) this support locating in the end cap.

The operating push rod (10) has a hardened spherical end which engages the concave end of the plunger and is retained in the cylinder by a dished washer (11) and a circlip (12). A rubber boot (13) is fitted over this end of the cylinder to exclude dirt and dust, and a jaw end (14) screws on to the end of the push rod.

Always exercise extreme cleanliness when dealing with any parts of the Hydraulic system.

Dismantling

Before removing the master cylinder from the tractor it is advisable to drain off most of the hydraulic fluid. Attach a bleed tube to one of the bleed screw nipples shown in Fig. 18 and lower the open end into a clean receptacle. Unscrew the bleed screw about three quarters of a turn and pump the foot pedal until no more fluid enters the container.

Prepare a clean space (free of oil, grease, dirt etc.) upon which to work and lay the parts. Disconnect the pipe union (15) from the top of the cylinder, the operating rod (10) from its connection to the relay lever, withdraw the two securing bolts, disconnect return spring and remove the cylinder. Unscrew the end cap (2) complete with gasket (3) and seal support (9) and withdraw the plunger return spring (5). Pull back the rubber boot (13) and remove the circlip (12) with pliers then withdraw the push rod (10).

Push the plunger (4) out from the pressure end and detach end seal (6), remove the recuperating seal (7) and shim (8) from the body (1). Carefully examine all components and replace any that appear worn or damaged. It is especially important to renew any seals which appear distorted or lack resilience.

Never allow Petrol, Paraffin or Trichlorethelene to contact Hydraulic parts.

Assembly

Thoroughly clean all parts with clean Girling Brake Fluid which must not be used again. The rubber seals and the plunger should be smeared with clean fluid immediately before assembly.

Insert the steel shim (8) into the pressure end of the cylinder against the shoulder formed inside. Replace the recuperating seal (7) with the back of the seal towards the shim.

Fit the end seal (6) to the plunger (4) with the lips of the seal on first, facing away from the concave end of the plunger. Insert the plunger (4) (open end first) into the cylinder from the push rod end, easing the end seal carefully into the bore. (The lips of both Seals will then be facing towards the pressure or end cap end of the cylinder). Insert the push rod assembly (10) round end first into the bore, and secure with circlip (12). Pack the Boot with Wakefield Girling Rubber Grease No. 3 (red) and stretch over the end of the cylinder body.

Insert the plunger return spring (5) in the open end. Replace the end cap (2) complete with gasket (3) and recuperating seal support (9) ensuring that the four legs of support are even in height. Tighten End cap firmly. Refit the master cylinder to the tractor in the reverse order to removal. Top up the supply tank and bleed the system.

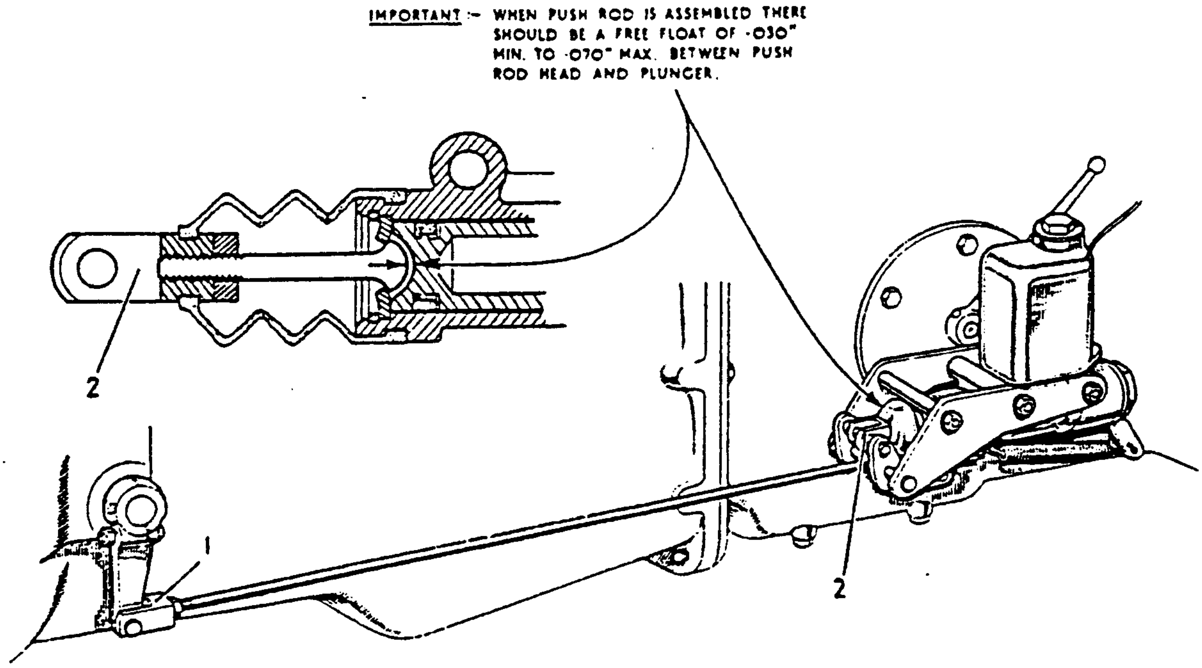


FIG. 20 ADJUSTMENT LINKAGE

Adjustment of Linkage

To ensure that the plunger is not prevented from returning to its fully ' off ' position, when the brakes are released there must be a free float of ·030"/·070" between push rod head and plunger.

To adjust, proceed as follows with reference to Fig. 20.

1. Disengage operating rod clevis 1 from drop arm of cross shaft.
2. Ensure that combined brake pedal is against its stop in " off " position.
3. Pull back clevis 2 of master cylinder push rod to the fullest extent against its external stop.
4. Adjust operating rod so that pin of clevis 1 can be re-inserted without disturbing drop arm or master cylinder, and re-assemble.
5. Check to ensure that free travel of the combined brake pedal is at least ¼".

General Maintenance—
Replenishment of Hydraulic Fluid

Inspect the Supply Tank at regular intervals and maintain at about three quarters full by the addition of clean Girling crimson brake fluid. Great care should be exercised when adding brake fluid to prevent dirt or foreign matter entering the system.
IMPORTANT Serious consequences may

result from the use of incorrect fluids and on no account should any other than GIRLING CRIMSON BRAKE FLUID be used. This fluid has been specially prepared and is unaffected by high temperatures or freezing.

Never top up the system with any other fluid.

Bleeding the Hydraulic System (Fig. 21)

Equipment required.

A supply of 'Girling Brake Fluid' (Crimson). $\frac{3}{16}$" bore rubber tube and a clean glass jar, capable of holding about two pints.

Bleeding is necessary any time a portion of the hydraulic system has been disconnected, or if the level of the brake fluid has been allowed to fall so low that air has entered the master cylinder.

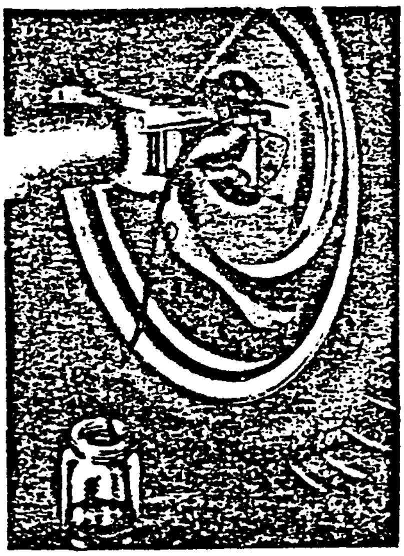


FIG. 21. BLEEDING HYDRAULIC SYSTEM

Method

With all the hydraulic connections secure and the supply tank top up with fluid, remove the rubber cap from the R.H. rear wheel cylinder bleed nipple (9) and fit the bleed tube over the bleed nipple, immersing the free end of the tube in a **clean** jar containing a little Girling Brake Fluid.

Unscrew the bleed nipple about two turns and then operate the brake pedal with slow full strokes until the fluid entering the jar is completely free of air bubbles. Then during a down stroke of the brake pedal, tighten the bleed screw sufficiently to seat the ball, remove bleed tube and replace the bleed nipple dust cap. *under no circumstances must excessive force be used when tightening the bleed screw.*

This process must now be repeated for the L.H. rear brake. Always keep a careful check on the supply tank during bleeding since it is most important that a full level is maintained. Should air reach the master cylinder from the supply tank, the whole operation of bleeding must be repeated.

After bleeding, top up the supply tank to its correct level of approximately three-quarters full. Never use fluid that has been bled from a brake system for topping up the tank, since this brake fluid may be to some extent aerated.

Great cleanliness is essential when dealing with any parts of the brake hydraulic system, and especially so where the brake fluid is concerned. Dirty fluid must **never** be added to the system.

General Advice on Hydraulic Components

The following precautions should be studied carefully and observed punctiliously by all concerned.

Essential Precautions

ALWAYS exercise extreme cleanliness when dealing with any parts of the hydraulic system. NEVER handle rubber seals or internal hydraulic parts with greasy hands or greasy rags.

ALWAYS use Girling crimson brake fluid from sealed quart tins. NEVER use fluid from a container that has been cleaned with petrol, paraffin or trichlorethylene. NEVER put dirty fluid into the reservoir, nor that which has been bled from the system.

ALWAYS use clean Girling Brake Fluid or alcohol, for cleaning internal parts of the hydraulic system. NEVER allow petrol, paraffin or trichlorethylene to contact these parts.

ALWAYS examine all seals carefully when overhauling hydraulic cylinders and replace with genuine Girling spares, any which show the least sign of wear or damage.

ALWAYS take care not to scratch the highly finished surfaces of cylinder bores and pistons.

ALWAYS use Wakefield Girling Rubber grease No. 3 (red) for packing rubber boots, dust covers, and lubricating parts likely to contact any rubber component. NEVER use Girling White Brake Grease, or other grease for this purpose.

ALWAYS replace all Seals, and Gaskets, with new ones if it is suspected that incorrect fluids have been used, or that the system is contaminated with mineral oil or grease. Drain off the fluid, thoroughly wash all metal parts, and flush out all pipes, etc., with alcohol or clean Girling Crimson Brake Fluid. NEVER use anything else for this purpose.

ALWAYS Remember that **YOUR** safety and the safety of others may depend on the observance of these precautions always.

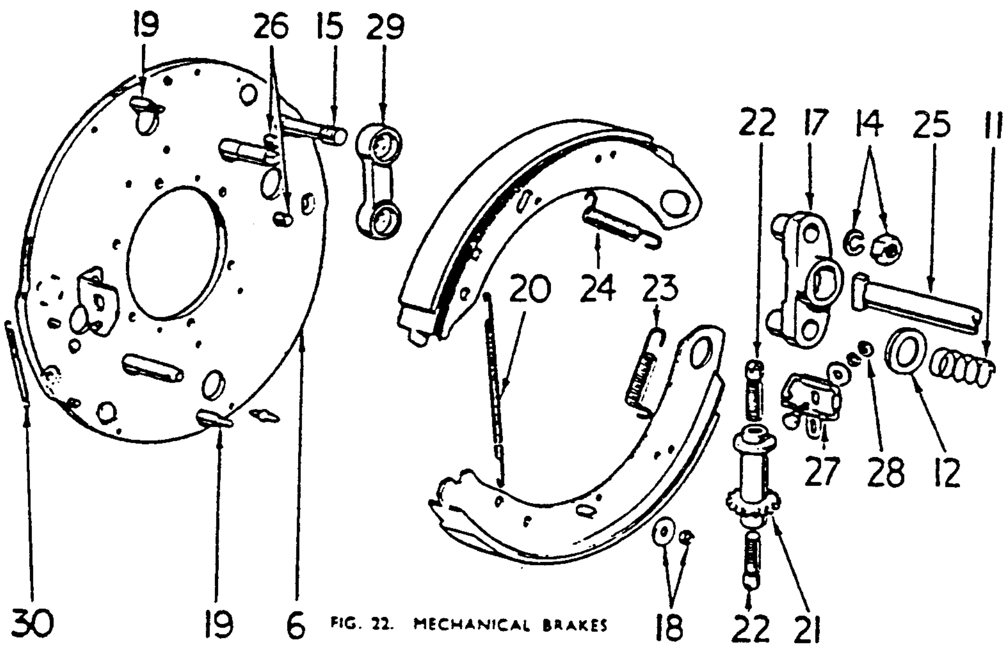


FIG. 22. MECHANICAL BRAKES

The Mechanical Brakes (Figs. 22 & 17)

These are Bendix type Servo-action Floating Cam brakes. The shoes are fixed at the anchor pin end only, the adjuster unit (21) being free to float within the confines of the centralizer spring (27) mounted on the torque plate (6).

The design of the cam (25) together with the use of two shoe return springs (23) and (24) of different tension, ensures that the primary shoe operates first, and the leading edge, meeting the drum, creates a servo action which is transferred through the floating adjuster to the secondary shoe. The brake is mounted on the inside face of the torque plate and consists of an anchor pin assembly securing one end of each shoe. Between the opposite ends of the shoe webs, is a barrel type adjuster (21) which can be operated by means of a screwdriver inserted through a hole in the back cover. A centralizer (27) mounted on the torque plate engages with a flange on this adjuster and ensures that the shoes return to the central position after each operation. Between the shoe webs at the anchor pin end is the operating camshaft to which the independent foot pedal lever is directly connected. The handbrake is also connected to this shaft by means of adjustable rods.

Two shoe return springs are fitted, one from the web of each shoe, to pegs mounted on the torque plate. The shoes are kept square against the torque plate by means of adjustable steady posts (9), spacer pins (19) and washers (18) also by two steady springs passing through the torque plate to locate on the hydraulic leading shoe webs.

One spring fits from shoe to shoe at the adjuster end of the brake.

Running Adjustment (Fig. 18)

1. Jack up rear wheels clear of the ground.
2. Ensure that all shafts and pins work freely, and that when the brakes are " off " the brake pedals and handbrake are against their stops.
3. Move cover plate C on Back Plate to expose adjuster E. Slacken off the centralizer nut D then by using a screwdriver, expand the shoes fully in the drum by rotating the adjuster E in the direction of the arrow for the R.H. Brake (L.H. brake opposite direction) until the wheel is fully locked.
4. Tap lightly round the drum with a mallet to assist centralizing, and tighten centraliser nut.
5. Slacken adjuster spindle six to eight " Clicks " when the wheel should spin freely.

NOTE The brakes **MUST NOT** be adjusted by altering the length of operating rods. The shoes themselves must be adjusted in the drums.

Testing — Mechanical Brakes

To test brakes for even balance, engage second gear and, driving at a slow speed, apply the handbrake firmly. Any tendency to veer off course should be counteracted by slackening off the adjusters on the side towards which the veering takes place.

Fitting Replacement Shoes (Figs. 22 & 17)

When the linings are very worn or if through any cause the linings become soaked in oil or grease, it is essential to fit genuine Girling factory lined replacement Shoes, with Don R.7 linings which are identified by a red mark on left hand edge and centre.

1. To replace the worn shoes first jack up the rear axle, and remove wheels and drums. Also detach handbrake rods from cross shaft levers.
2. Extract the four set screws securing the back plate to the torque plate (6) move the spring (11) and cover plate (12) fitted to the operating shaft to a point midway along the shaft, remove the two rubber grommets from the hydraulic pipes (13) and ease the back plate along the axle casing.
3. Remove the two nuts and spring washers (14) from the anchor pins (15) and (16) and prize off the bridge plate (17). Detach the self locking nuts and washers (18) of both spacer pins (19) remove the steady springs (1), shoe to shoe spring (20) and adjuster (21). Lift each shoe in turn over the anchor pins (15) at the same time removing the shoe return springs (23) and (24).
4. Smear steady posts (9) and cam (25) with Girling brake grease. Never use ordinary grease for this purpose.
5. Fit Shoes by locating the " swan necked " end of the primary (Blue) Spring (23) into the hole (nearest to edge of web) in the primary shoe, and the hooked end of the spring round the peg (26) on the torque plate, then lift the shoe over the anchor pin. Using the secondary spring (Red) (24) repeat for secondary shoe.

NOTE Always fit NEW springs when fitting replacement shoes.

6. Replace bridge plate (17) spring washers and nuts (14).
7. Replace adjuster and screws (21) and (22) locating flange in the centraliser (27), and refit shoe to shoe spring (20) and steady springs (1).
8. Grease shoe webs around spacer pin holes and replace spacer pin washers and nuts (18). These nuts must not be tightened excessively. The washer should be free to rotate with the fingers.
9. Slacken adjuster (21) right off and centraliser nut (28) and replace drum.
10. The shoes must be set to obtain the correct clearance between lining and drum. This operation is most important as the ultimate efficiency of the brake depends on the accuracy with which the shoes are centralised and set.
11. Fully expand the shoes in the drum by means of the adjuster. With a hide or copper hammer, tap bridge plate and tap lightly around the drum to ensure that the shoes settle in their correct positions. Ensure that the shoes are still fully expanded in the drum by tightening on the adjuster. If this will tighten further, repeat tapping procedure.
12. Tighten up anchor pin nuts to a torque reading of 100 lbs./ft. Also tighten centraliser nut (28).
13. Remove brake drum, replace back plate, and four set screws. Also move cover plate (12) and spring (17) along the control shaft until cover plate is under slight tension between spring (11) and back plate. Replace rubber grommets to hydraulic pipes.
14. Replace brake drum, and fully expand shoes in drum by means of the adjuster, and reconnect linkage as below.

15. With both handbrake rods detached from the cross shaft arm, and brake shoes fully expanded in the drum and the handbrake engaged in the first notch of the ratchet, adjust yoke ends of brake rods, so that the clevis pins can just be inserted.

16. Slacken off brake adjuster until the drums are just free to rotate.

17. Refit road wheels and test brakes as described under "Running Adjustments."

Industrial Brakes — Backing Plate.

A backing plate is now supplied for replacements which is identical for FE-35 and TE-20 tractors. When this backing plate is used with the TE-20 tractor, it is necessary to manufacture a *packing* plate to the following dimensions and to re-adjust the shims as necessary to obtain the required axle shaft end float :—

Packing Plate :

Outside diameter $6\frac{3}{16}$".
Inside diameter $4\frac{33}{64}$"
Thickness $\frac{1}{8}$"
12 holes $\frac{15}{32}$" dia. equally spaced on a pitch circle diameter of $5\frac{1}{4}$".

FAULT TABLE—DUAL BRAKE ASSEMBLY

Refer to the Fault Table at rear of Section P and note also the following additional items which apply to the Hydraulic Brakes.

FAULT	POSSIBLE CAUSE	ATTENTION REQUIRED
Brakes Bind.	(*a*) Insufficient clearance between push rod head and plunger.	(*a*) Adjust in accordance with instructions on page T.21.
	(*b*) Damaged or distorted seals resulting from presence of lubricating oil or incorrect fluid in system.	(*b*) Renew seals. Clean system, flush with hydraulic fluid and bleed brakes.
	(*c*) Filler Cap air vent choked.	(*c*) Clean vent hole, check that supply tank is not over-filled.
Insufficient Braking Power	(*a*) Air in hydraulic system.	(*a*) Bleed system.
	(*b*) Fluid level in supply tank too low.	(*b*) Top up and bleed system.
	(*c*) Leak in hydraulic system.	(*c*) Rectify and bleed brakes.
	(*d*) Linings of incorrect material.	(*d*) Re-line with standard linings.
	(*e*) Seals worn.	(*c*) Renew.

FRONT BUMPER AND RADIATOR GRILLE GUARD

The Full Industrial, Semi-Industrial Pattern and Council Type Tractors are supplied already fitted with this assembly. The Front Bumper and Radiator Grille Guard are also available under codes A-TE-114 and A-TE-F114 as an accessory for fitting to the later Basic Industrial Tractor, TEF-ZE and TE-TZE, a starting handle with longer reach required to suit the bumper being included in the kit.

Description

The front bumper assembly consists essentially of an all-steel welded construction with a support bracket located between the front wheels and secured to the front engine mountings. The support bracket incorporates two plunger units containing compression springs and necessary fittings. The welded bumper beam which covers the complete width of the tractor, is easily detachable, and when in position is secured with pins to shafts protruding forwards from each plunger unit.

These springs cushion impact when shifting packing cases and other similar commodites. The radiator grille guard, of light tubular construction, pivots about lugs on the support brackets. The guard pivots forward against the tension of two coil springs whenever the bonnet is raised for servicing the engine and offers no impediment. When closing the bonnet, the grille guard returns unassisted to its former position.

Assembly Instructions — For Kits A-TE-114 (Carburettor Engine Type) and A-TE-F114 (Diesel Engine Type).

When fitting these Kits to the Basic Industrial Tractor, proceed as follows :—

1. **Bumper and Guard Assembly**
   Bolt support bracket assembly to front engine mountings with longer bolts supplied.

NOTE : The necessary nuts and washers are those used with the former bolts, and are not supplied with this assembly.

2. Secure bumper beam to plunger shafts with support pins and linch pins.
3. Secure guard to lugs on support bracket with swivel pins provided. The small, coil type return springs are also positioned on the inside of these pins.

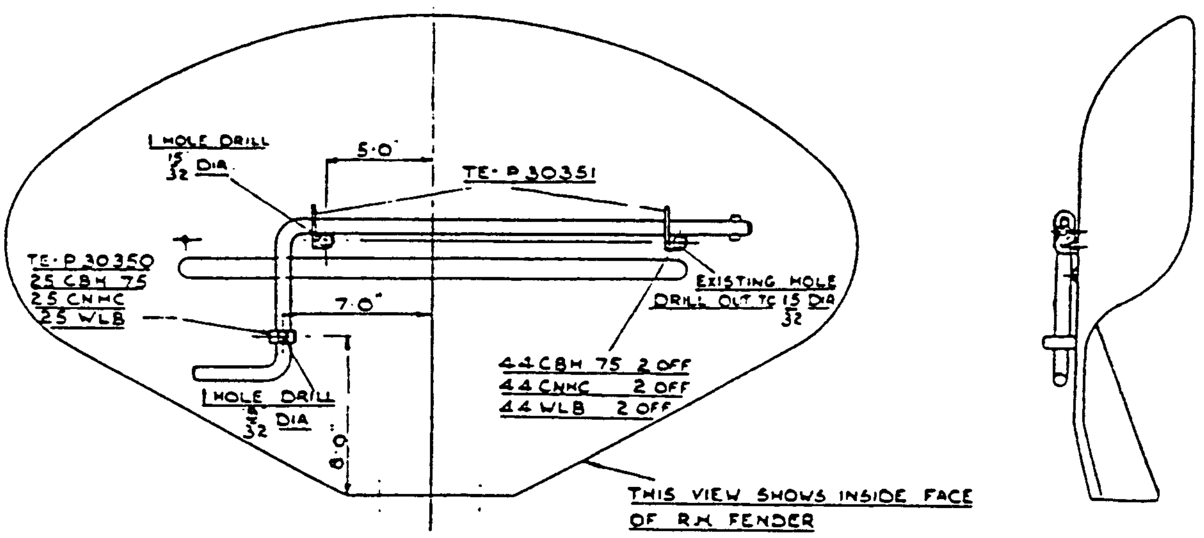
Starting Handle

The longer starting handle is stowed on the R.H. rear fender on the carburettor engine types and within the bumper support bracket on the Diesel Models.

On the carburettor type the hole for the rear support bracket is drilled in the fender during manufacture ; the holes for the forward bracket and support clip must be drilled in accordance with Fig. 23.

On diesel engine models, holes are drilled in the support bracket through which the new starting handle is inserted. The protruding part of the handle (when stowed) is held in the small bracket welded to the support bracket and secured by means of a lock ring. This arrangement is due to the impracticability of stowing the handle on the rear fenders as on carburettor models.

FIG. 23. STARTING HANDLE STOWAGE



FENDERS

The Industrial Tractors are intended for operation along roads at speeds approaching the maximum, and fenders are necessary for the protection of the driver.

The full Industrial and Council Type Tractors are supplied fitted with substantial fenders — see Fig. 12. A Front and Rear Industrial Fender Assembly is also available for fitting to the Basic Industrial Tractor under Code Number A-TE-120 or A-TE-115 Front Wheel Fenders only or A-TE-116 Rear Wheel Fenders only.

Fenders fitted to Full Industrial and Council type Tractors

Types TE-P/R/S/T20 Fig. 12 refers

The front fenders hinge around two very strong, easily detachable, vertical pivots, mounted on the bumper bracket. They are secured at their rear end by a spring mounted catch. Once this catch is undone the fenders are free to swing around the front pivots and give complete accessibility to the engine. In addition, the design allows the fenders to be quickly lifted from their pivots and clear of the machine.

The rear bulkhead is extended to give the driver protection from the hot blast of air coming from the engine.

The rear fenders partly envelop the rear wheels and have easily detachable side covers. The two fenders are strengthened by a traverse crossbar to eliminate vibration. To this crossbar a rear number plate can be secured.

It should be noted that it is necessary to remove the side covers if the rear wheel has to be extended to settings over 52".

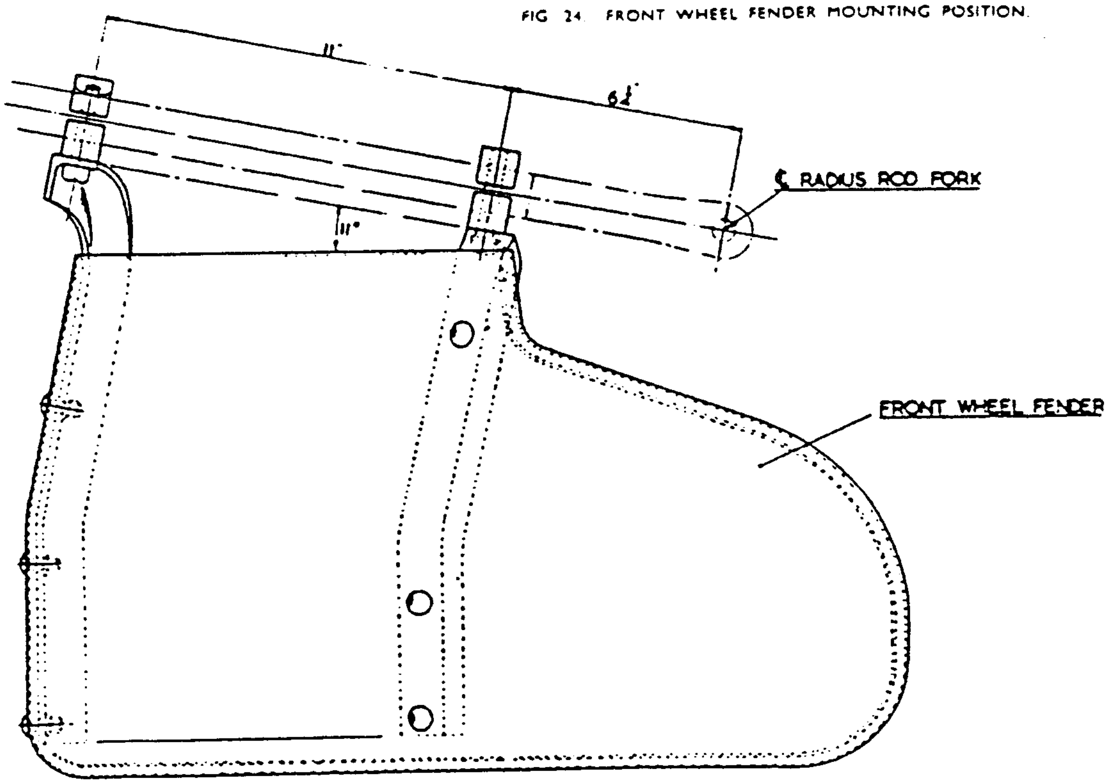
The standard front wheel setting is 48". If wider settings are required, the front fenders must be removed.

Provision is made for stowage of the starting handle on the R.H. rear fender of carburettor engine type.

Front and rear Industrial Fender Assembly for fitting to Basic Industrial Tractor

These differ in design from those fitted to the Full Industrial and Council Type Tractors.

FIG 24 FRONT WHEEL FENDER MOUNTING POSITION.



Front Wheel Fenders

The two pressed steel fenders are bolted to the radius rods and held in position by angle iron supports and clamps. Rubber mud-flaps of adequate size are bolted to the rear edge of each fender. The fender dimensions are such that excellent protection from mud and splash is provided.

Figure 24 shows the correct position of the rear mounting clamp in relation to the centre line of the radius rod fork. In this position the front wheel fender will be clear of adjacent parts of the tractor when the axle swings to its maximum.

NOTE : When fitting fenders to Diesel Engine types it is important for the chamfered clamps to be mounted to the rear, so that clearance is provided for the engine oil filter. Further, the tool box, when situated on the left hand radius rod of Diesel Engine Tractors, will have to be moved rearwards to the position shown in Fig. 25. The existing rear clamp of the tool box is then used to secure the front end and a new clamp Part No. 112064 obtained to suit the thinner section of the radius rod at the rear.

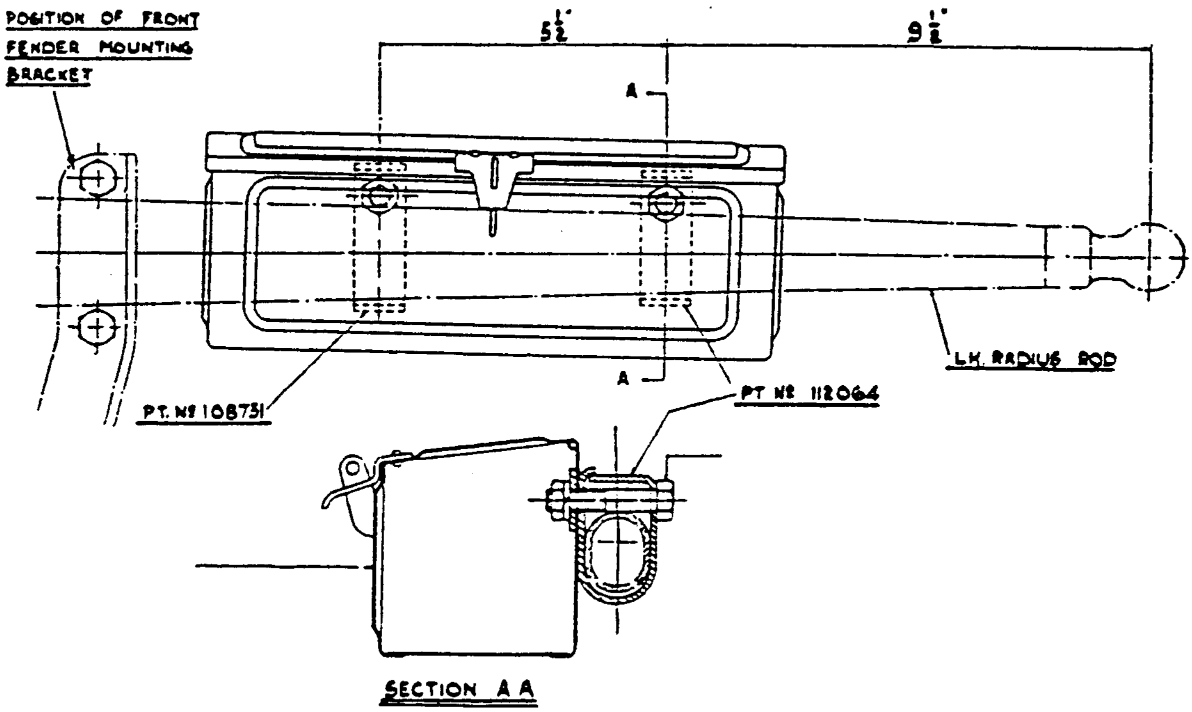


FIG. 25. TOOL BOX REPOSITIONING TO ACCOMMODATE FRONT WHEEL FENDERS — DIESEL ENGINE TRACTORS.

Rear Wheel Fenders

The rear fenders are secured to the rear axle housings in an identical manner to that used for securing agricultural fenders.

The lower part of each fender is identical with that of the agricultural pattern. The top part is extended to reach outwards over the wheels and tyres to afford protection for all types of industrial work.

Each fender is drilled symmetrically on both sides of its centre line to enable the brackets supporting the crossbar to be secured should the fenders be interchanged. The crossbar gives additional strength to the fenders and reduces vibration. A rear number plate may also be attached to the crossbar, which is made easily detachable to permit the fitting of the winch, woodsaw and certain other implements.

HINGED SEAT AND STEPBOARDS — KIT No. A-TE-61 Fig. 4 refers.

These are fitted to the Full Industrial and Council Type tractors, TE/P/R/S/T20, and are available as an accessory for fitting to the Basic Industrial Tractor, TE/P/ZD/ZE and TE-T/ZD/ZE.

The stepboards are provided to give an alternative leg position to reduce fatigue and to enable the driver to stand up while manoeuvring. At the same time the seat can be tilted backwards out of the way. The seat can also be swung completely over and thus kept clean and dry, when the tractor is parked.

To fit Stepboards to Basic Industrial Tractors

The stepboard assemblies are designed to hook over the standard foot rest bars and to be secured at the rear to the transmission housing inspection covers. Attachment to the inspection cover is made by substituting the appropriate plate securing bolt by a longer bolt supplied with the accessory. The securing bracket locates against the edge of the inspection cover and, to align bolt holes, it may be necessary to loosen the nut securing the bracket to the step board When the bracket is correctly aligned, retighten the nut.

In order to clear the master cylinder and actuating linkage, it is necessary to fit the left-hand stepboard in accordance with Fig. 26. The sketch calls for an additional bolt and seven washers 56WFB and shows the position of the rear step bracket, enabling the L.H. stepboard to clear the master cylinder and actuating linkage. The bracket is moved forward $2\frac{1}{2}''$ from the standard position and secured by the lower bolt on the L.H. inspection cover, thus lowering the rear end of the stepboard by $\frac{1}{4}''$. Copper washers, TE-P 30357, supplied must be used, as shown in Figure No. 26, when replacing this bolt in order to prevent the possibility of leakage.

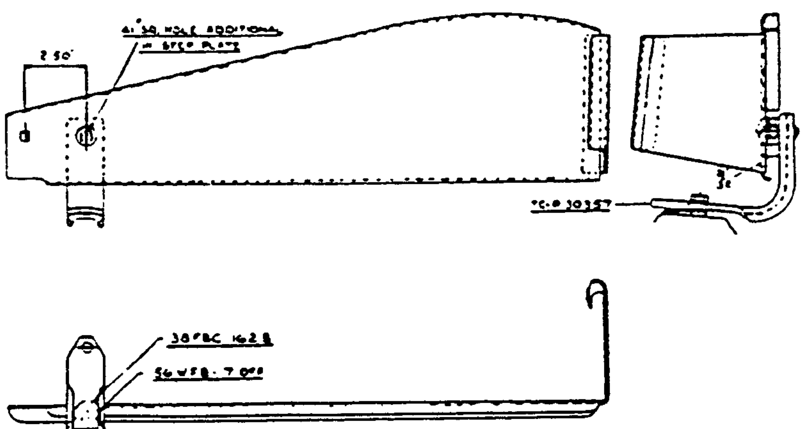


FIG. 26. STEPBOARD MODIFICATION

TO FIT HINGED SEAT ASSEMBLY TO INDUSTRIAL TRACTOR

Remove existing spring and seat assembly and detach seat.

To Mark Out Seat :

Place seat squarely on parallel blocks and using height gauge, mark rear face of seat 2·81″ from base ; this mark should extend at least $2\frac{1}{2}''$ either side of hole A as shown in Figure 27 (a).

Scribe centre line passing through centre of two drain holes in seat base, and hole A. Parallel to this line, scribe two lines $\frac{3}{4}''$ either side of the square hole in base intersecting them by a line drawn at right angles through the centre line of the square hole as shown in Figure 27 (b).

Mounting : Drill $\frac{1}{2}''$ dia. holes at intersections and press in rubber bumpers, large head downward.

On outer face of hinge mounting bracket mark vertical and horizontal lines passing through centre of small hole as shown in Figure 27 (c).

Temporarily secure hinge assembly to seat with nut, bolt and suitable washers through hole A and hole in mounting bracket. Line-up vertical and horizontal lines on bracket and seat back, then weld around bracket as shown in Figure 27 (c).

Welding completed, remove securing bolt, and mount assembly complete with spring to tractor.

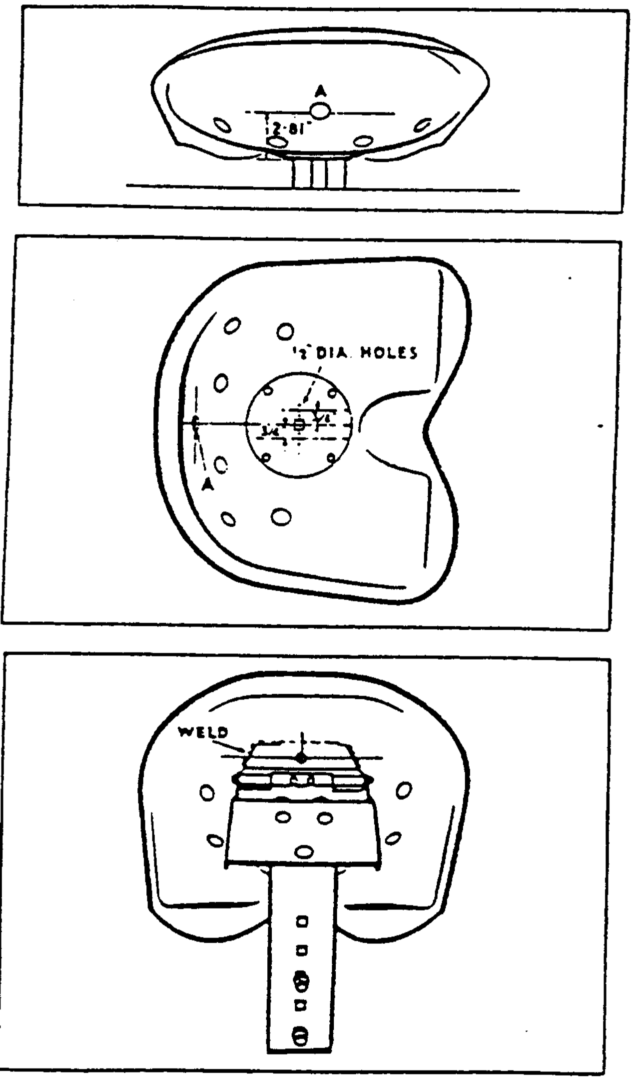


FIG. 27. FITTING HINGED SEAT ASSEMBLY

LIGHTING SYSTEM

Fitted as standard to the Full Industrial and Council Type Tractors only. TE-P/R/S/T20 The kit was subsequently redesigned to suit the revised lighting regulations introduced in October 1954 and this same Kit, called " Universal " suits all Ferguson machines including the Agricultural Tractor.

LIGHTING SYSTEM ON FULL INDUSTRIAL TRACTOR TE-P/R/S/T20 Fig. 1 refers.

To confrom with legal requirements in force at the time, the Full Industrial Tractor was fitted with a complete lighting system comprising the following items :—

Two side lights on the rear wings.

Two head lamps mounted on side of the hood, equipped with dipping filament bulbs.

Rear number plate light and tak-off point for rear trailer light.

The combined switches to operate all the above services, and electric horn button are shown in Fig. 28.

Provision is also made for a rear floodlight and operating switch, for illuminating work undertaken at night.

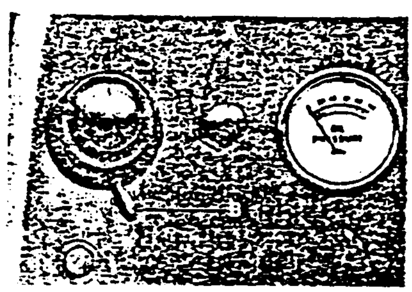


FIG. 28.

LIGHTING SYSTEM ON COUNCIL TYPE TRACTOR

This differs from that fitted to the Full Industrial Tractor Models TE-P/R/S/T20 in that a single headlamp is located centrally on top of the bonnet and the other situated within the radiator grille to obviate all interference between the lighting system and the front end loader. See Fig. 13.

LIGHTING EQUIPMENT MAINTENANCE

To maintain efficient lighting equipment, wiring must be regularly inspected for breaks or chafing which would provide a path for short circuiting. Always keep electrical connections and lamps clean, secure and free from rust.

Setting and Focusing Headlamps

Position tractor on level ground, with front square with, and at least 25 ft. in front of a flat vertical surface or screen, which will clearly indicate the position of the beams. To adjust, slacken the lamp fixing nut inside the hood, and direct beams, by moving each lamp on its adjustable mounting bracket, until the diagram shown in Fig. 29 is reproduced on the screen. For ease of setting, one headlamp should be covered. After adjustment, tighten fixing nut.

The construction of the bulb ensures that the filament is correctly positioned in relation to the reflector and no focusing is neccessary.

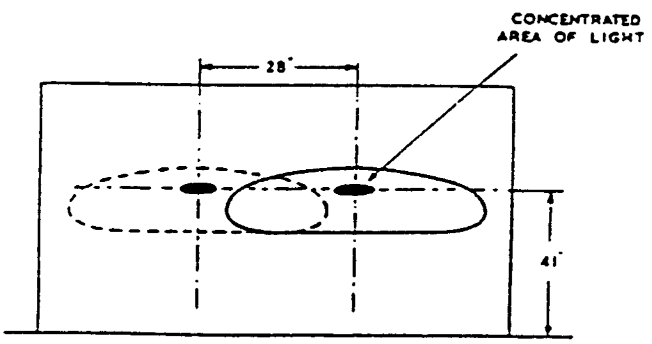


FIG. 29. FOCUSING HEADLAMPS

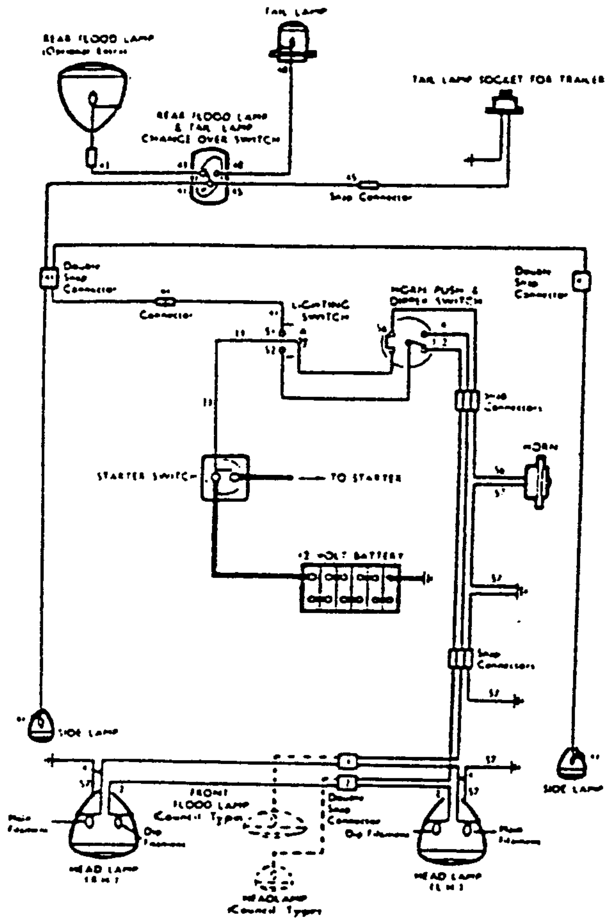


FIG. 30. WIRING DIAGRAM OF LIGHTING EQUIPMENT

Lighting Equipment—Full Industrial and Council Type Tractors only.

Bulbs	Lucas No.	Volts	Watts	Contact	Filament
Headlamps	354	12	42/36	Double	Transverse R.H. drive — double filament.
Side and Tail Lamp	207	12	6	Single	Coil.
Rear Floodlight	323	12	48	Single	Transverse

Bulb Renewal

If a bulb fails, first try to ascertain the cause, which may be due to a faulty circuit as described above. When renewing, it is most important that only the same size and type is fitted. See Specification, above or "Lucas Tractor Lighting Set No. 302." instruction leaflet, as applicable.

Cleaning Lamps

The reflectors are, of course, permanently protected. Care must be taken, however, when handling reflectors to prevent them becoming finger marked. DO NOT USE METAL POLISH ON REFLECTORS. They must be washed with plenty of water and polished with a chamois leather or soft dry cloth.

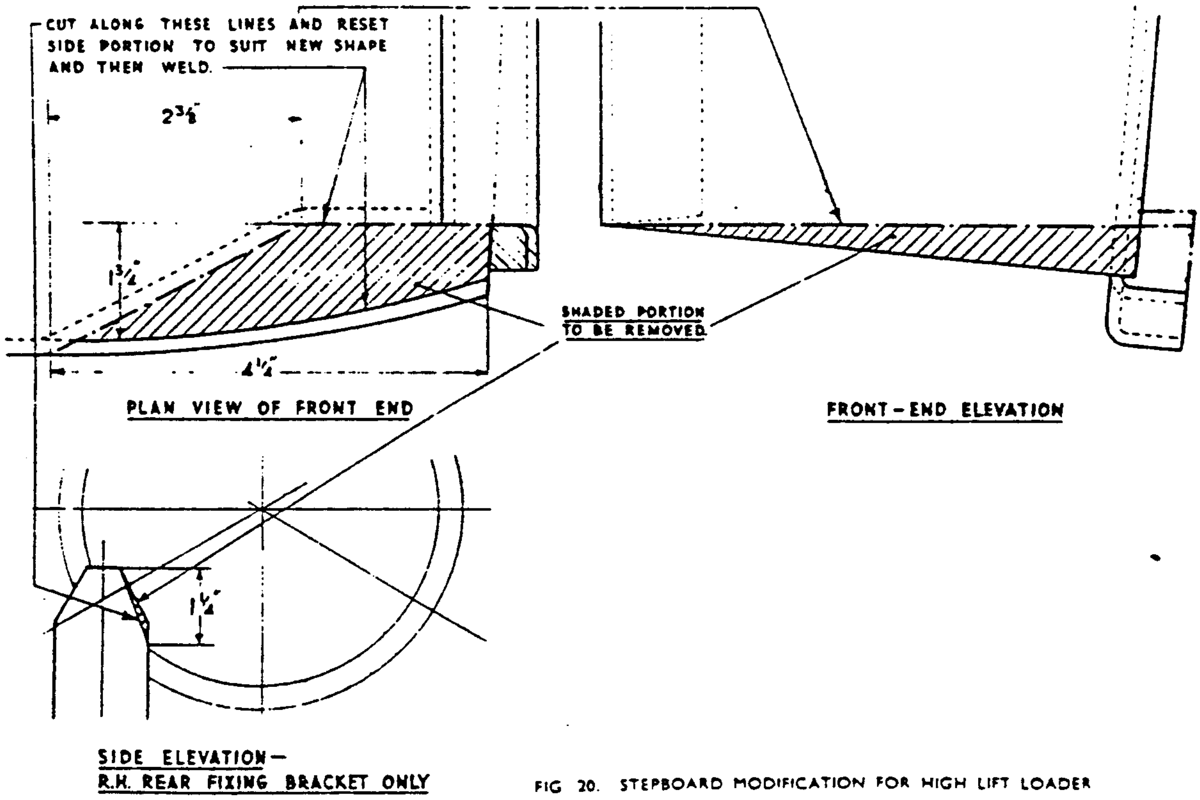


FIG 20. STEPBOARD MODIFICATION FOR HIGH LIFT LOADER

HORN AND MIRROR

Mirror: An adjustable mirror is supplied, originally fitted on the R.H. front fender of Full Industrial and Council Type Tractors, and on subsequent machines on the instrument panel on Basic Industrial Tractors.

Horn: A horn is provided on the Full Industrial and Council Type Tractors, TE-P/R/S/T20, and the press button combines with the lighting switch (See Fig. 28).

On Basic Industrial tractors a plain horn press button, is mounted in the same position on the instrument panel.

The horn itself is mounted on L.H. side of the engine.

IMPLEMENT SUITABILITY FULL INDUSTRIAL AND COUNCIL TYPE TRACTORS

In most instances the agricultural implements manufactured by this Company can be attached to the Full Industrial and

Council Type Tractors without revision, but in others slight alteration is necessary. The list which follows is divided into appropriate categories.

1. The following range of Ferguson implements hitch in the normal manner without alteration to the tractor :—

Mouldboard Ploughs
Disc Ploughs
Subsoiler
Tandem Disc Harrows
Spring Tooth Harrows
Tiller
Ridger
Weeder
Spring Tine Cultivator
Potato Spinner
Post Hole Digger
Trailer Hitch
Pulley
Front Tractor Jack
Rear Tractor Jack
Multi-Purpose Seed Drill
Steerage Hoe
Blade Terracer
Transport Box
Soil Scoop
Hammermill
Reversible Plough
Mounted Tandem Disc Harrow
Mounted Spring Tine Harrow
Side Delivery Rake
Rigid Tine Cultivator.

2. The following implements can be hitched provided that the tractor rear mudguards are removed or, alternatively, are replaced by the normal agricultural type :—

Manure Spreader
Potato Planter
Spike Tooth Harrow

3. The following Ferguson implements can be hitched provided that the crossbar between the mudguards is removed :—

Woodsaw
Winch
Low Volume Sprayer

4. The following Ferguson implements can be hitched provided that certain revisions are carried out as follows :—

Mower :

To attach the mower it is necessary to remove the right hand footboard to obtain sufficient clearance for the pull-bar assembly.

Manure Loader L-UE-20

Prior to fitting this loader, the front and rear mudguards, the front bumper and the footboards must be removed. It is unnecessary, however, to remove the front bumper brackets.

High Lift Loader M-UE-20/21

This requires the removal of the front wings, pivots and headlamps. It will also be necessary for the stepboards to be modified in accordance with the particulars given in Fig. 20.

In addition, should the loader be used with the manure fork attachment, the front bumper beam must be removed. When the gravel bucket only is employed, the front bumper beam may remain in position. It should be noted, however, that the bumper beam will restrict the entry of the bucket in the soil or gravel to a few inches.

When it is intended to use Loader M-UE-20/21 extensively with the Industrial tractor, conversion to the Council type, which provides an alternative lighting arrangement, should be considered.

To prevent fouling of the R.H. rod of handbrake assembly against patent valve control linkage and pipe from patent valve to selector valve, the brake rod must be turned end to end, still leaving the fork ends in their original position, i.e. slotted type on independent brake shaft, plain hole type to lever on hand brake cross-shaft.

NOTE : The length of thread on the brake rod now connecting to the plain hole type fork end must be increased to provide sufficient adjustment of the brake rod in the new position.

Trailers — 30 cwt. and 3 ton.
In extreme conditions of lock and simultaneous tilt, slight interference is apparent between the handbrake lever of both trailers and the rear mudguard of the tractor. In very unfavourable operating conditions it is recommended that the rear mudguards be replaced by the agricultural pattern.

SEMI-INDUSTRIAL AND BASIC INDUSTRIAL TRACTORS

Implements hitch normally to these tractors. However, where accessories such as industrial fenders or stepboard assemblies have been fitted to the Basic Industrial Tractor, some revision may be necessary on the lines indicated above.

SERVICE EQUIPMENT

for

THE FERGUSON SYSTEM
TRADE MARK

Ferguson

Special tools to facilitate service operations are listed in this brochure.

The tools illustrated are durable, efficient and adaptable, and are the result of close collaboration between our Service Division and tool manufacturers.

To keep the cost to a minimum, the smallest number possible, consistent with good practice, is included in the set.

Throughout this brochure Churchill and Britool equipment are listed separately.

TOOLS ARE MANUFACTURED BY :

V. L. CHURCHILL Co. Ltd.
WALNUT TREE WALK,
KENNINGTON,
LONDON S.E.11.

JENKS BROS. Ltd.
BRITOOL WORKS,
BUSHBURY, WOLVERHAMPTON.
(Marketed under the name "BRITOOL")

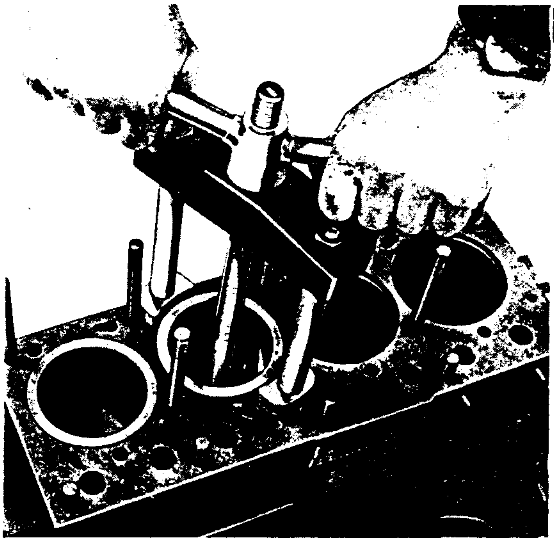
Domestic Dealers should place orders direct with the manufacturers.

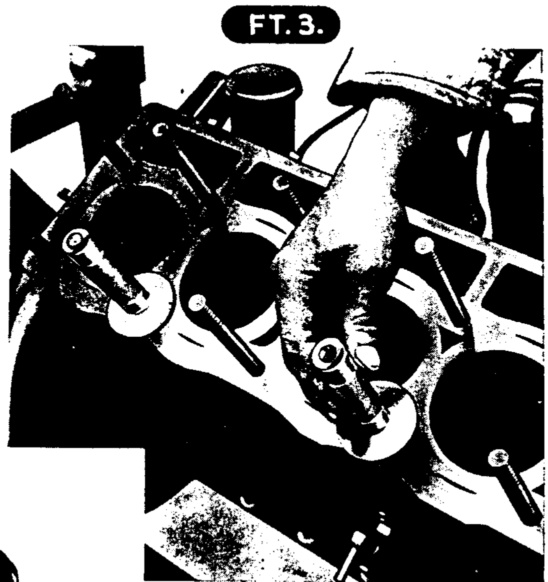
Export Distributors' orders should be forwarded to Harry Ferguson Limited, Coventry, England.

INDEX

SECTION "U"

SERVICE EQUIPMENT

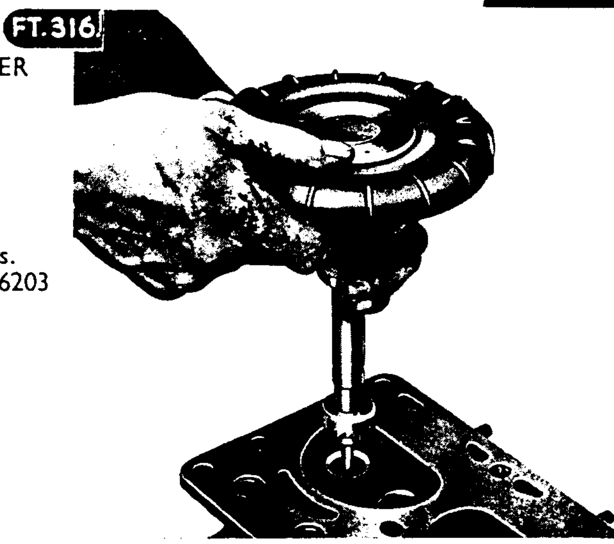




FT.1.

CYLINDER
SLEEVE
PULLER

Removes Cylinder Sleeves Parts Nos. 4207 & 56203



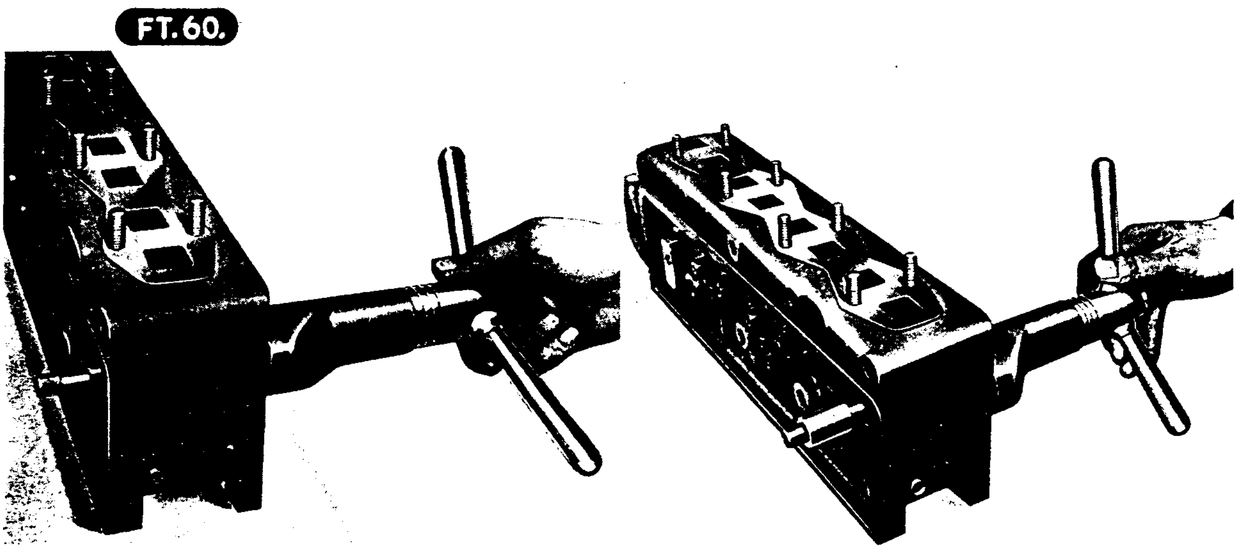
FT.3. CYLINDER SLEEVE RETAINERS

Retains cylinder sleeves Parts Nos. 4207 & 56203

FT.316.
LEFT : VALVE SEAT CUTTER AND PILOT

Alternative Cutters :
Tractor type TE-20—No. 31720
Tractor type TE-A-20—No. 37831

Narrowing Cutter :
(both Tractor types No. 32173)



FT.60 VALVE GUIDE REMOVER AND REPLACER

Removes and replaces Valve Guides Part Nos. 1704, 55877, 55876

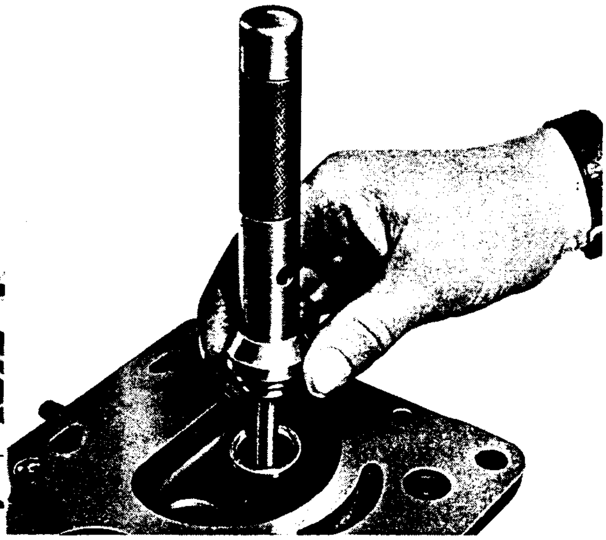
SERVICE EQUIPMENT

ENGINE

FT. 540.

FT.540 VALVE SEAT INSERT REMOVER (TE-20 only)
Removes Valve Seat insert Part No. 1678

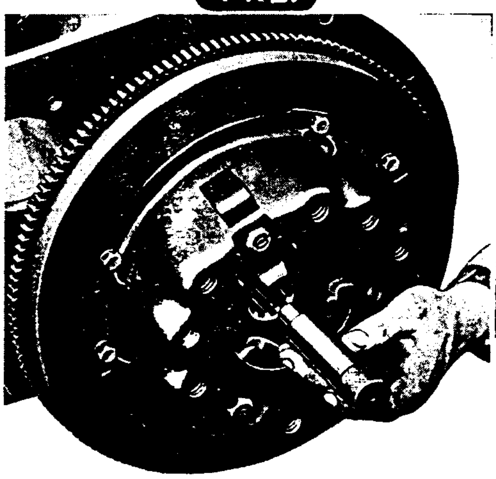
FT.6057.



F.T.6057 VALVE SEAT INSERT REPLACER (TE-20 only)
Replaces Valve Seat insert Part No. 1678

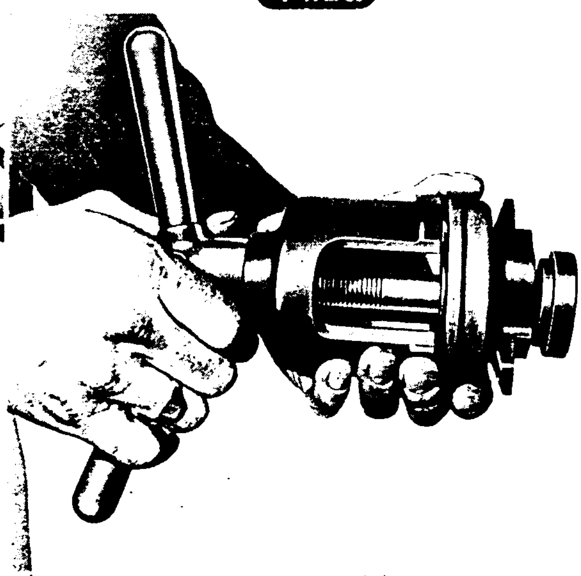
CLUTCH

FT. 2.



FT.2. CLUTCH PLATE CENTRALISER
Positions clutch plate Part No. 8572

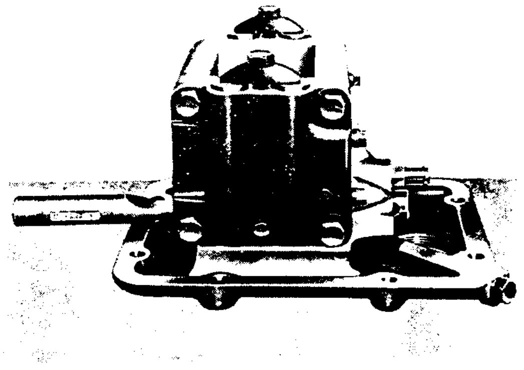
FT.20.



FT.20. CLUTCH THRUST BEARING REMOVER AND REPLACER
Removes and Replaces Bearing Part No. 4069

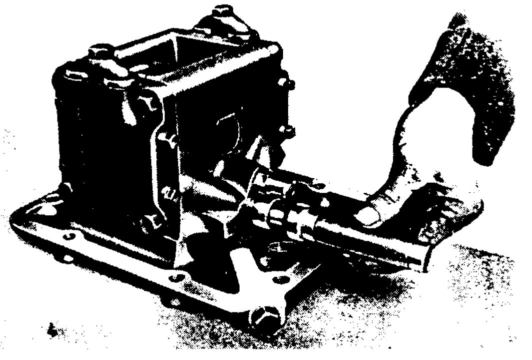
SERVICE EQUIPMENT

FT.21.A.



FT.21.A.
CONTROL VALVE BUSH DRIVER
Removes control valve bush.
Part No. 1044.

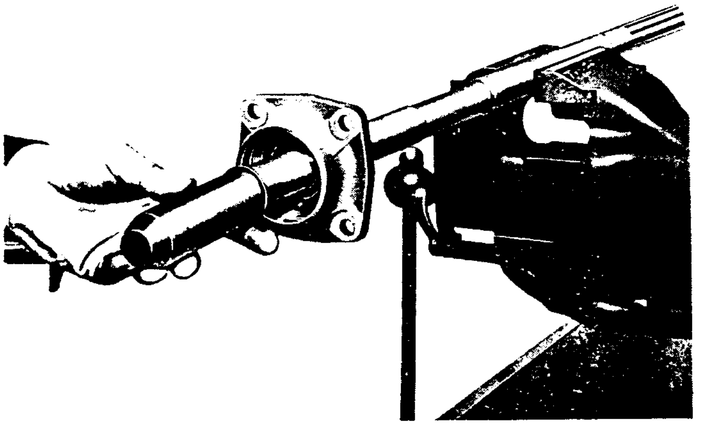
FT.21.B.



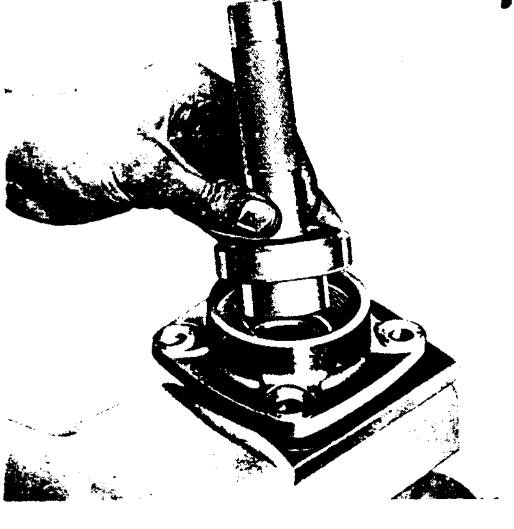
FT.21.B.
CONTROL VALVE BUSH REPLACER
Replaces control valve Bush.
Part No. 1044.

POWER TAKE-OFF

FT.25.



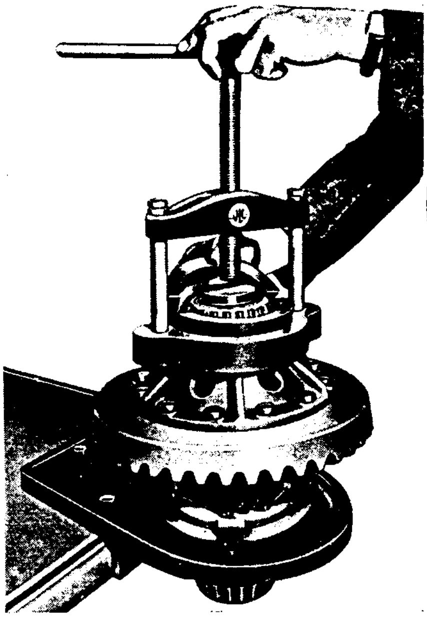
FT.31.B.



FT.25 POWER TAKE-OFF CIRCLIP INSTALLER
Replaces Bearing Snap Ring
Part No. 1134

FT.31.B POWER TAKE-OFF SEAL DRIVER.
Replaces Bearing Seal
Part No. 1190

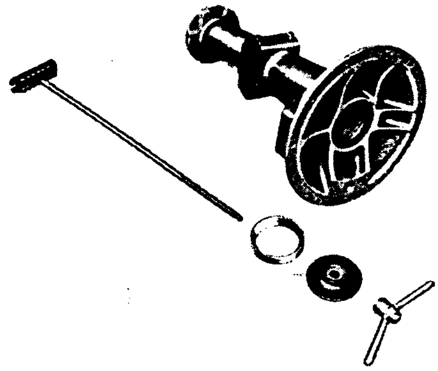
SERVICE EQUIPMENT



FT.4221
DIFFERENTIAL BEARING CONE REMOVER, PINION BEARING REMOVER AND REPLACER

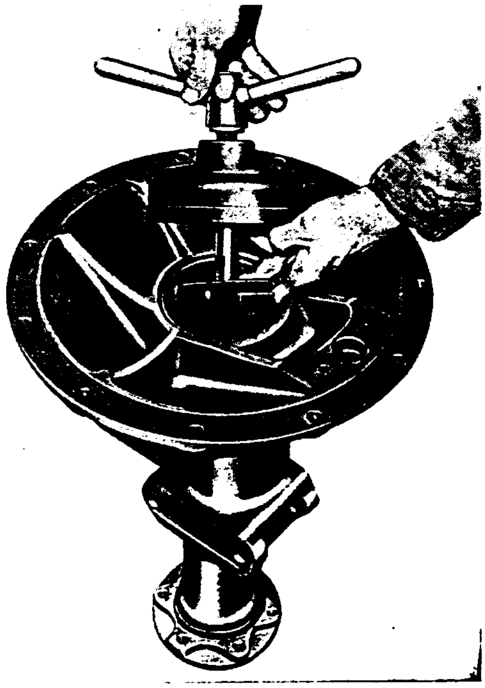
Removes cone and roller assembly, Part No. 4080

Removes and replaces cone and roller assembly, Part No. 4033



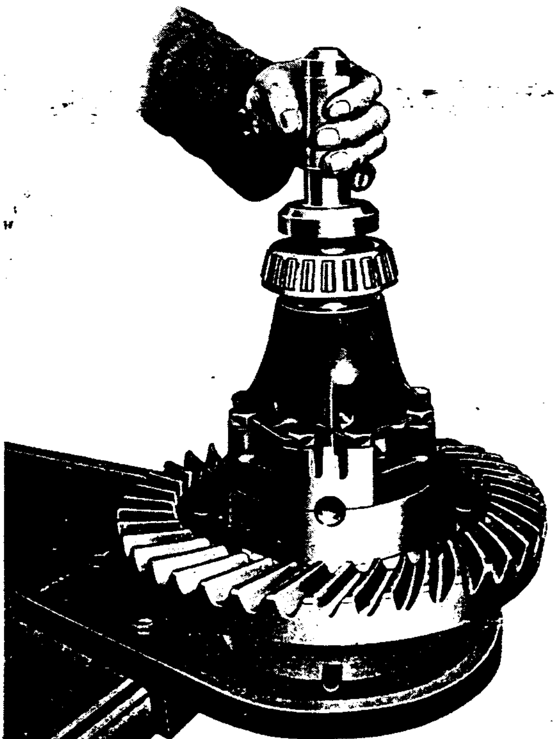
FT.32.B. DIFFERENTIAL BEARING CUP REPLACER

Replaces differential Bearing cup Part No. 4025



FT.32.A. DIFFERENTIAL BEARING CUP REMOVER

Removes differential bearing cup Part No. 4025

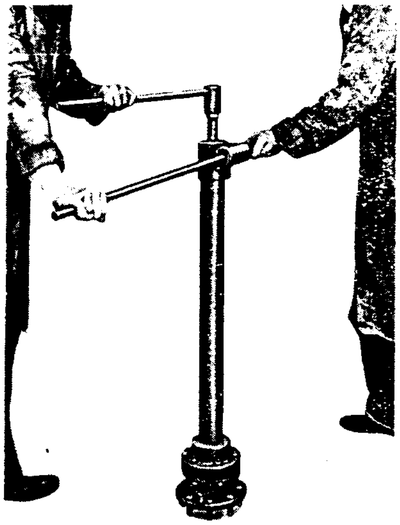


FT.12. DIFFERENTIAL BEARING CONE REPLACER

Replaces cone and roller assy. Part No. 4080

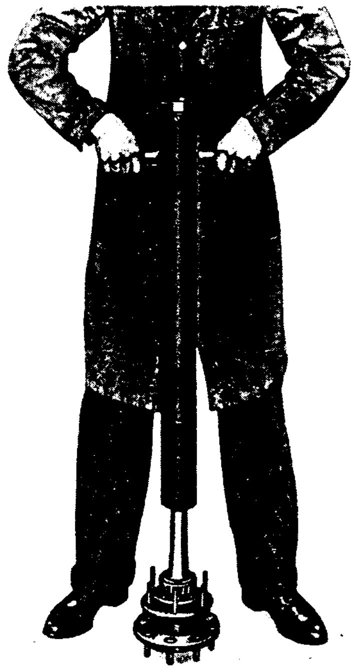
THE DIFFERENTIAL BEARING CONE REMOVER AND REPLACER ARE ILLUSTRATED IN USE WITH THE DIFFERENTIAL HOUSING HOLDER CHURCHILL TOOL No. FT. 9
See Page 10.

FT. 26.



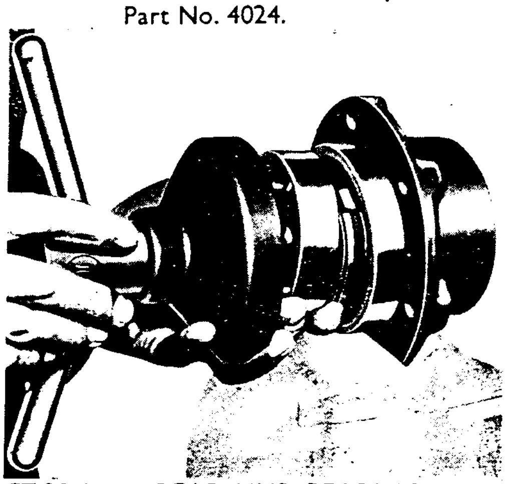
FT.26. AXLE SHAFT BEARING REMOVER
(with wrench Part No. 26.A.)
for removal of cone and roller assy.
Part No. 4024.

FT. 28.



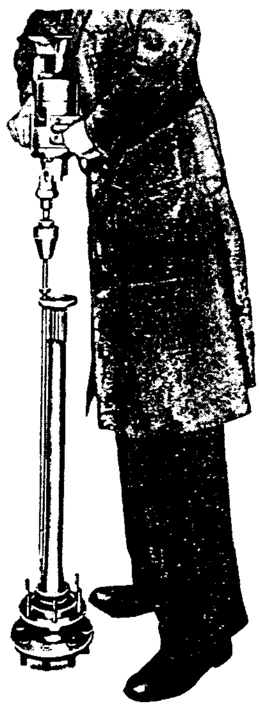
FT.28. AXLE SHAFT BEARING REPLACER
Replaces cone and roller assy.
Part No. 4024.

FT.30.A.



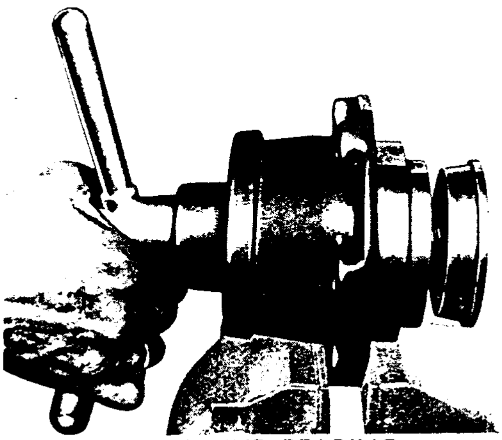
FT.30.A. REAR HUB BEARING CUP REMOVER
Removes bearing cup Part No. 4025

FT.26.B.



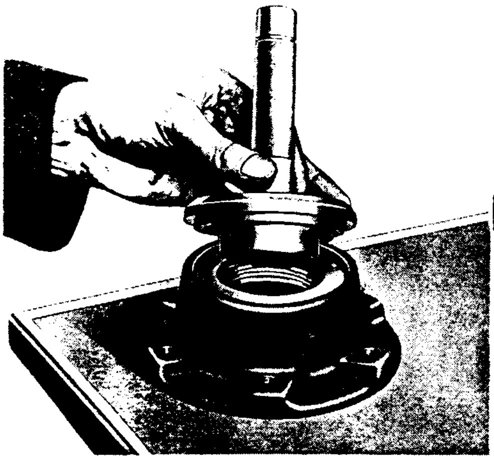
FT.26.B. JIG & EXTENSION DRILL
For removal of collar
Part No. 1174

FT.30.B.



FT.30.B. REAR HUB BEARING CUP REPLACER
Replaces bearing cup. Part No. 4025

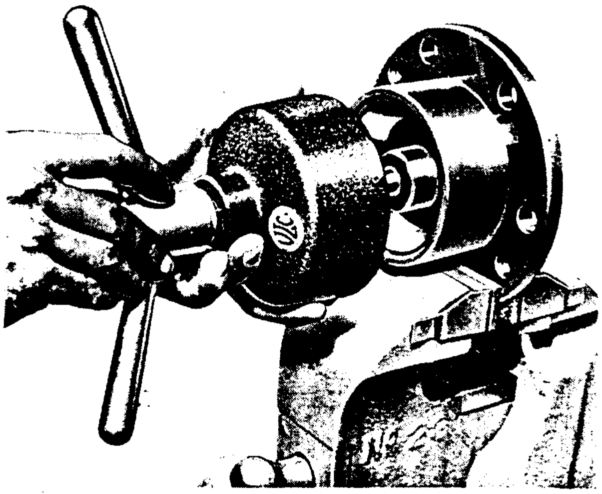
SERVICE EQUIPMENT



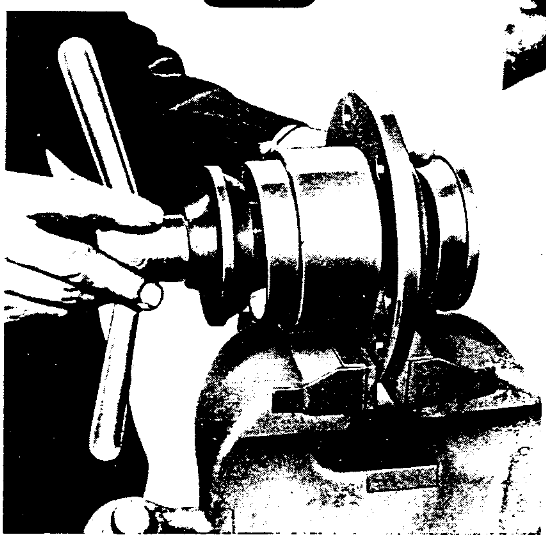
FT.29.

FT.29. REAR HUB OIL SEAL DRIVER
for replacement of oil seal
Part No. 1082

FT.23.



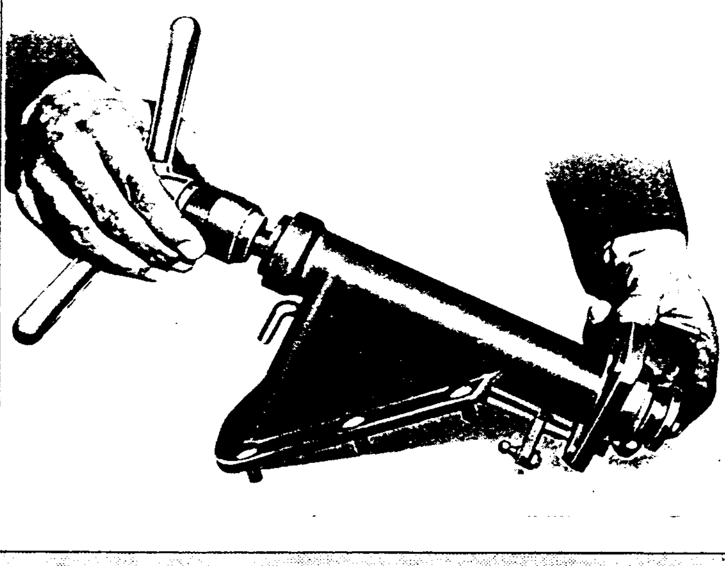
FT.24.



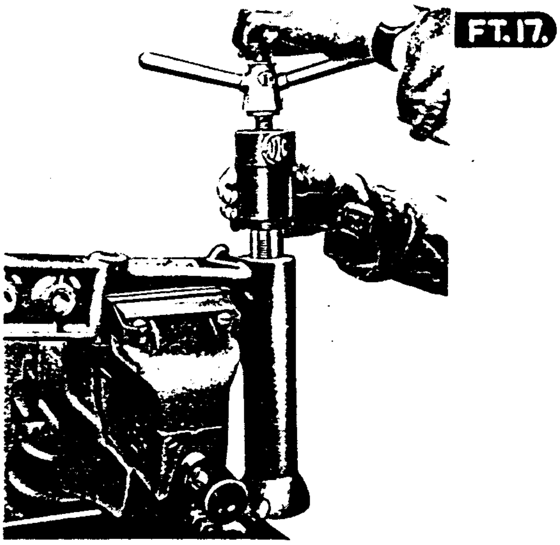
FT.23. DRIVING PINION BEARING CUP REMOVER
Removes bearing cup
Part No. 4032

FT.24. DRIVING PINION BEARING CUP REPLACER
Replaces bearing cup
Part No. 4032

FT.13.

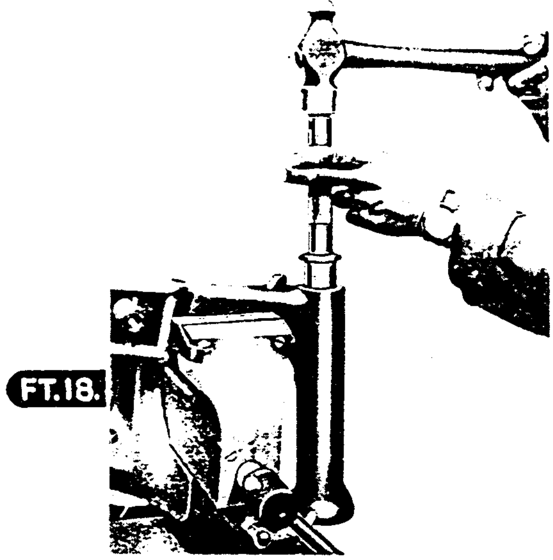


FT.13.
STEERING COLUMN BEARING OUTER CONE REPLACER
Replaces outer cone of bearing.
Part No. 1251



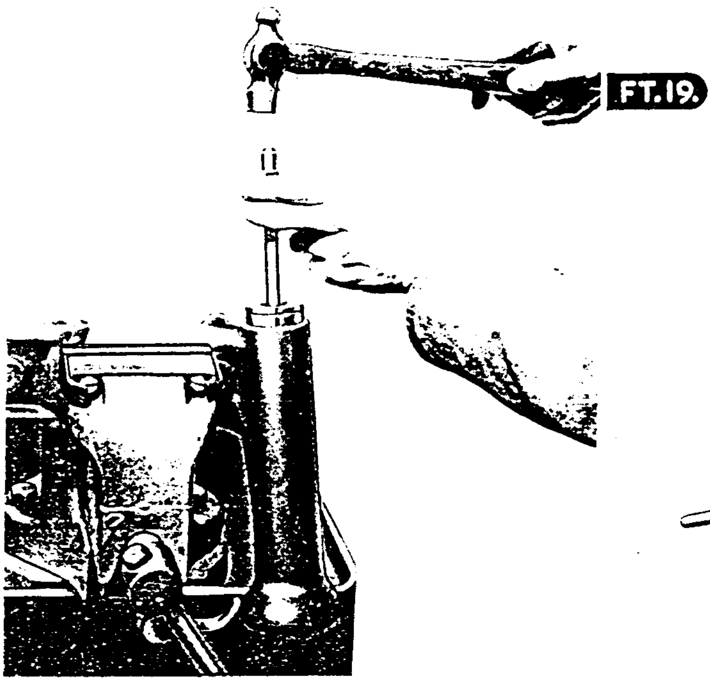
FT.17. FRONT AXLE SPINDLE BUSH REMOVER

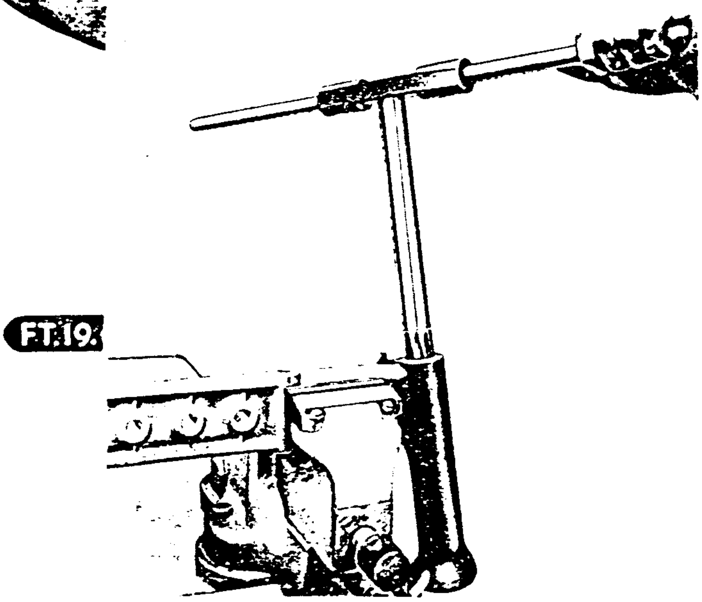
Removes Spindle Bush
Part No. 1128



FT.18. FRONT AXLE SPINDLE BUSH REPLACER

Replaces spindle bush.
Part No. 1128





FT.19. FRONT AXLE SPINDLE BUSH EXPANDER AND REAMER COMPLETE

Reamer FT. 19/1. Bush FT. 19/2.
Rod FT. 19/3

Expands and Reams Bush
Part No. 1128

SERVICE EQUIPMENT

FT.36A

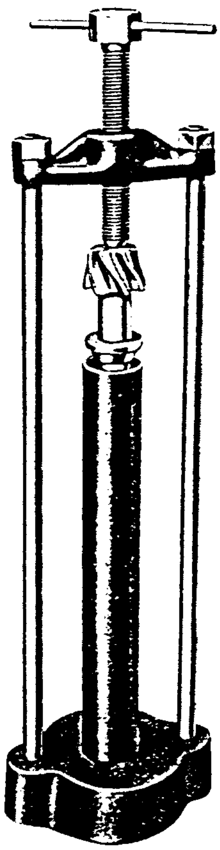
FT.36.A.
STEERING COLUMN
BEARING INNER
CONE REMOVER

Removes inner
cone of bearing
Part No. 1251

FT.36.B.
STEERING COLUMN
BEARING INNER
CONE REPLACER.

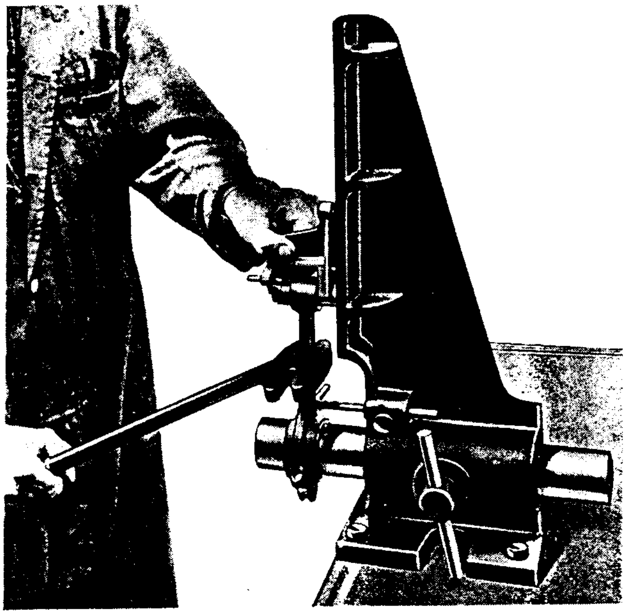
Removes inner
cone of bearing
Part No. 1251

FT.36B.



CHURCHILL SPECIAL EQUIPMENT

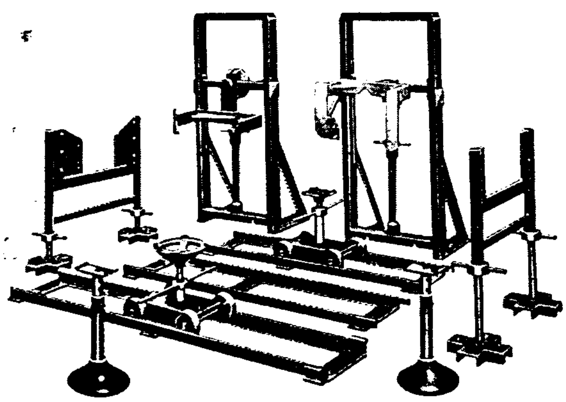
FT.335.



FT.335.
CONNECTING ROD JIG AND ARBOR

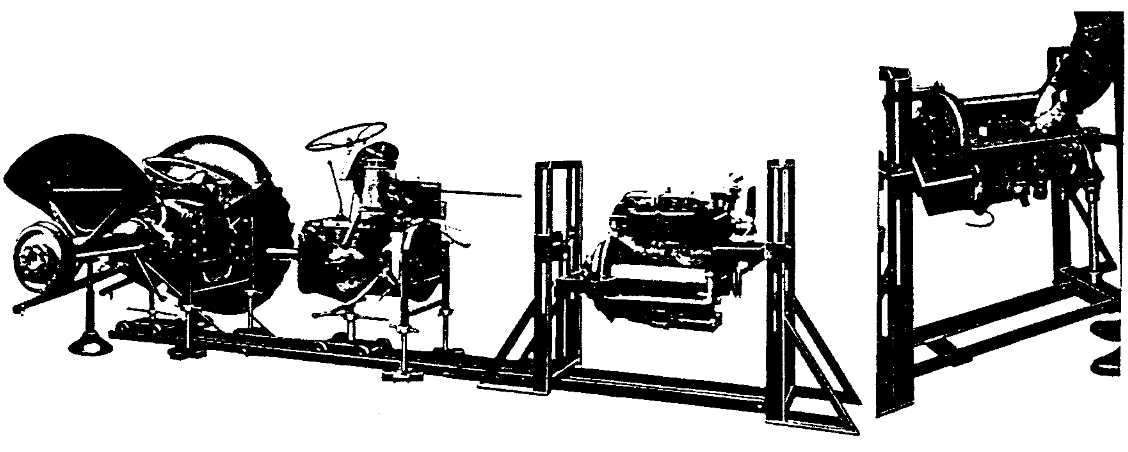
TRACTOR TE-20 and TE-A-20 for parts 8599, 57965, 58393.

FT.27.



FT.27.
TRACTOR DISMANTLING STAND.

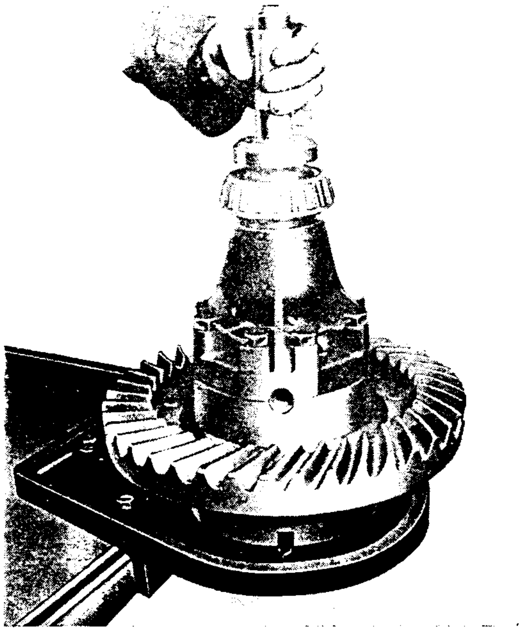
Showing some typical applications



SPECIAL EQUIPMENT

SERVICE EQUIPMENT

FT.9.



FT.9.
DIFFERENTIAL
HOUSING HOLDER

Illustrated in use
with FT.12.
Differential bearing
cone replacer

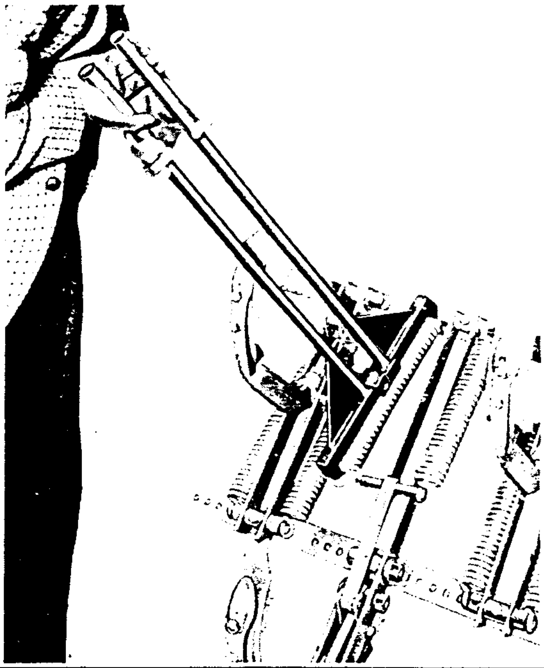
SPECIAL IMPLEMENT TOOL

FT.37.

FT.37

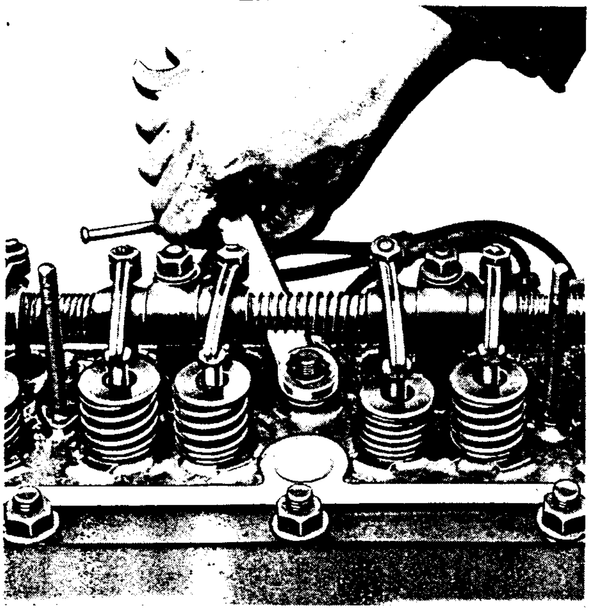
TILLER SPRING
REMOVER AND
REPLACER

Removes and replaces
Spring
Part No. BE.7010



FTB.2

FTB.3.

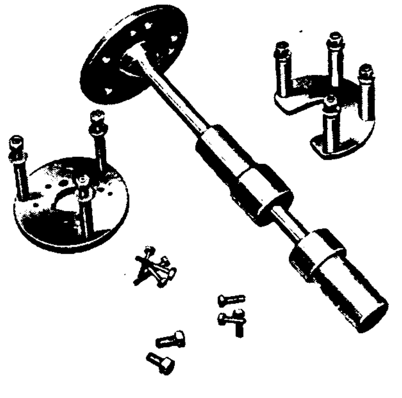


FTB.2. MANIFOLD NUT WRENCH

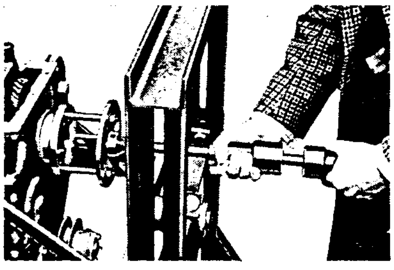
FTB.3. CYLINDER HEAD NUT WRENCH

FTB. 7
UNIVERSAL PULLER AND REPLACER COMPLETE (*left*)

FTB.7.



(1)

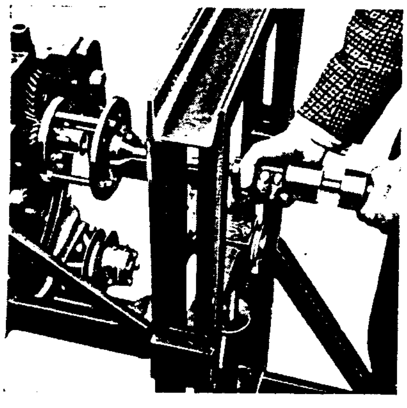


FTB. 7A—Adaptor to fit pulley hub (1) and crankshaft gear (2). Tractor TE-20 only.

Removes and replaces pulley hub Part No. 4239 and gear, Part No. 4213.

FTB. 7B—Adaptor to fit camshaft gear (3). Tractor TE-20 only.

Removes and replaces gear Part No. 4212.

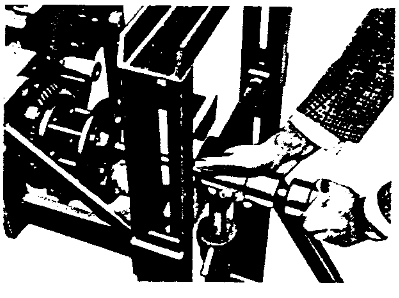


(2)

FTB. 7C
Adaptor to fit crankshaft chain wheel (not illustrated). Tractor TE-A-20 only.

Removes and replaces crankshaft chain wheel, Part No. 55971.

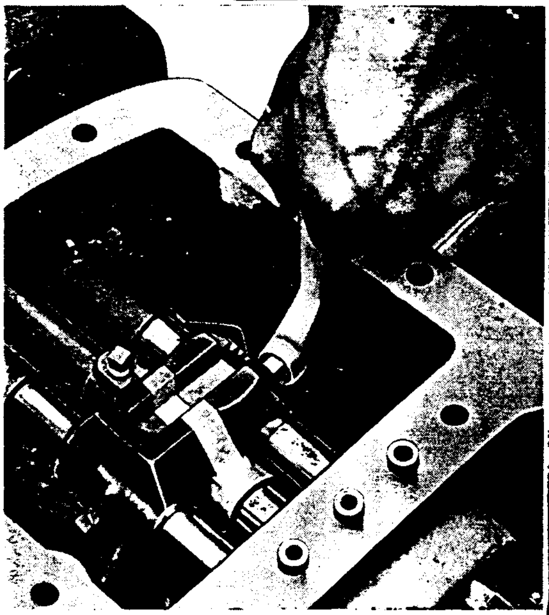
(3)



SERVICE EQUIPMENT

TRANSMISSION STEERING & FRONT AXLE

FTB.11.



FTB.5.

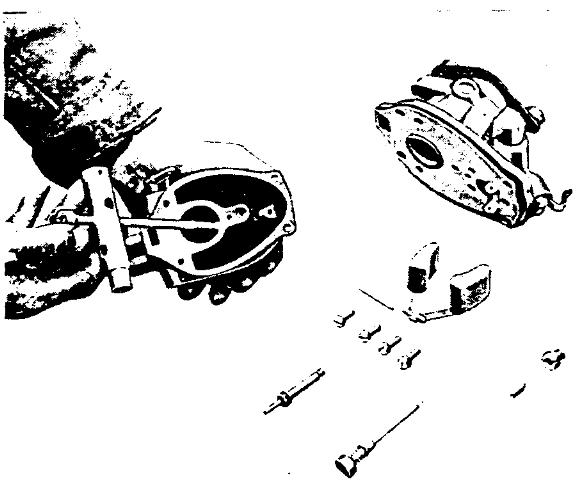
FTB.11. SELECTOR FORK LOCK PIN WRENCH

To fit Lockpin
Part No. 1286

FTB.5. STEERING COLUMN LOCKNUT WRENCHES (2)

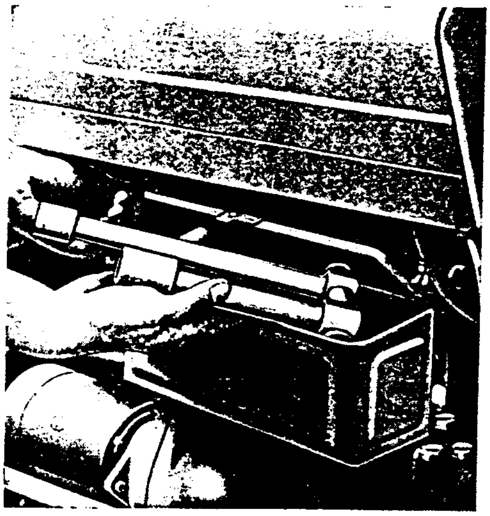
To Fit Locknuts
Part No. 1265

CARBURETTOR

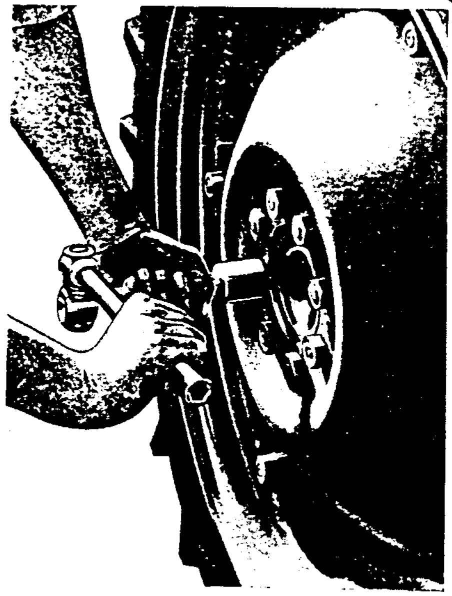


FTB.4.

FTB.4.
CARBURETTOR WRENCH
(Tractor type TE-20 only)



FTB.18.



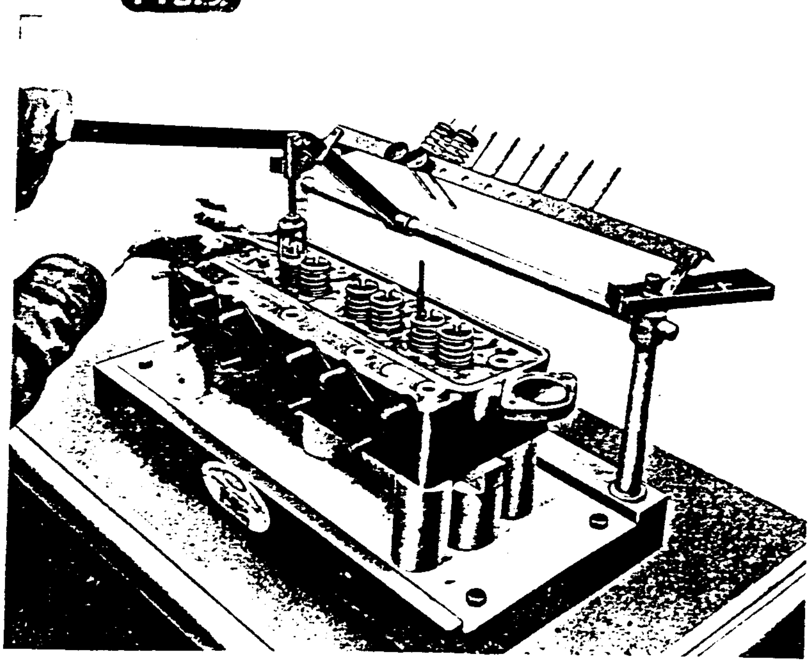
FTB. 18.

TWIN WHEEL NUT WRENCH

Not only a workshop tool—for the tool box of any tractor.

SPECIAL EQUIPMENT

FTB.9.

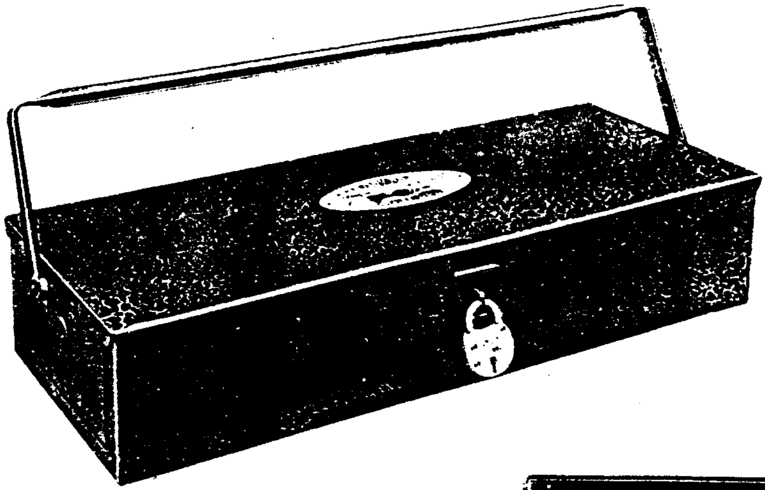


FTB.9.

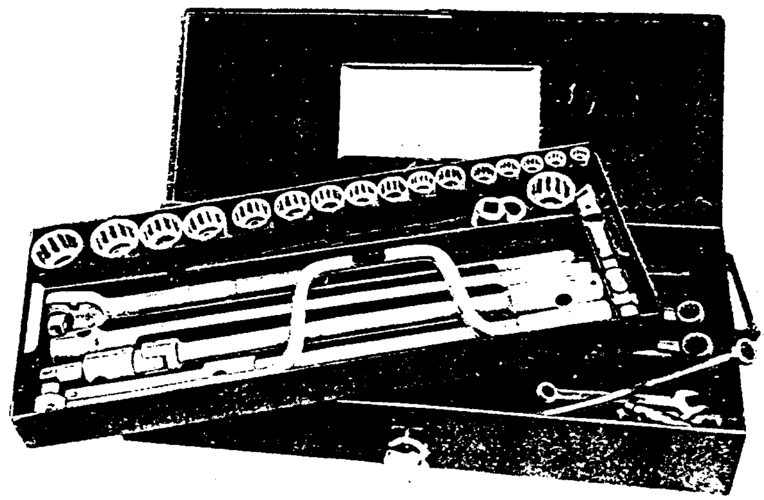
CYLINDER HEAD SERVICE FIXTURE.

Head reversible for Valve Seat Service.

SERVICE EQUIPMENT



FTB.1.



FTB.1.
SPECIAL
FERGUSON
WRENCH
SET

—

SUPPLIED
IN
DOUBLE
DECKER
STEEL BOX
CONTAINING :

↓

- 17 BIHEXAGONAL SOCKETS $\frac{7}{16}$" to $1\frac{1}{4}$" A.F.
- TURNSCREW SOCKET BIT.
- SPEED BRACE.
- BAR HANDLE.
- SWIVEL HANDLE.
- RATCHET HANDLE.
- UNIVERSAL JOINT.
- 4 TEE-HANDLE EXTENSIONS 3" to 18"
- 2 SPARK PLUG SOCKETS 14 mm. & 18 mm.
- STUD EXTRACTOR FTB. 10.
- 7 JAWRING WRENCHES $\frac{3}{8}$" to 1.1$\frac{1}{16}$" A.F.
  (COMBINED HEXAGON RING AND OPEN JAW SPANNERS).
- MANIFOLD WRENCH FTB.2.
- CYLINDER HEAD NUT WRENCH FTB.3.
- CARBURETTER WRENCH (TYPE TE-20 ONLY) FTB.4.