Pay Line Group

Service Manual

INTERNATIONAL

BD-144, BD-154 Series

DIESEL ENGINES

and

BC-144 Series

PETROL ENGINES

SM-12A

INTERNATIONAL HARVESTER COMPANY of GREAT BRITAIN LIMITED

P.O.BOX 25 259 CITY ROAD LONDON ECIP 1AD

KBB/4/78 McC

SM-12A
SERVICE MANUAL

INTERNATIONAL

BC-144 BD-144 & BD-154
SERIES ENGINES

The black tabs shown on the right-hand side of this page line up with the corresponding tabs on the index pages of the respective groups.

NOTE

Refer to the SUPPLEMENT AND CHANGE INDEX for a list of supplements, and to the end of the appropriate group for the latest instructions, before carrying out work on this equipment.

INTERNATIONAL HARVESTER COMPANY
OF GREAT BRITAIN LIMITED

PO BOX 25, 259 CITY ROAD, LONDON EC1P 1AD

GROUP 1

GENERAL

1. INTRODUCTION

1a. GENERAL

The instructions contained in this service manual are for the information and guidance of servicemen who are responsible for overhauling and repairing International BD-144 and BD-154 diesel engines. and BC-144 petrol engines.

1b. SERVICE TOOLS

International engines are designed so that few special tools are required. However, whenever the use of inexpensive special service equipment will facilitate work, such equipment is mentioned in this manual. Where this equipment can easily be made in the workshop, dimensional drawings have been provided.

1c. SERVICE PARTS

I.H. engines deserve genuine I.H. service parts. The best material obtainable and experience gained through many years of construction and farm equipment manufacturing enable the International Harvester Company to produce quality that will not be found in imitation or "just as good" repair parts. No serviceman can afford to guarantee a repair job that has not been serviced with genuine I.H. parts. For the correct service parts to be used always refer to the Parts Catalogue. The loose-leaf catalogues are accurate and are brought up to date continually by issuing revisions.

1d. SERIAL-NUMBERS

The engine serial number is stamped on a pad on the R.H. side of the crankcase.

1e. DIESEL FUEL INJECTION EQUIPMENT

If detailed information on the fuel injection equipment and fuel lift pump is desired, refer to the "FUEL INJECTION SERVICE MANUAL SM-11".

1f. ELECTRICAL

Full details of servicing and adjusting the electrical equipment will be found in the "ELECTRICAL EQUIPMENT SERVICE MANUAL SM-14".

1g. ADJUSTMENTS

Where adjustments are necessary the group will contain the relevant information. Reference to that section before commencing to dismantle the unit may prevent unnecessary work being carried out.

1h. ILLUSTRATIONS

Four types of illustration references will be found in this manual and these are explained by the following examples:

(a) (1-4) This refers to the item marked by indicator number 1 in FIGURE 4 of the GROUP in which the reference appears.

(b) (1 & 2-4) This refers to the items marked by indicator numbers 1 and 2 in FIGURE 4 of the GROUP in which the reference appears.

(c) (1-4 & 2-6) This refers to items marked by indicator number 1 in FIGURE 4 and indicator number 2 in FIGURE 6 of the GROUP in which the reference appears.

(d) (1-4 GROUP 5) This is used when reference is made to an illustration in another GROUP. A GROUP number may be used in conjunction with (a), (b), or (c) to show the indicator number, FIGURE number and GROUP in which the illustration appears.

1i. INSPECTION AND REPAIR

The following notes should be used as a general guide to inspection and repair. Where a special procedure is necessary for a component or assembly, full details will be found in the relevant section of the group.

(a) BEARINGS

Inspect for evidence of overheating, cracks, scores, pitting and general wear. Replace if necessary. Soak in oil, wrap or cover until ready for assembly.

(b) PINS AND BUSHES

Inspect for damage, scoring and pitting. Check with mating parts for wear.

(c) GASKETS AND SEALS

Always use new gaskets and seals during assembly. Be extremely careful not to damage the seal or gasket during installation. Pack lip type seals with grease and use sleeves wherever a seal has to be passed over splines or threads.

(d) GEARS AND SPLINES

Check for cracks, pitting, burrs, broken or missing teeth. Check for excessive wear with mating parts. Remove burrs carefully. DO NOT interfere with tooth or spline profile. REPLACE all parts which show damage or excessive wear.

(e) WELDS

Check all welded assemblies for cracks, twisting and misalignment. Information concerning the use of special welding rods or welding procedure is detailed, where relevant, in the appropriate section of the group.

(f) CASTINGS

Check castings for cracks and distortion.

(g) FUEL, OIL AND COOLANT PIPES AND HOSES

Check unions for leaks, stripped threads or other faults. Check pipes for cracks or chafing, hoses for chafing, twisting, perishing or other damage.

(h) LUBRICATION FITTINGS

Check for damaged or missing fittings and replace. Check that grease and oil galleries are clear.

1j. LUBRICATION

When assembling any part, always coat all wearing surfaces with the lubricant specified in the operator's manual. Use sufficient quantities of lubricant to prevent any danger of seizing, scoring or excessive wear when the assembly is first operated.

FAILURE TO PROVIDE "STARTING LUBRICATION" MAY RESULT IN SERIOUS DAMAGE.

1k. METRIC CONVERSIONS

The following table gives conversion factors for use in converting the British specifications to their metric equivalents:

To convert from:	To:	Multiply by:
inches	cm	2.540
lb	kg	.4536
ounces	kg	.02835
lb ft	metre - kg	.1383
lb in	metre - kg	.0115
lb/in^2	kg/cm^2	.07031
Imp galls	litres	4.5454
Imp pints	litres	.5682
miles	km	1.6

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2. BOLT IDENTIFICATION CHART

IH TYPE	BSS	MANUFACTURERS MARKINGS						
2	R	R45-55	BEES 45 R 55	NEWALL HITENSILE "R"	SPNR	NEWTON R	SPARTS R	TWLR
	T	T55-65	BEES 55 T·65	NEWALLOY T or NEWALL HITENSILE T	SPNT	NEWTON T	SPARTS T	TWLT
4	V	V65-75	BEES 65 V 75	NEWALLOY "V"	SPNV	NEWTON V	SPARTS V	TWLV

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3. STANDARD TORQUE DATA FOR NUTS AND BOLTS

Where no special torque data is specified, the following torque should be used on all nuts and bolts providing that the threads are lubricated with engine oil or chassis grease.

Bolt Size	TYPE 2		TYPE 4	
	Min.	Max.	Min.	Max.
1/4	9	10	12	14
5/16	19	21	27	30
3/8	33	37	45	50
7/16	53	60	75	85
1/2	80	90	115	130
9/16	115	130	165	185
5/8	160	180	220	250
3/4	290	320	400	450
7/8	420	470	650	730
1	630	710	970	1090
1-1/8	850	950	1380	1550
1-1/4	1200	1350	1940	2180

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NOTE: When re-using nuts and bolts in service; use the minimum torque figure.

4. SPECIFICATIONS

The following specifications are listed in GROUP order. During the overhaul of worn components personal initiative must be exercised to determine whether or not a component is suitable for re-use. It is obviously uneconomical to return worn parts to service with an expectation of life which may involve labour costs at an early date.

	BC-144 Series	BD-144 Series	BD-154 Series
1. GENERAL			
Number of cylinders	4	4	4
Bore (in)	3-3/8	3-3/8	3-1/2
Stroke (in)	4	4	4
Displacement (in^3)	144	144	154
Compression ratio	6.3 : 1	21.1 : 1	23 :1
Compression pressure lb/in^2			
at 200 rev/min	80/105	330/355	445/470
at 300 rev/min	90/115	350/375	510/535
Firing order	1-3-4-2	1-3-4-2	1-3-4-2
ENGINE SPEED (rev/min)			
Full load, governed	BC-144 2000 BC-144A 1875 BC-144H 2200 BC-144H Propane (LPG) 2200	BD-144 Mechanical Governor 1750 ± 10 BD-144 Pneumatic Governor 1800 BD-144A Pneumatic Governor 1900 BD-144 Pneumatic Governor (for B-55 Baler) 1525 ± 10 BD-144 Mechanical Governor (for Canadian Engine) 2000 ± 10 BD-144 DPA Injection Pump 1775 BD-144A DPA Injection Pump 1900 BD-144B DPA Injection Pump 1525 BD-144C & BD-144F 2000 BD-144 (DPA) 6000 ft Derated 1775 BD-144A (DPA) 6000 ft Derated 1900 BD-144C & BD-144F(DPA) 6000 ft Derated 2000	BD-154 DPA Injection Pump 2000 BD-154D DPA Injection Pump 2000 BD-154H DPA Injection Pump 2200 BD-154 (DPA) 6000 ft Derated 2000 BD-154H (DPA) 6000 ft Derated 2200

	BC-144 Series	BD-144 Series	BD-154 Series
ENGINE SPEED - Continued High idle	BC-144 2200 ± 25 BC-144A 2075 ± 25 BC-144H 2400 ± 25 BC-144H Propane (LPG) 2400 ± 25	BD-144 Mechanical Governor 1925 ± 40 BD-144 Pneumatic Governor 1860 to 1900 BD-144A Pneumatic Governor 2000 Max. BD-144 Pneumatic Governor (for B-55 Baler) 1700 Max. BD-144 Mechanical Governor (for Canadian Engine) 2200 ± 25 BD-144 DPA Injection Pump 1925 ± 25 BD-144A DPA Injection Pump 2075 ± 25 BD-144B DPA Injection Pump 1600 ± 25 BD-144C & BD-144F DPA Injection Pump 2200 ± 25 BD-144 (DPA) 6000 ft Derated 1925 ± 25 BD 144A (DPA) 6000 ft Derated 2075 ± 25 BD-144C & BD-144F (DPA) 6000 ft Derated 2200 ± 25	BD-154 DPA Injection Pump 2200 ± 25 BD-154D DPA Injection Pump 2200 ± 25 BD-154H DPA Injection Pump 2380 ± 25 BD-154 (DPA) 6000 ft Derated 2200 ± 25 BD-154H (DPA) 6000 ft Derated 2380 ± 25
Low idle	All Versions 500 + 25 - 0	BD-144 Mechanical Governor 475 to 525 All Pneumatic Governors 540 to 600 Mechanical Governor (for Canadian Engine) 500 to 550 All Versions With DPA Pumps 520 to 580	All Versions 520 to 580 NOTE: When speed amplifier attachment is fitted to 434 tractors low idle setting is 750 to 800.
FUEL	Petrol - 82 octane LPG - High Purity Propane (C3 H8)	Diesel	Diesel

		BC-144 Series	BD-144 Series	BD-154 Series	
2. MANIFOLDS, CYLINDER HEAD & VALVES					
INLET VALVES					
Stem diameter	(in)	0.341/0.342	0.341/0.342	0.341/0.342	
Port diameter	(in)	1.252	1.310	1.310	
Head diameter	(in)	1.407/1.417	1.465/1.475	1.465/1.475	
Clearance in guide	(in)	0.002/0.004	0.002/0.004	0.002/0.004	
Valve face angle		44° 30' to 45°	44° 30' to 45°	44° 30' to 45°	
Valve seat angle		45°	45°	45°	
Tappet clearance	(in)	0.020 Hot & Cold	0.020 Hot & Cold	0.020 Hot & Cold	
EXHAUST VALVES					
Stem diameter	(in)	0.341/0.342	0.341/0.342	0.341/0.342	
Port diameter	(in)	Valve seat insert 1.090	BD-144, 144A & 144B 1.105 BD-144C & BD-144F 1.016	1.016	
Head diameter	(in)	1.245/1.255	1.171/1.181	1.171/1.181	
Clearance in guide	(in)	0.002/0.004	0.002/0.004	0.002/0.004	
Valve face angle		44° 30' to 45°	44° 30' to 45°	44° 30 to 45°	
Valve seat angle		45°	45°	45°	
Tappet clearance	(in)	0.020 Hot & Cold	0.020 Hot & Cold	0.020 Hot & Cold	
VALVE GUIDES					
Length-inlet	(in)	2.469	3.250	3.250	
Length-exhaust	(in)	2.625	3.000	3.000	
Inside diameter	(in)	0.344/0.345	0.344/0.345	0.344/0.345	
Set height of guide measured from		Spring recess	Cylinder head top deck	Cylinder head top deck	
Height-inlet	(in)	0.828	0.940 ± 0.030	0.940 ± 0.030	
Height-exhaust	(in)	0.984	0.940 ± 0.030	0.940 ± 0.030	
VALVE SPRINGS				INNER	OUTER
Test Length	(in)	1.346	1.672	1.258	1.475
Test load	(lb)	75.4 ± 3.5	42.5 ± 2.2	24	58
Min. length in use	(in)	1.346	1.562	1.258	1.475
Max. length in use	(in)	1.700	1.922	1.653	1.870
Free length	(in)	2.085	2.531 ± 0.047	2.125	2.550
VALVE LEVERS, SHAFT AND BRACKETS					
Shaft diameter	(in)	0.748/0.749	0.748/0.749	0.748/0.749	
Running clearance	(in)	0.002/0.004	0.002/0.004	0.002/0.004	
Bushing I.D.	(in)	0.751/0.752	0.751/0.752	0.751/0.752	
Brackets bore	(in)	0.7495/0.7510	0.7495/0.7510	0.7495/0.7510	
VALVE TAPPETS					
Diameter	(in)	0.560/0.561	0.560/0.561	0.560/0.561	
Running clearance	(in)	0.0005/0.003	0.0005/0.003	0.0005/0.003	

	BC-144 Series	BD-144 Series	BD-154 Series
VALVE PUSH RODS			
Diameter (in)	0.3125	0.3125	0.3125
Length (in)	10.690/10.720	10.510/10.540	10.510/10.540
VALVE TIMING			
Inlet opens	20° before TDC	20° before TDC	20° Before TDC
Inlet closes	40° after BDC	40° after BDC	40° after BDC
Exhaust opens	40° before BDC	40° before BDC	40° before BDC
Exhaust closes	10° after TDC	10° after TDC	10° after TDC
TORQUE LOADINGS			
Cylinder head bolts (lb ft)	75/80	75/80	75/80
Nozzle body stud or bolt to cylinder head (lb ft)		20/30	20/30
Nozzle body nut to stud (lb ft)		30/35	30/35
Tappet adjusting screw nut (lb ft)	20/25	20/25	20/25
Valve housing cover nut (lb ft)	20/25	20/25	20/25
3. CONNECTING RODS, PISTONS AND CYLINDER SLEEVES			
CONNECTING RODS			
Crankshaft bearing diameter (in)	1.8755/1.8760	1.8755/1.8760	1.8755/1.8760
Running clearance (in)	0.001/0.0029	0.001/0.0029	0.001/0.0029
Side clearance (in)	0.003/0.010	0.003/0.010	0.003/0.010
Piston pin bush ID (in)	1.1028/1.1031	1.1028/1.1031	1.1028/1.1031
PISTON PINS			
Diameter (in)			
Standard	1.1021/1.1023	1.1021/1.1023	1.1021/1.1024
Oversize - marked +5	1.1071/1.1073	1.1071/1.1073	1.1071/1.1074
Clearance between end of pin and circlip (in)	0.008/0.020	0.012/0.020	0.012/0.021
Clearance in piston (in)	0.00025 Loose to 0.00015 tight	0.00025 Loose to 0.00015 tight	0.0003 Loose to 0.0005 tight
Clearance in con rod (in)	0.0005/0.0010	0.0005/0.0010	0.0005/0.0010
Length (in)	2.898/2.902	2.898/2.902	3.019/3.024
PISTONS			
Skirt clearance at bottom 90° from pinhole (in)			
Graded	0.0031/0.0039	0.0031/0.0039	0.0031/0.0039
Individual replacements	0.0039/0.0047	0.0039/0.0047	0.0039/0.0047
Number of rings	4	5	5

	BC-144 Series	BD-144 Series	BD-154 Series
PISTONS - Continued			
Width of ring grooves (in)			
Top compression	0.0953/0.0963	0.0963/0.0969	0.0972/0.0982
Second compression	0.0953/0.0963	0.0967/0.0973	0.0972/0.0982
Third compression	0.0953/0.0963	0.0959/0.0965	0.0965/0.0975
Oil control	0.189/0.190	0.1877/0.1883	0.1877/0.1883
Ring clearance in grooves (in)			
Top compression	0.0018/0.0033	0.0028/0.0039	0.0035/0.0055
Second compression	0.0018/0.0033	0.0032/0.0043	0.0035/0.0055
Third compression	0.0018/0.0033	0.0024/0.0035	0.0028/0.0048
Oil control		BD-144 & BD-144B	
Top	0.0025/0.0040	0.0012/0.0023	0.0012/0.0028
Bottom	Not applicable	0.0012/0.0023	0.0012/0.0028
Oil control		BD-144A, 144F & 144C	
Top		Not applicable	
Bottom		0.0012/0.0023	
PISTON RINGS - Compression			
Number of rings per piston	3	3	3
Type			
Top	Chrome	Chrome internally stepped	Chrome
Second	Taper face	Plain	Internally stepped
Third	Taper face	Plain	Internally stepped
Width of all rings (in)	0.0930/0.0935	0.0930/0.0935	0.0927/0.0937
Ring gap. All rings (in)	0.012/0.018	0.012/0.018	0.015/0.019
PISTON RINGS - Oil control			
Number of rings per piston	1	2	2
Type		BD-144 & BD-144B	
Top	Slotted	Slotted	Slotted
Bottom	Not applicable	Slotted	Slotted
Type		BD-144A, 144F & 144C	
Top		Multi-piece	
Bottom		Slotted	
Ring gap (in)		BD-144 & BD-144B	
Top	0.012/0.018	0.012/0.018	0.010/0.015
Bottom	Not applicable	0.012/0.018	0.010/0.015
Ring gap (in)		BD-144A, 144F & 144C	
Top		0.015/0.045	
Bottom		0.012/0.018	
CYLINDER SLEEVES			
Wall thickness (in)	0.2134/0.2235	0.2134/0.2235	0.15065/0.16125
Sleeve O.D. (in)	3.6865/3.688 (packing ring)	3.6865/3.688 (packing ring)	3.6865/3.688 (packing ring)
Flange stand out (in)	0.001/0.005	0.001/0.005	0.001/0.005
Flange width (in)	0.227/0.229	0.227/0.229	0.227/0.229
Max. taper (in)	0.0005	0.0005	0.0005
Max. ovality (in)	0.0008	0.0008	0.0008
TORQUE LOADINGS			
Connecting rod bolts (lb ft)	40/45	40/45	40/45

	BC-144 Series	BD-144 Series	BD-154 Series
4. LUBRICATION SYSTEM			
PRESSURE REGULATING VALVE			
Location	Oil pump body	Oil pump body	Oil pump body
Spring free length (in)	2.556	2.556	2.556
Spring test length (in	1.73	1.73	1.73
Spring test load (lb)	15.510 ± 3%	15 510 ± 3%	15.510 ± 3%
Opening pressure (lb/in^2)	30 to 35	30 to 35	30 to 35
Valve clearance in bore (in)	0.001/0.003	0.001/0.003	0.001/0.003
BY-PASS VALVE			
Location	Mounting head	Mounting head	Mounting head
Opening pressure (lb/in^2)			
AC	8 to 12	8 to 12	8 to 12
PUROLATOR	15 to 20	15 to 20	15 to 20
TECALEMIT	8 to 12	8 to 12	8 to 12
OIL PUMP			
Backlash (in)			
Idler to body gears	0.003/0.008	0.003/0 008	0.003/0.008
Drive pinion to camshaft	0.008/0.012	0.008/0.012	0.008/0.012
Clearances (in)			
Gears to housing	0.0053/0.0083	0.0053/0.0083	0.0053/0.0083
Gears to end plate	0.0035/0.006	0.0035/0.006	0.0035/0.006
Drive shaft to body	0.0015/0.0035	0.0015/0.0035	0.0015/0.0035
Drive pinion to body	0.002/0.004	0.002/0.004	0.002/0.004
TORQUE LOADINGS			
Crankcase drain plug (lb ft)	35/40	35/40	35/40
5. COOLING SYSTEM			
WATER PUMP			
Impellor shaft diameter			
Front (in)	0.6262/0.6267	0.6262/0.6267	0.6262/0.6267
Rear (in)	0.6262/0.6267	0.6262/0.6267	0.6262/0.6267
Clearances (in)			
Body face to impellor face	Flush	Flush	Flush
Bearing shaft to impellor bore	0.001 interference	0.001 interference	0.001 interference
Bearing shaft to pulley hub bore	0.001 interference	0.001 interference	0.001 interference
Bearing to pump body	0.0003 clearance to 0.0008 interference	0.0003 clearance to 0.0008 interference	0.0003 clearance to 0.0008 interference
THERMOSTAT			
Range (°F)	170 to 199	170 to 199	170 to 199
TORQUE LOADINGS			
Water pump bearing retaining screw (lb ft)	10/11	10/11	10/11

	BC-144 Series	BD-144 Series	BD-154 Series
6. TIMING GEAR TRAIN, FRONT COVER AND CAMSHAFT			
CAMSHAFT			
Number of bearings	3	3	3
Bearing journal diameter			
Front (in)	1.811/1.812	1.811/1.812	1.811/1.812
Centre (in)	1.577/1.578	1.577/1.578	1.577/1.578
Rear (in)	1.499/1.500	1.499/1.500	1.499/1.500
Bearing bushing diameter			
Front (in)	1.8135/1.8145	1.8135/1.8145	1.8135/1.8145
Centre (in)	1.5795/1.5805	1.5795/1.5805	1.5795/1.5805
Rear (in)	1.5015/1.5025	1.5015/1.5025	1.5015/1.5025
Running clearance (in)	0.0015/0.0035	0.0015/0.0035	0.0015/0.0035
Exhaust cam lift (in)	0.1975	0.1975	0.1975
Inlet cam lift (in)	0.2195	0.2195	0.2195
Max. camshaft lobe wear (in)	0.020	0.020	0.020
End clearance (in)	0.008/0.017	0.008/0.017	0.008/0.017
Backlash (in)	0.0025/0.0045	0.0025/0.0045	0.0025/0.0045
TIMING GEARS			
Backlash between any pair of gears (in)	0.0025/0.0045	0.0025/0 0045	0.0025/0.0045
Idler gear end clearance (in)	0.005/0.010	0.005/0.010	0.005/0.010
Idler gear to shaft clearance (in)	0.0015/0.0028	0.0015/0.0028	0.0015/0.0028
Idler gear ID (in)	3.0005/3.0013	3.0005/3.0013	3.0005/3.0013
TORQUE LOADINGS			
Idler gear shaft bolt (lb ft)	75 Min	75 Min	75 Min
Camshaft thrust plate bolts (lb ft)	35/40	35/40	35/40
Front pulley nut to crankshaft (lb ft)	225/250	225/250	225/250
Governor gear jam nut (lb ft)	110/125		
7. CRANKSHAFT, MAIN-BEARINGS & FLYWHEEL			
CRANKSHAFT			
Number of main bearings	5	5	5
Main journal diameter (in)	2.1247/2.1257	2.1247/2.1257	2.1247/2.1257
Running clearance (in)	0.002/0.005	0.002/0.004	0.002/0.004
Crankpin diameter (in)	1.7502/1.7507	1.7502/1.7507	1.7502/1.7507
End clearance (in)	0.004/0.008	0.004/0.008	0.004/0.008
MAIN BEARINGS			
Reaming dimensions for replacement bearing caps (in)	2.2965/2.2975	2.2965/2.2975	2.2965/2.2975

	BC-144 Series	BD-144 Series	BD-154 Series
TORQUE LOADINGS			
Main bearing cap bolts (lb ft)			
New caps (painted white) new bolts thread length 1.12 in must be used.	95/100	95/100	95/100
Old caps and old bolts	80/85 Max.	80/85 Max.	80/85 Max.
Old caps and new bolts	80/85 Max.	80/85 Max.	80/85 Max.
With lockwire on bolts	70/75	70/75	
Rear oil seal retainer bolts (lb ft)	27/31	27/31	27/31
Flywheel bolts (lb ft)	65/70	65/70	65/70
8. GOVERNOR	**BC-144B, C, F, & H**	**L.P.G.**	**BC-144A**
GOVERNOR SHAFT			
Sleeve contact area (in)	0.501/0.502	0.501/0.502	0.501/0.502
Carrier contact area (in)	0.613/0.623	0.613/0.623	0.613/0.623
Sleeve ID (in)	0.5045/0.5060	0.5045/0.5060	0.5045/0.5060
Shaft bushing ID (in)	0.5035/0.5045	0.5035/0.5045	0.5035/0.5045
GOVERNOR SPRING			
Test length (in)	3.810	3.810	3.810
Test load (lb)	20.7	20.7	20.7
Min. length in use (in)	2.44 to 2.50	2.44 to 2.50	2.44 to 2.50
Max. length in use (in)	4.047	4.047	4.047
9. CARBURETTOR			
Type	Downdraught	Downdraught	Downdraught
Make	Zenith 30VNN	Solex	Zenith 30VNN
Adjustments	Idle and speed		Idle and speed
Fuel level (in)	7/8 below top of float chamber		7/8 below top of float chamber
Venturi size (mm)	24	25	22
Compensating jet	85		75
Slow running jet	50		50
Main jet	90	5.5 (mm)	77
Main air bleed size (mm)	2.6		2.6
Needle valve size (mm)	1.5		1.5
CARBURETTOR (with accelerator pump)			
Type	Downdraught		Downdraught
Make	Zenith 30VNP		Zenith 30VNP
Adjustments	Idle and speed		Idle and speed
Fuel level (in)	7/8 below top of float chamber		7/8 below top of float chamber
Venturi size (mm)	24		24
Compensating jet	85		75
Slow running jet	50		50
Main jet	92		77
Pump jet	60		60
Main air bleed size (mm)	2.6		2.6
Needle valve size (mm)	1.5		1.5

	BC-144 Series	BD-144 Series	BD-154 Series
HELI-COIL INSERTS			
Depth below surface (in)			
Cylinder head	$3/32 \begin{smallmatrix}+1/32\\-0\end{smallmatrix}$	$3/32 \begin{smallmatrix}+1/32\\-0\end{smallmatrix}$	$3/32 \begin{smallmatrix}+1/32\\-0\end{smallmatrix}$
Idler gear	$1/16 \pm 1/32$	$1/16 \pm 1/32$	$1/16 \pm 1/32$

SPECIFICATIONS OF VALVE GUIDES AND SPRINGS USED ON BC-144A ENGINES WHEN EQUIPPED WITH DUAL VALVE SPRINGS (early models).

VALVE GUIDES					
Length	(in)	2.625			
Inside diameter	(in)	0.344 to 0.345			
Set height of guide measured up from spring recess	(in)	1.047			
VALVE SPRINGS		INLET		EXHAUST	
		INNER	OUTER	INNER	OUTER
Test length	(in)	1.258	1.475	1.299	1.516
Test load	(lb)	24 ± 5%	58 ± 5%	22.5 ± 5%	56 .5 ± 5%
Free length	(in)	2.125	2.550	2.125	2 550

GROUP 2

MANIFOLDS, CYLINDER HEAD AND VALVES

1. DESCRIPTION

1a. MANIFOLDS

Separate manifolds are fitted to the BD-144 and BD-154 series engines. The inlet manifold on the left hand side and the exhaust manifold on the right hand side of the cylinder head.

A one piece casting housing both the inlet and exhaust manifolds is fitted on the left hand side of the BC-144 series engines cylinder head. The intake manifold also serves as the mounting for the carburettor.

1b. CYLINDER HEAD AND VALVES

The cylinder head houses the valves, valve guides, pre-combustion chambers and glow plugs on the diesel engines, or valves, valve guides and spark plugs on the petrol engine.

The valve lever shaft assembly, thermostat housing, inlet and exhaust manifolds are fitted on the cylinder head.

The valves are closed by single valve springs on BD-144 series engines and by dual valve springs on the BD-154 series engines. Early models of the BC-144 series engines were fitted with dual valve springs but current models have single valve springs. The exhaust valves on BC-144 series engines are fitted with rotators to ensure that all parts of the valve head are subjected to equal combustion temperatures. Exhaust valve seat inserts of specially hardened material are fitted to BC-144 series engines.

2. MANIFOLDS

2a. REMOVAL

1. DIESEL ENGINES-INLET MANIFOLD

(a) Remove the crankcase breather pipe (1-1).

(b) Disconnect the feed pump to filter fuel pipe (2-1) from the filter.

(c) Disconnect the filter to injection pump fuel pipe (3-1) from the filter.

(d) Disconnect the injection pump excess outlet pipe (4-1) from the filter.

(e) Disconnect the injector spill pipe (5-1) from the filter.

(f) Remove the four bolts (6-1) and lift off the manifold.

2. DIESEL ENGINES-EXHAUST MANIFOLD

(a) Remove the four nuts (1-2) and withdraw the manifold.

3. PETROL ENGINES-COMBINED MANIFOLD

(a) Remove the governor to carburettor control rod (1-3).

(b) Disconnect the fuel feed pump line (2-3) from the carburettor.

(c) Remove the six bolts (3-3) and withdraw the manifold.

2b. INSTALLATION

Reverse the removal procedure.

3. VALVE LEVER SHAFT ASSEMBLY

3a. REMOVAL

(a) Remove the two nuts (2-2) then remove the valve housing cover and gasket.

(b) Remove the nuts (1-4) from the valve lever shaft brackets (2-4).

(c) Remove the bolt (3-4) from the centre valve lever shaft bracket (4-4).

(d) Lift off the valve lever shaft pressing inward to prevent the assembly dismantling.

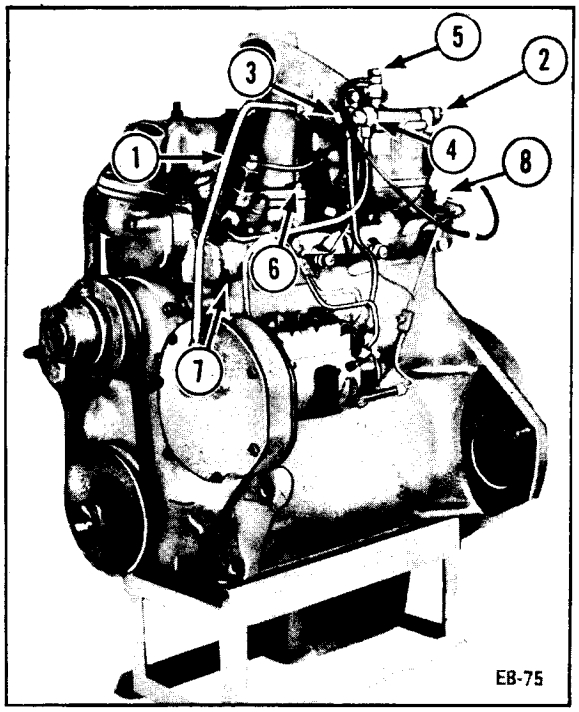


Fig.1

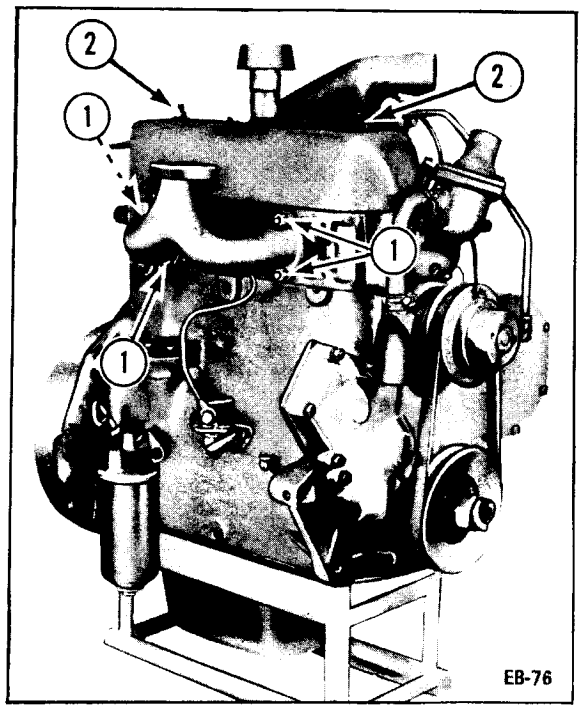


Fig.2

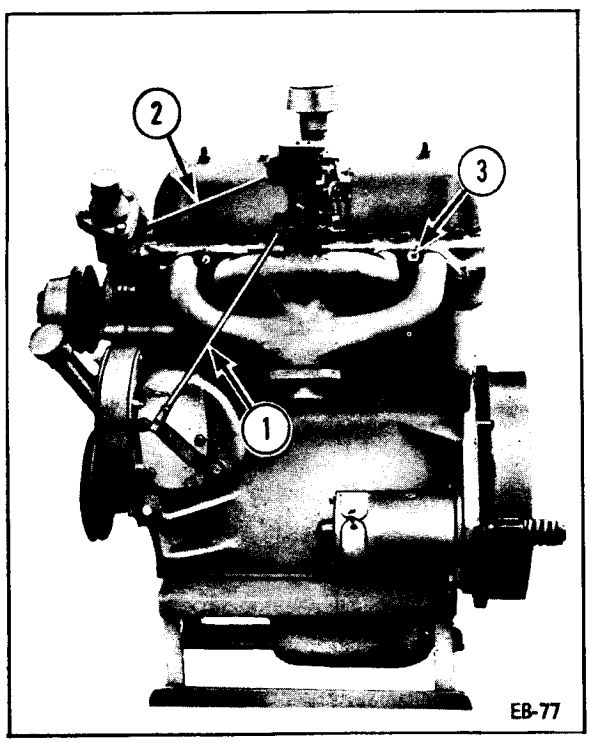


Fig.3

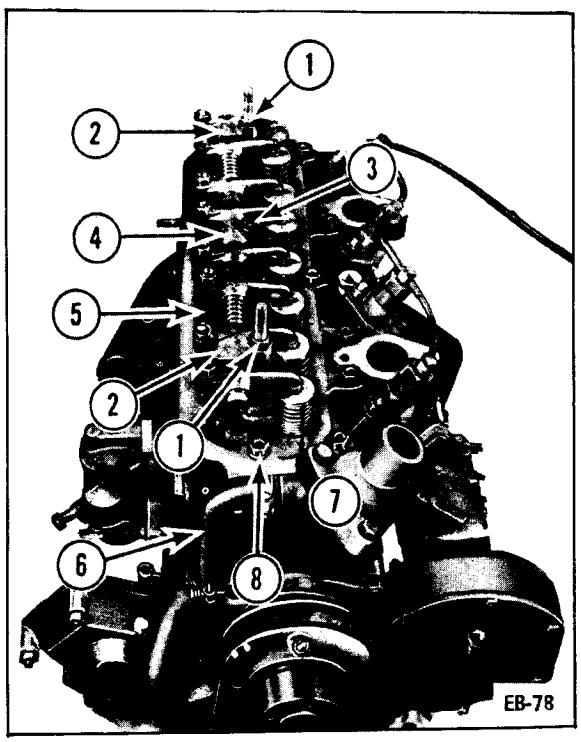


Fig.4

3b. DISMANTLING

(a) Remove the valve lever shafts from the centre bracket (4-4).

(b) Remove the levers (7-8), spacer (9-8), and spring (8-8) from the shaft (1-8).

(c) Drive the groove pin (3-8) out of the bracket (2-8) and remove the bracket from the shaft.

(d) Remove the end valve lever (6-8) and washer (4-8) from the shaft.

(e) Remove the snap ring (5-8) from the shaft.

(f) Proceed as detailed in ops. (b) to (e) for the other shaft.

3c. INSPECTION AND REPAIR

(a) Thoroughly clean all components and blow dry using compressed air.

(b) Check the valve lever shaft expansion plugs.

(c) Check the clearance between the valve lever bushes and the valve lever shaft to specifications.

(d) Check the valve lever shaft brackets for wear in the bore to specifications.

(e) Stone or lightly grind the unworn area of the valve lever contact pad, maintaining the original profile until both surfaces are level.

(f) Check the springs for cracks or loss of tension.

3d. ASSEMBLY

(a) Position the shaft (1-8) in the end bracket (2-8) and secure with a new groove pin (3-8).

(b) Assemble the valve lever (6-8) to the shaft then secure with the washer (4-8) and snap ring (5-8).

(c) Assemble the levers (7-8), spring (8-8), and spacer (9-8) to the shaft.

(d) Proceed as detailed in ops. (a) to (c) for the other valve lever shaft then assemble both shafts to the centre bracket maintaining inward pressure until the valve lever assembly is installed on the cylinder head.

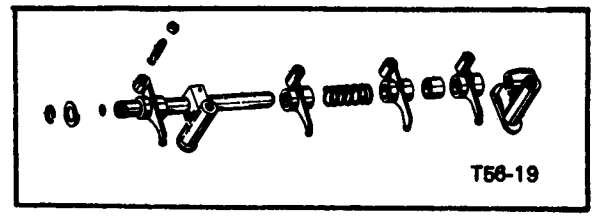


Fig. 5 BC-144 VALVE LEVER ASSEMBLY

NOTE: The valve lever adjusting screws on the BC 144 series engines are offset and must be positioned as shown in Fig. 5.

3e. INSTALLATION

(a) Loosen the locknuts on each valve lever and back off the adjusting screws

(b) Install the valve lever assembly on the studs, and install the nuts finger tight.

(c) Install the bolt in the centre bracket then tighten the nuts to the correct torque.

(d) Adjust the valve clearance as detailed in para. 3f.

(e) Install the valve housing cover using a new gasket then tighten the nuts to the specified torque.

3f. ADJUSTMENTS

(a) Set No. 1 piston at T.D.C. on the compression stroke by turning the crankshaft until No. 4 inlet valve is just beginning to open and No. 4 exhaust valve is just beginning to close.

(b) Adjust No. 1 cylinder valves to the specified clearance.

(c) Turn the crankshaft one half revolution at a time in normal direction of rotation and set the valve clearance on the remaining cylinders in firing order.

4. CYLINDER HEAD

4a. REMOVAL

1. DIESEL ENGINES

(a) Remove the manifolds as detailed in para.2a.

(b) Remove the valve lever assembly as detailed in para.3a.

(c) Remove the valve push rods (5-4) and identify them so they can be installed in their original positions.

(d) Remove the thermostat housing by-pass hose (6-4).

(e) Remove the three bolts then remove the thermostat housing (7-4).

(f) Remove the glow plug earth wire (7-1) from the front cover.

(g) Disconnect the injector pipes (8-1) at the injectors.

(h) Undo the cylinder head bolts (8-4) progressively in the reverse order to the tightening sequence Fig.6.

(i) Remove the cylinder head and gasket.

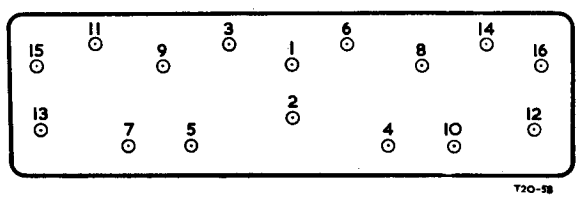


Fig.6 DIESEL ENGINE CYLINDER HEAD BOLT TIGHTENING SEQUENCE

2. PETROL ENGINES

(a) Proceed as detailed in para. 4a-1 ops. (a) to (e).

(b) Remove the spark plug leads from the spark plugs.

(c) Undo the cylinder head bolts progressively, in the reverse order to the tightening sequence (Fig.7).

(d) Remove the cylinder head and gasket.

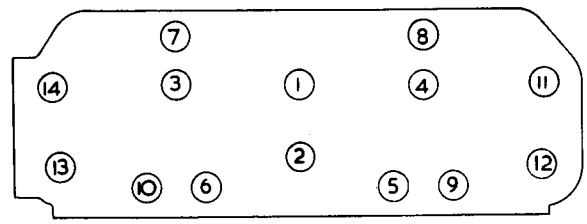


Fig.7 PETROL ENGINE CYLINDER HEAD BOLT TIGHTENING SEQUENCE

4b. DISMANTLING

1. DIESEL ENGINES

(a) Remove the glow plug wires (1-9).

(b) Remove the glow plugs (2-9).

(c) Remove the injector spill pipes (3-9) from each injector.

(d) Remove the injector body securing nuts (4-9) and withdraw the injectors from the cylinder head.

(e) Using the special tool shown in Fig.10 remove the pre-combustion chambers, and nozzle body holders, by inter-changing the wedges (1 & 2-10) and collets (4 & 8-10).

(f) Using a valve spring compressor, compress the valve springs sufficiently to allow removal of the collets (6-11).

(g) Release the pressure then remove the retainer (5-11) and spring (4-11). On BD-154 series engines the valve spring seat should also be removed.

(h) Remove the valves (3-11) and identify them so they can be installed in their original positions.

2. PETROL ENGINES

(a) Remove the spark plugs.

(b) Using a valve spring compressor, compress the valve spring sufficiently to allow removal of the collets.

(c) Release the pressure then remove the retainer or rotator and valve spring.

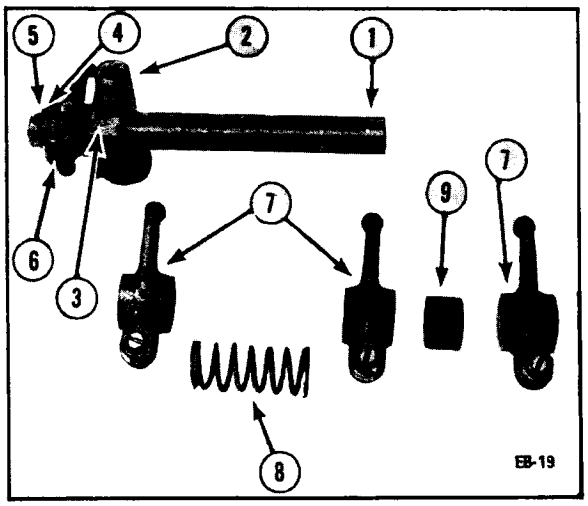


Fig. 8

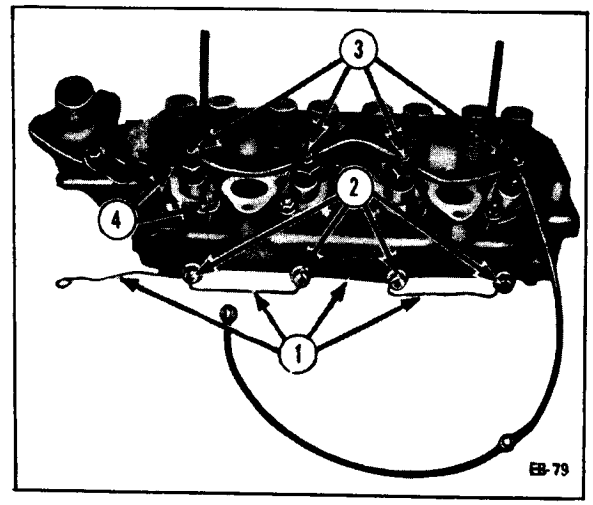


Fig. 9

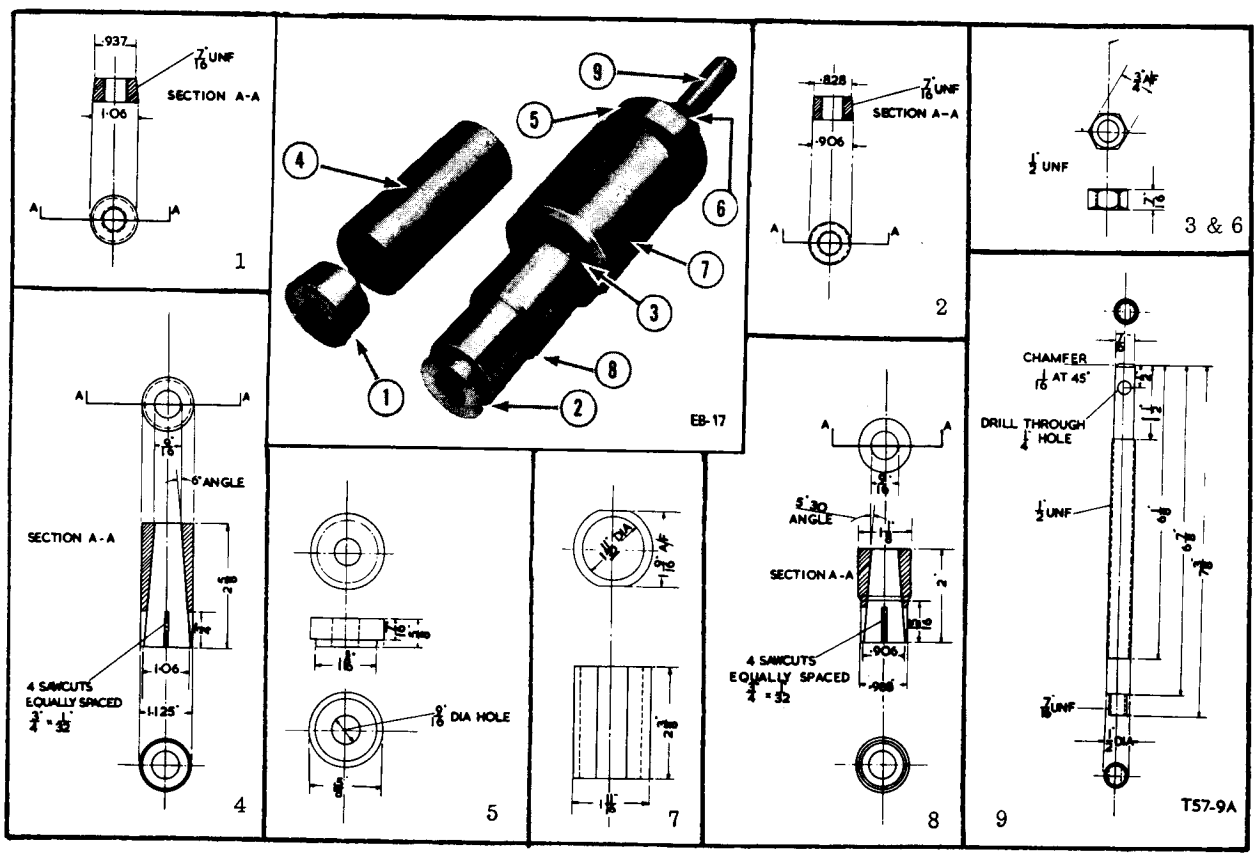


Fig. 10

(d) Slide the rubber cups, if fitted, off the inlet valve stems. These can be discarded.

(e) Remove the valves and identify them so they can be installed in their original positions.

4c. INSPECTION AND REPAIR

(a) Thoroughly clean all components removing all traces of old gasket material and carbon deposits, especially from the valve guide bores.

(b) Inspect the cylinder head for cracks and burnt metal around the valve ports.

(c) Inspect the valve seats for pitting. On BC-144 series engines the exhaust valve seat inserts may be removed by grinding or chiselling if inspection proves this necessary.

(d) Check the valve guides for burning or cracks and against the dimensions given in specifications. Press out the valve guides (2-11) from the underside of the cylinder head (1-11) if inspection proves this necessary.

(e) Check that the valve heads are not excessively worn or pitted.

(f) Check the valve stems for bends, wear, excessive pitting, or "mushrooming" of the ends. Check the collet grooves in the stems to ensure they have not lost their shoulders.

(g) Check the valve springs for rust, pitting, or cracks and against the loads given in specifications.

(h) Check the retainers for rust and cracks.

(i) Check the valve rotators for rust and wear.

(j) Check the operation of the valve rotators by placing the rotator on a spring, a ball bearing on top of the rotator and place the assembly in a valve spring tester with the ram bearing on the ball bearing. On applying pressure to the ram the rotator, if serviceable, will be seen to move.

(k) Check the outside face and the ribs inside the collets for wear.

(l) If the valve guides were removed press in new guides to the dimensions given in specifications. Ream the valve guides to the dimensions given in specifications.

(m) If the exhaust valve seat inserts were removed take a fine cut, if necessary, from the bottom of the counterbore to ensure a square seat for the replacement insert.

(n) Thoroughly chill the valve seat inserts, install them then peen over the edge of the insert around its entire circumference. The inserts should be recessed in the head 0.006" - 0.014".

(o) Reface the valve seats to the correct angle. Seats that are too wide after refacing should be narrowed by grinding the top edge of the seat with a stone of a smaller angle, (15^{o} preferred). Refer to Fig.12.

(p) Mount a dial indicator on the pilot shank and check that seat run-out does not exceed 0.003".

(q) Reface the valves but reject valves that grind down to a fine edge.

(r) Using carborundum paste lap in the valves. Ensure that all carborundum paste is removed from the valves and valve seats after the lapping operation.

(s) Check the valves in their seats using engineers blue. A complete ring of contact must be shown on both faces.

(t) If necessary, grind the ends of the valve stems removing only sufficient metal to give a square end.

4d. ASSEMBLY

1. DIESEL ENGINES

(a) Coat the valve stems with clean engine oil and install them in their original positions.

(b) On BD-154 series engines install the valve spring seats.

(c) Install the valve springs and retainers.

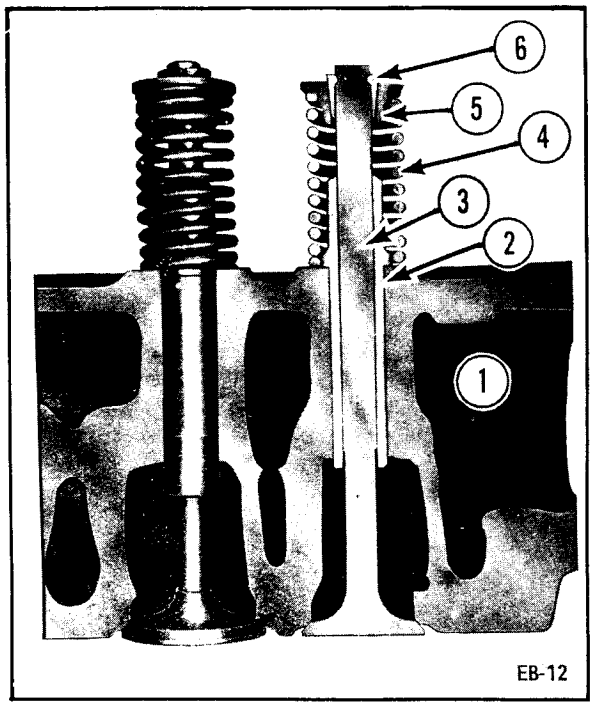


Fig. 11

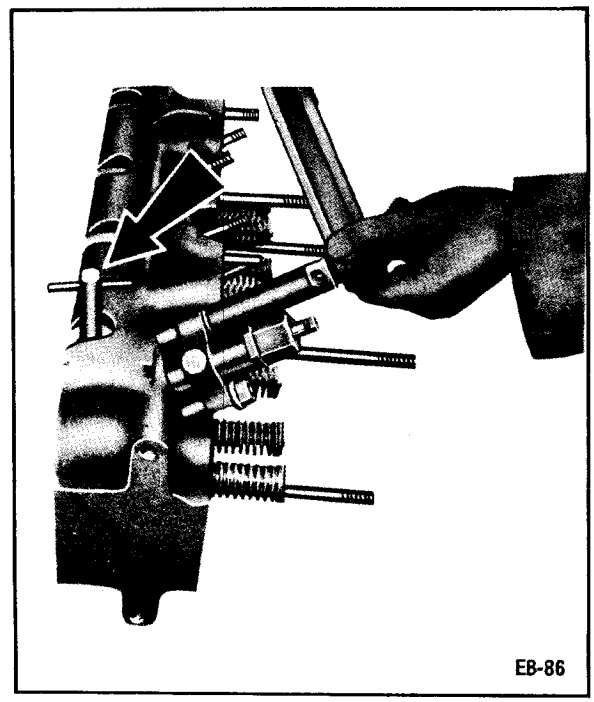


Fig. 13

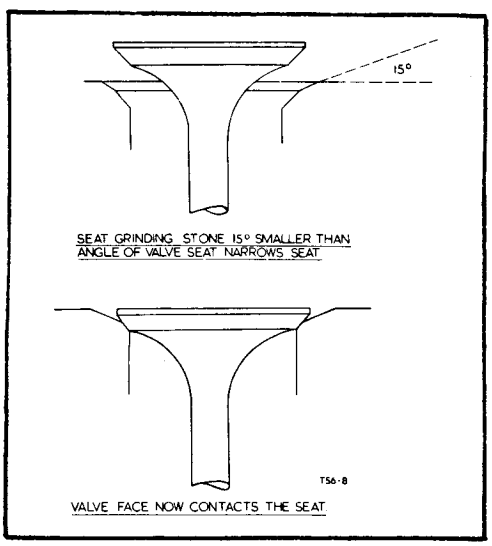


Fig. 12 REFACING THE VALVE SEAT

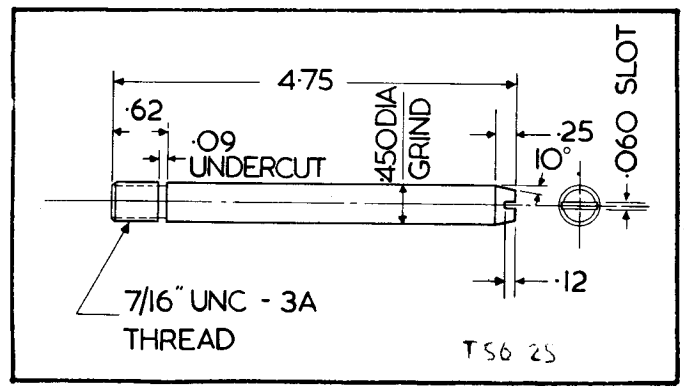


Fig. 14 THE GUIDE STUD

(d) Using a valve spring compressor, compress the springs and fit the collets.

(e) Install new pre-combustion chamber gaskets then insert the pre-combustion chambers using aligning tool number IH 3454 Fig. 13.

NOTE: Ensure that the pre-combustion chamber is entered correctly in the head, otherwise the glow plug element may contact the sides of the chamber and be burnt out.

(f) Install the second gaskets and the pre-combustion chamber holders.

(g) Install the injectors and tighten the nuts to the specified torque.

(h) Install the glow plugs and glow plug interconnecting wires.

2. PETROL ENGINES

(a) Coat the valve stems with clean engine oil and install them in their original positions.

(b) Install the valve springs, retainers and rotators.

(c) Using a valve spring compressor, compress the springs and fit the collets.

(d) Install the spark plugs, using new washers.

4e. INSTALLATION

(a) Apply a light coating of clean engine oil to the cylinder head mating face and install a new gasket.

(b) Screw two guide studs manufactured to the dimensions shown in Fig. 14 into the cylinder block to hold the gasket in place and ensure the correct alignment of the cylinder head.

(c) Install the cylinder head.

(d) Dismantle the valve lever shaft assembly as detailed in para. 3b, op. (a), then install the centre valve lever shaft bracket on the cylinder head and insert the long bolt.

(e) Remove the guide studs then insert the remaining bolts.

(f) Tighten the bolts progressively in the order shown in Figs. 6 or 7 to the specified torque.

(g) Remove the long bolt from the centre valve lever shaft bracket and remove the bracket.

(h) Install the push rods in their original positions.

(i) Assemble the valve lever assembly as detailed in para. 3d. op. (d).

(j) Install the valve lever assembly as detailed in para. 3e.

(k) Install the thermostat housing.

(l) Install the thermostat by-pass hose.

(m) Secure the glow plug earth wire to the front cover.

(n) Install the manifolds as detailed in para. 2b.

GROUP 3

CONNECTING RODS, PISTONS AND CYLINDER SLEEVES

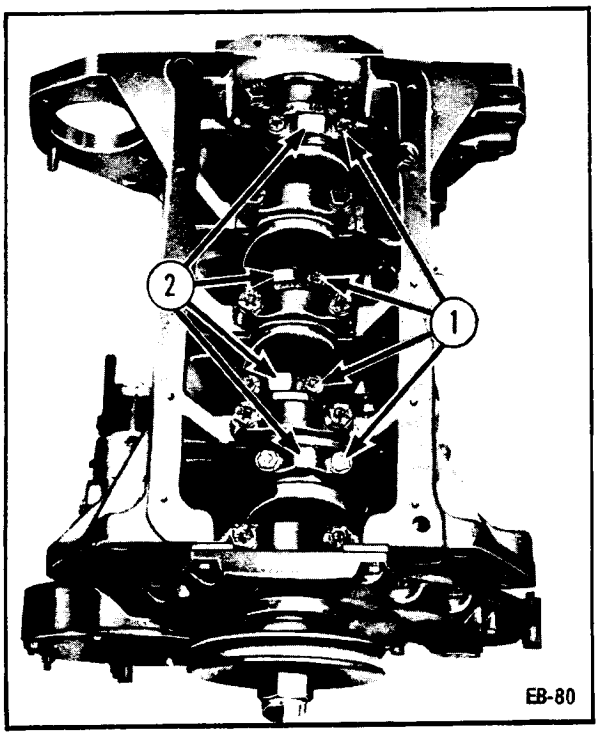


Fig. 1

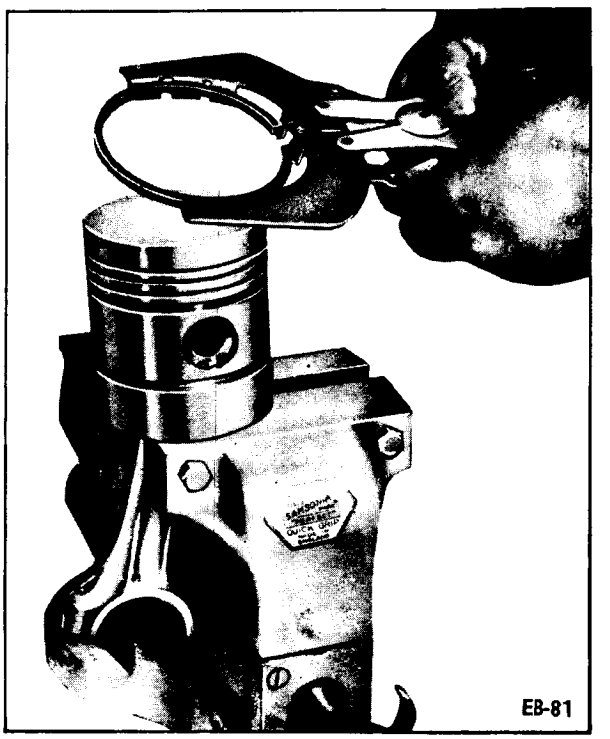


Fig. 2

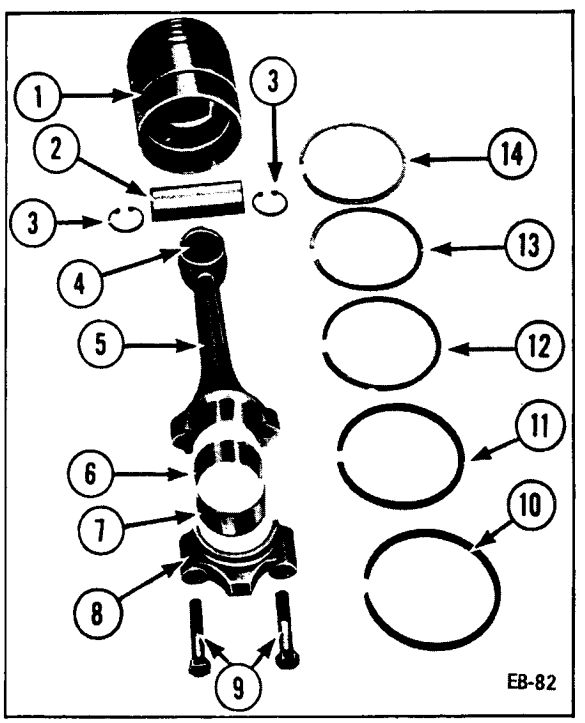


Fig. 3

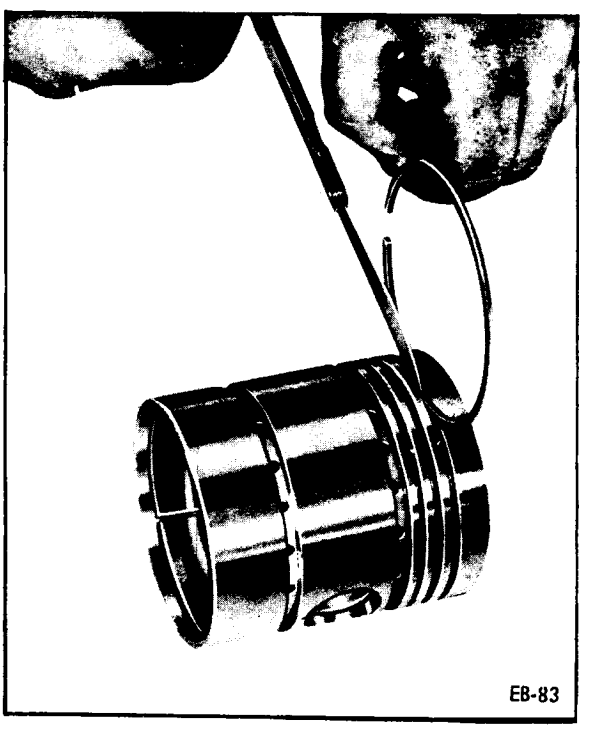


Fig. 4

1. DESCRIPTION

1a. THE CONNECTING RODS

The connecting rods are forged steel and are bushed at the piston ends for the piston pins. The crankshaft ends are equipped with replaceable steel backed alloy bearing inserts. The bearing caps are a matched fit with their respective connecting rods and both the rod and the cap are numbered to ensure correct assembly.

1b. THE PISTONS AND PISTON RINGS

The pistons are attached to the connecting rods by floating pins retained by circlips. The BD-144 and BD-154 series engines are fitted with three cast iron compression rings, the top one being chrome plated, and two oil control rings. The BC-144 series engines have three compression rings and one oil control ring.

1c. THE CYLINDER SLEEVES

The cylinder sleeves are the replaceable wet liner type and can be obtained as individual items or with graded pistons.

2. CONNECTING ROD AND PISTON ASSEMBLY

2a. REMOVAL

(a) Remove the cylinder head as detailed in GROUP 2, para.4a.

(b) Remove the carbon ridge at the top of each sleeve.

(c) Remove the lubricating oil pump as detailed in GROUP 4, para.2a.

(d) Remove the place bolts (1-1) securing the cap (2-1) to the connecting rod then remove each cap with its lower half of the bearing insert.

(e) Push each piston and connecting rod up and out of the sleeve then remove the upper half of the bearing insert.

NOTE: If the cylinder sleeve has been worn so that there is a ridge in the sleeve at the upper end of the piston travel this must be removed before the piston is withdrawn to prevent damage to the ring lands and rings during removal of the piston and also damage to new top rings if installed.

2b. DISMANTLING

(a) Using a piston ring expander (Fig.2) remove the piston rings in the following order; top compression ring (14-3), second compression ring (13-3), third compression ring (12-3), top oil control ring (11-3) and on diesel engines only the bottom oil control ring (10-3).

(b) Remove the circlips (3-3) from the piston (1-3) and push out the piston pin (2-3) by hand. If the piston pin cannot be pushed out by hand, heat the piston in water to 180°F. approximately.

2c. INSPECTION AND REPAIR

NOTE: DO NOT use a caustic solution for cleaning aluminium pistons.

(a) Check the piston ring grooves for wear using a new piston ring and feeler gauges (Fig.4).

(b) Check the pistons for ovality and taper.

(c) Check the connecting rods for alignment (Fig.5). The bores must be square and parallel with each other in all planes within ± 0.005 inch (L-5) measured 5 inches each side of the centre line (A-5).

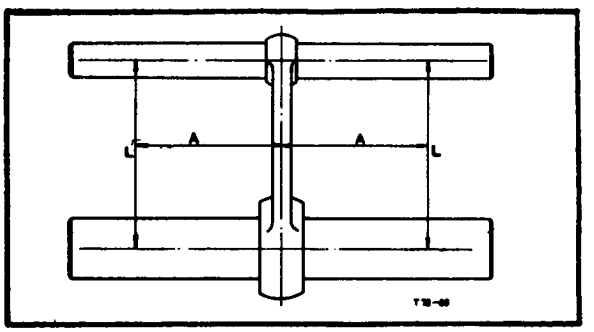


Fig.5 CHECKING CONNECTING ROD ALIGNMENT

(d) Check the threads in the connecting rod (5-3) big end for wear or damage.

(e) Check the wear and condition of the connecting rod bushings If replacement is necessary proceed as follows:

(1) Press out the old bushing (4-3).

(2) Align the oil hole in the new bushing with the oil hole in the connecting rod and, using a pilot dolly, press the bushing ino the rod.

(3) Ream the bushing to the dimension given in specifications and check the fit of the piston pin.

(f) Check the piston pins for wear or corrosion.

(g) If the piston pin is a slack fit in an otherwise serviceable piston, the piston bores and connecting rod bushing can be reamed to take an oversize piston pin. Refer to specifications for dimensions.

(h) Insert a piston ring in the bore and use a piston without rings to square it in the bore. Check the ring gap (Fig.6).

(i) Repeat op. (h) with each piston ring and reject any where the gap exceeds 0.030 inch on BD-144 and BC-144 engines or 0.025 inch on BD 154 engines.

(j) Check new rings in the same manner as detailed in op. (h) and check the gap to specifications. The ends of the rings may be filed carefully to bring the gap within the limits.

(k) Check the clearance between the connecting rod bearings and the crankshaft as follows:-

NOTE: DO NOT rotate the crankshaft while this check is being made.

(1) Assemble the inserts to the connecting rods and caps.

(2) Lay a length of 0.005 inch thick virgin lead wire across the bearing cap insert.

(3) Install the connecting rods on the crankshaft and tighten the bolts to the correct torque.

(4) Remove the bearing cap and measure the thickness of the lead wire to determine the bearing clearance.

(1) Remove the connecting rods from the crankshaft.

2d. ASSEMBLY

(a) Heat the piston in water to approximately 180°F.

(b) Push the piston pin into one boss of the piston.

(c) Position the connecting rod inside the piston and align the bushing with the piston pin.

NOTE: On later models of BD-154 series engines the piston pin is offset and must be installed so that the word "FRONT" stamped on top of the piston, is to the front of the crankcase on installation.

(d) Push the piston pin into the other boss and install the circlips.

(e) Using a piston ring expander fit the rings to the piston starting with the bottom ring and working up. The wide face of stepped rings must be toward the bottom of the piston.

(f) Position the rings so that the gaps are in line with the piston pin bore and at 180° from each other.

NOTE: Multi-piece oil control rings should be fitted to the top oil control groove. The expander (1-7) must be installed first, followed by the two flat rings (2-7) either side of the expander. The gaps in the flat rings must be at 180° to each other.

2e. INSTALLATION

(a) Immerse the piston assembly in clean engine oil and fit a ring compressor over the piston.

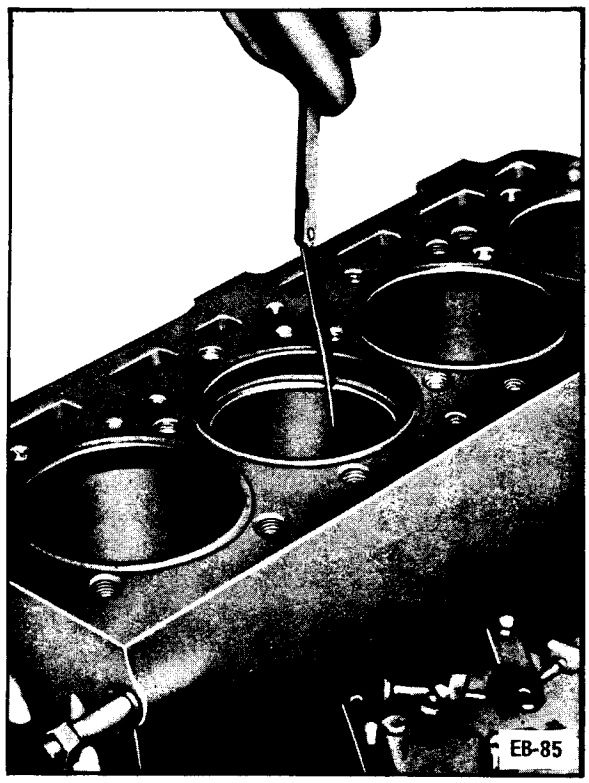


Fig. 6

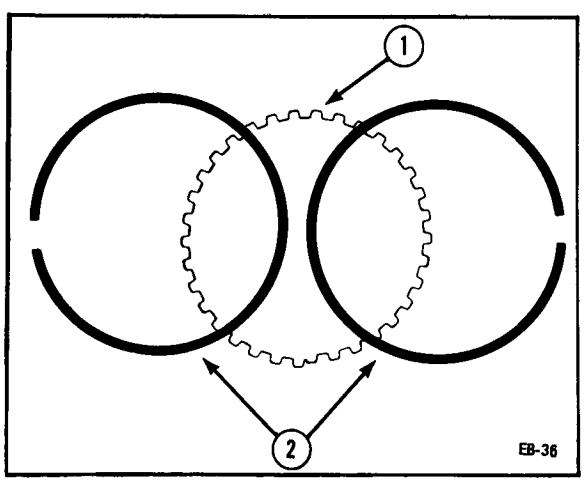


Fig. 7

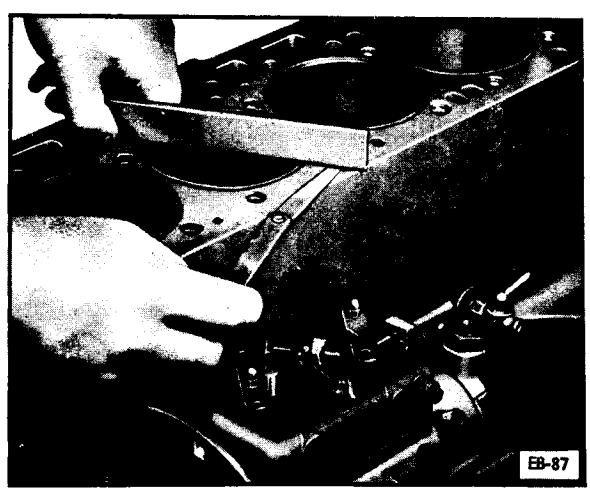


Fig. 8

(b) Place the connecting rod in the correct cylinder and push down steadily on the piston until it is completely in the cylinder.

(c) Wipe the crankshaft bearing end of the rod to remove any dirt gathered during installation. Wipe the bearing upper half clean then fit it to the connecting rod. Apply oil to the bearing surface and position the connecting rod on the crankshaft with the number to the camshaft side.

(d) Wipe the bearing cap and lower half bearing clean then assemble together. Apply oil to the bearing surface and install the cap on the connecting rod with the number to the camshaft side.

(e) Tighten the bolts to the specified torque.

(f) Proceed as detailed in ops. (a) to (e) for the remaining piston assemblies.

NOTE: When correctly positioned, the connecting rod cap bearing half will stand out 1/32 inch above the cap surface and will engage inside the connecting rod half bore. Failure to position correctly will result in the bearing halves being out of line when the bearing cap bolts are torqued.

(g) Install the oil pump as detailed in GROUP 4 para.2e.

(h) Install the cylinder head as detailed in GROUP 2 para.4e.

3. CYLINDER SLEEVES

3a. REMOVAL

NOTE: Removal of the cylinder sleeves need only be carried out if inspection proves this necessary.

(a) Remove the piston assemblies as detailed in para.2a.

(b) Using a suitable sleeve puller withdraw the cylinder sleeves.

(c) Remove the sealing ring from the groove in the crankcase bore.

3b. INSPECTION AND REPAIR

(a) With the sleeves in the crankcase measure the bores at the top and the bottom at 90° to the crankshaft to determine the amount of taper.

(b) Measure the bores at the top and the bottom in line with the crankshaft to determine the amount of taper.

(c) Compare the readings from op.(a) with those from op.(b) to determine the amount of ovality.

(d) Check the sleeves for scoring or signs of corrosion.

3c. INSTALLATION

(a) Dip each cylinder sleeve packing ring in a soap solution and install it in the groove in the crankcase bore.

(b) Coat the bottom of each sleeve with soap solution and press the sleeve into the crankcase bore.

(c) Check from below to ensure that the packing rings have not been sheared or pushed out of position.

(d) Check the cylinder sleeve stand-out (Fig.8) to specifications.

(e) Install the piston assemblies as detailed in para.2a.

4. CONDITIONING SCHEDULE

4a. GENERAL

After installation of new sleeves, pistons or piston rings, the engine must be run in before being operated at full load and speed. The first phase of running in must be gentle enough to prevent excessive pressures and temperatures but, if too gentle may result in cylinder wall glazing due to low combustion temperatures and incomplete combustion which results in short engine life, loss of power and high oil consumption.

Until the engine is run in the following conditions may be noted:-

(1) Low compression, poor combustion and smoking.

(2) High oil consumption.

(3) Blow by will be high.

4b. PREPARATION

(a) Check and fill the cooling system.

(b) Check the level of oil in the crankcase.

(c) Bleed the fuel system as detailed in the relevant Operator's Manual.

(d) Start the engine and run at 1/4 throttle opening until operating temperature is reached.

4c. OPERATION

1. DIESEL ENGINE

PERIOD 1 (1 HOUR)

Operate the tractor in high range third gear with no load at 3/4 throttle.

PERIOD 2 (2 HOURS)

Operate the tractor on light work at 3/4 throttle.

PERIOD 3 (1 HOUR)

Operate the tractor on medium work at full throttle.

2. PETROL ENGINE

PERIOD 1 (1/4 HOUR)

Operate the tractor in high range third gear with no load at 3/4 throttle.

PERIOD 2 (3/4 HOUR)

Operate the tractor on light work at 3/4 throttle.

PERIOD 3 (2 HOURS)

Operate the tractor on medium work at full throttle.

3. DIESEL POWER UNIT

PERIOD 1 (1 HOUR)

Operate the engine on 1/4 load at 3/4 rated speed.

PERIOD 2 (2 HOURS)

Operate the engine on 1/2 load at 3/4 rated speed.

PERIOD 3 (1 HOUR)

Operate the engine on 3/4 load at full rated speed.

4. ALL ENGINES

(a) Check for air, oil and water leaks.

(b) Inspect and replace the oil filter element if necessary.

(c) 1. DIESEL ENGINE

After 25 hours of operation the crankcase oil and oil filter element must be changed.

2. PETROL ENGINE

The crankcase oil can be used until the next oil change period.

(d) After the first 25 hours of operation the cylinder head bolts must be re-torqued and the valve clearance adjusted.

4

GROUP 4

LUBRICATION SYSTEM

1. DESCRIPTION

1a. OIL PUMP

The oil pump is the spur gear type mounted in the crankcase. Oil is drawn through either a fixed or floating screen and passed under pressure through the lubricating oil filter, along galleries in the crankcase to the crankshaft main bearings, connecting rod bearings, camshaft bearings, timing gears and valve mechanism. The pistons are splash lubricated from the crankshaft. The governor on BC-144 series is lubricated by spray from the driving gear.

A spring loaded relief valve located in the pump body maintains the specified circulating pressure.

1b. LUBRICATING OIL FILTERS

The full flow lubricating oil filter is located externally, on the right hand side of the crankcase.

Filters made by three manufacturers are used and these are interchangeable as complete assemblies. The replaceable elements are also interchangeable but the other service parts are not.

2. OIL PUMP

2a. REMOVAL

(a) Remove the crankcase drain plug and drain the oil while the engine is warm.

(b) Install the drain plug then remove the fourteen bolts securing the oil pan to the crankcase and, remove the oil pan and gasket.

(c) Remove the bolt (1-1) securing the oil pump (2-1) to the crankcase and withdraw the oil pump.

NOTE: On BC-144 series engines the oil pump can only be withdrawn when No.4 piston is at T.D.C. on the compression stroke due to the flange for the distributor drive having to pass the teeth of the oil pump drive gear on the camshaft. The distributor drive flange has a sector (4-2) cut away to allow it to pass the gear.

2b. DISMANTLING

(a) FIXED SCREEN

Remove the two bolts (2-3) which secure the oil pump screen (1-3) to the pump body cover (3-3) and remove the screen.

FLOATING SCREEN

Remove the cotter pin (2-4) which secures the oil pump screen (1-4) to the pump body cover (3-4) and remove the screen.

(b) Remove the bolts (4-3 or 4-4) and the nuts and bolts (5-3 or 5-4) which secure the cover to the body.

(c) Remove the cover (3-5) and gasket (15-5), then lift out the regulating valve spring (14-5) and regulating valve (13-5).

(d) Remove the gear case (4-5), gasket (11-5) and idler gear (12-5).

(e) Drive out the roll pins (8-5) then remove the coupling (7-5), drive pinion (6-5), and key (9-5) from the shaft.

NOTE: On BC-144 series engines there is only one roll pin (2-2) securing the drive pinion (3-2).

(f) Remove the oil pump body gear and shaft (10-5) from the pump body (5-5).

(g) EARLY ENGINES

Press the oil pump body gear (2-6) down the drive shaft (1-6) until it is clear of the gear retainer (4-6). Spring off the gear retainer then press the drive shaft and key (1 & 3-6) out of the body gear and remove the key (3-6).

CURRENT ENGINES

On current engines the pump body gear is a shrink fit on the shaft and the assembly is treated as one unit.

2c. INSPECTION AND REPAIR

(a) Check the oil pressure regulating

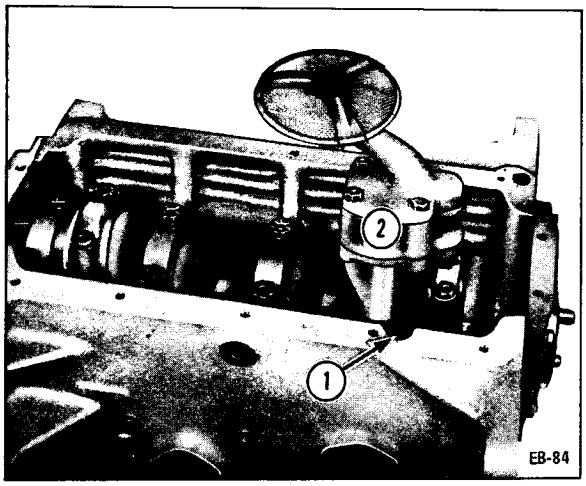


Fig.1

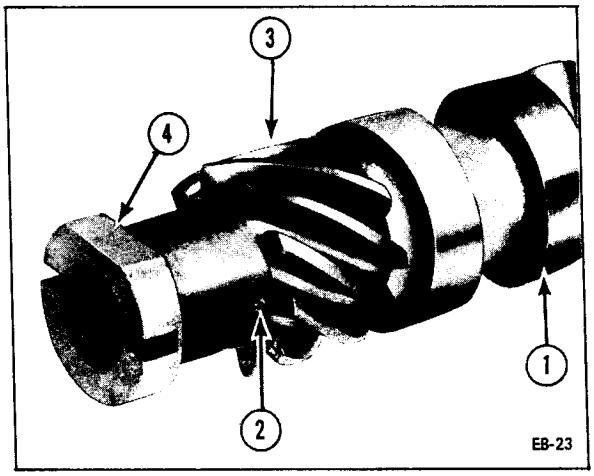


Fig.2

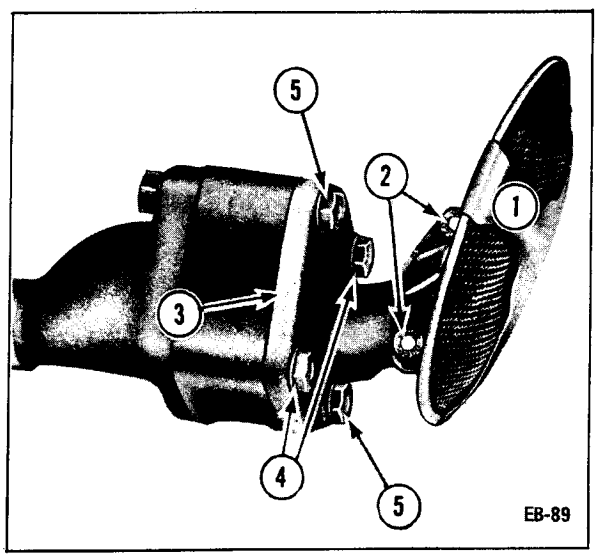


Fig.3

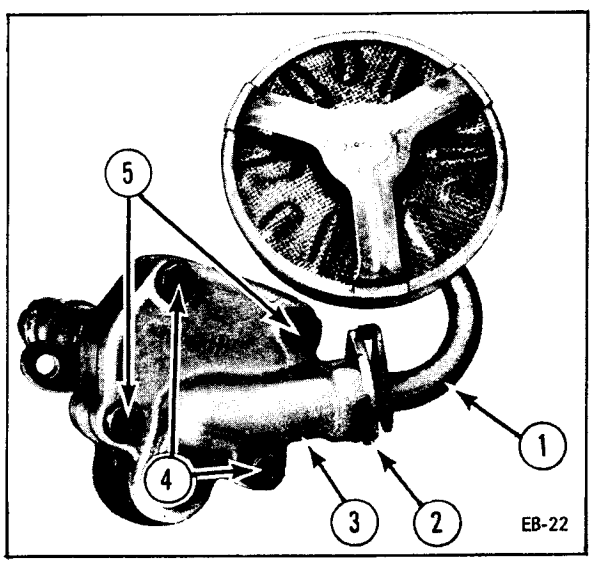


Fig.4

valve spring agasint the loads given in specifications.

(b) Check the oil pressure regulating valve and seat for wear pitting or corrosion.

(c) Check the drive shaft to pump body clearance to specifications.

(d) Check the drive pinion for wear or damage.

(e) Check the gears for wear, damage or pitting. Burrs can be removed from the gears using a fine carborundum stone.

(f) Check the backlash between the gears to specifications.

(g) Check the clearance between the gears and end plate as follows:-

(1) Install the gear case on the pump body using a new gasket.

(2) Install the gears, then place a length of 0.010 inch thick virgin lead wire across the top of each gear.

(3) Install the end cover using a new gasket and tighten the bolts to the specified torque.

(4) Remove the cover and measure the thickness of the lead. This must not exceed the dimension given in specifications.

(h) If the clearance is excessive check the end plate using a straight edge and feeler gauges. If necessary, the end plate can be ground flat using a sheet of crocus paper on a surface plate. Assemble the end plate and re-check the clearance.

(i) If no clearance exists, insert one additional gasket and re-check the clearance.

(j) Check the clearance between the oil pump drive pinion and the body after the pump is assembled (Fig. 7).

2d. ASSEMBLY

(a) EARLY ENGINES

Insert a key into the drive shaft then press on the body gear until the retainer groove is exposed. Spring the gear retainer into the groove and press the gear back down the shaft until it is hard against the retainer then install the drive shaft and gear in the oil pump body.

CURRENT ENGINES

Install the drive shaft and gear in the oil pump body.

(b) Fit the key (9-5) into the shaft and press on the drive pinion, aligning the hole in the gear with that in the shaft.

(c) Drive in a new roll pin.

(d) On BD-144 and BD-154 engines only install the coupling (7-5) and drive in a new roll pin.

(e) Using a new gasket assemble the gear case (4-5) to the oil pump body.

(f) Install the regulating valve and spring in the oil pump body.

(g) Install the idler gear.

(h) Using a new gasket install the pump end cover and tighten the bolts to the correct torque.

(i) FIXED SCREEN

Assemble the screen to the pump end cover and tighten the bolts to the correct torque.

FLOATING SCREEN

Fit the float screen tube into the pump end cover and secure with a new cotter pin.

2e. INSTALLATION

(a) Install the oil pump in the crankcase then tighten the bolt to the correct torque.

NOTE: On BC-144 series engines No. 4 piston must be at T.D.C. compression.

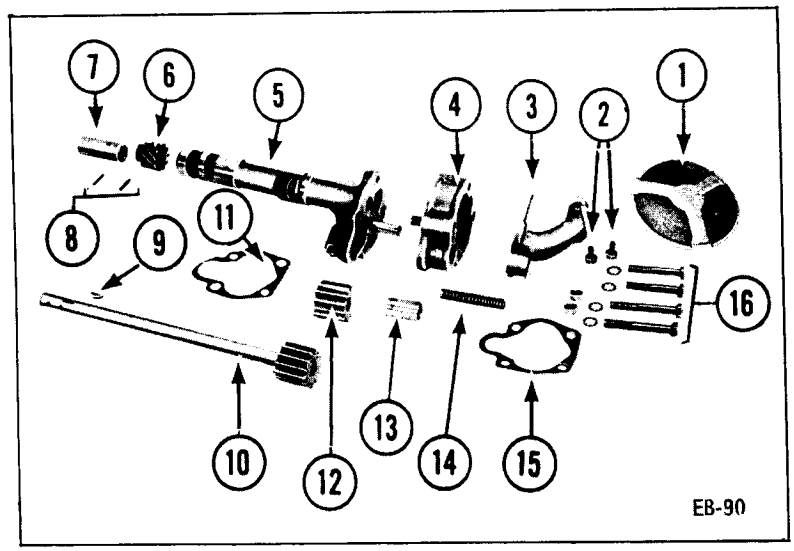


Fig. 5

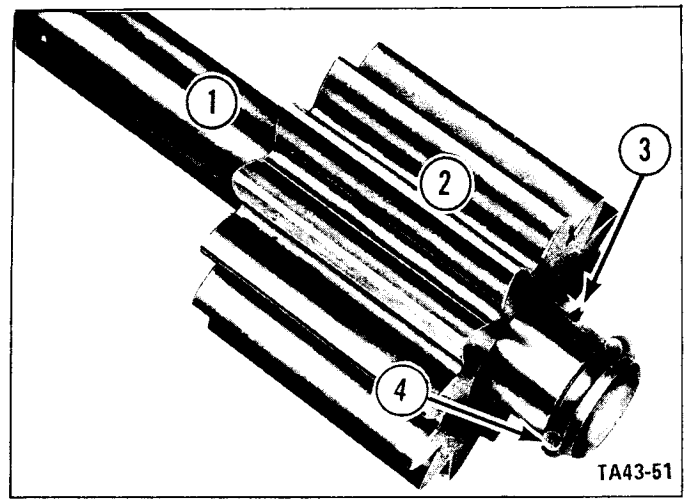


Fig. 6

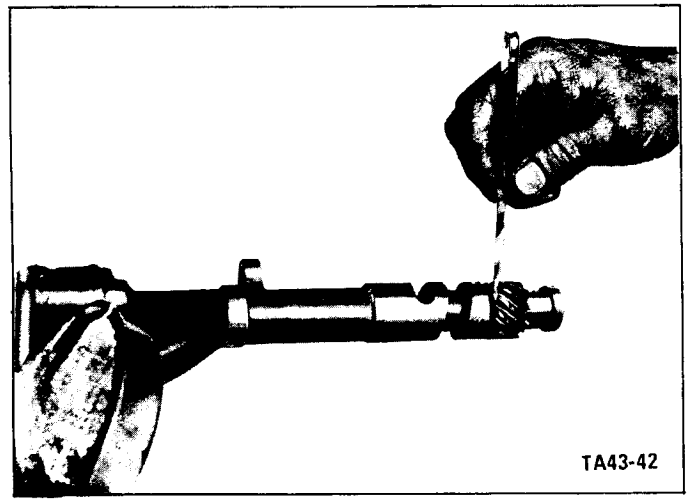


Fig. 7

(b) Use a new gasket and install the crankcase oil pan, tightening the bolts to the correct torque.

(c) Fill the crankcase with the correct grade of lubricating oil to the oil level mark on the dipstick.

3. LUBRICATING OIL FILTERS

3a. REMOVAL

(a) Remove the two bolts securing the filter to the crankcase then remove the filter and gasket.

3b. DISMANTLING

1. "TECALEMIT" FILTER

(a) Unscrew the centre bolt (2-8) then remove the bowl and element assembly from the filter head (12-8).

(b) Lift the element (10-8) out of the bowl.

(c) Remove the circlip (9-8) from the centre bolt (2-8) then slide the pressure plate (8-8), felt washer (7-8), washer (6-8), spring (5-8), and sealing washer (3-8) off the centre bolt.

(d) Remove the head seal (11-8) from the filter head.

2. "PUROLATOR" FILTER

(a) Unscrew the centre bolt (14-8) then remove the bowl and element assembly from the filter head (31-8).

(b) Lift the element (23-8) out of the bowl.

(c) Remove the circlip (22-8) from the centre bolt (14-8) then slide the bottom element guide (21-8), centre spindle seal (20-8), plain washer (19-8), spring (18-8), sealing washer (16-8), and centre bolt collar (15-8) off the centre bolt.

(d) Remove the head seal (24-8) from the filter head.

(e) Remove the circlip (28-8) then remove the top element guide (29-8) and gasket (30-8) from the filter head.

(f) Unscrew the relief valve seat (25-8) from inside the filter head then remove the ball (26-8) and spring (27-8).

NOTE: On later type "Purolator" filters items (25, 26 & 27-8) are not serviceable.

3. "A.C. DELCO" FILTER

(a) Unscrew the centre bolt (34-8) then remove the bowl and element assembly from the filter head (43-8).

(b) Lift the element (40-8) out of the bowl then remove the element seals (39-8) from the element.

(c) Remove the centre bolt, sealing washer (35-8), spring (37-8), and lower seal retainer (38-8) from the bowl (36-8).

(d) Remove the head seal (42-8) from the filter head.

(e) Unscrew the relief valve plug (47-) then remove the spring (45-8) and ball (44-8) from the head.

3c. INSPECTION AND REPAIR

(a) Check the relief valve seat and ball for pitting and corrosion.

(b) Check the relief valve spring for cracks or pitting.

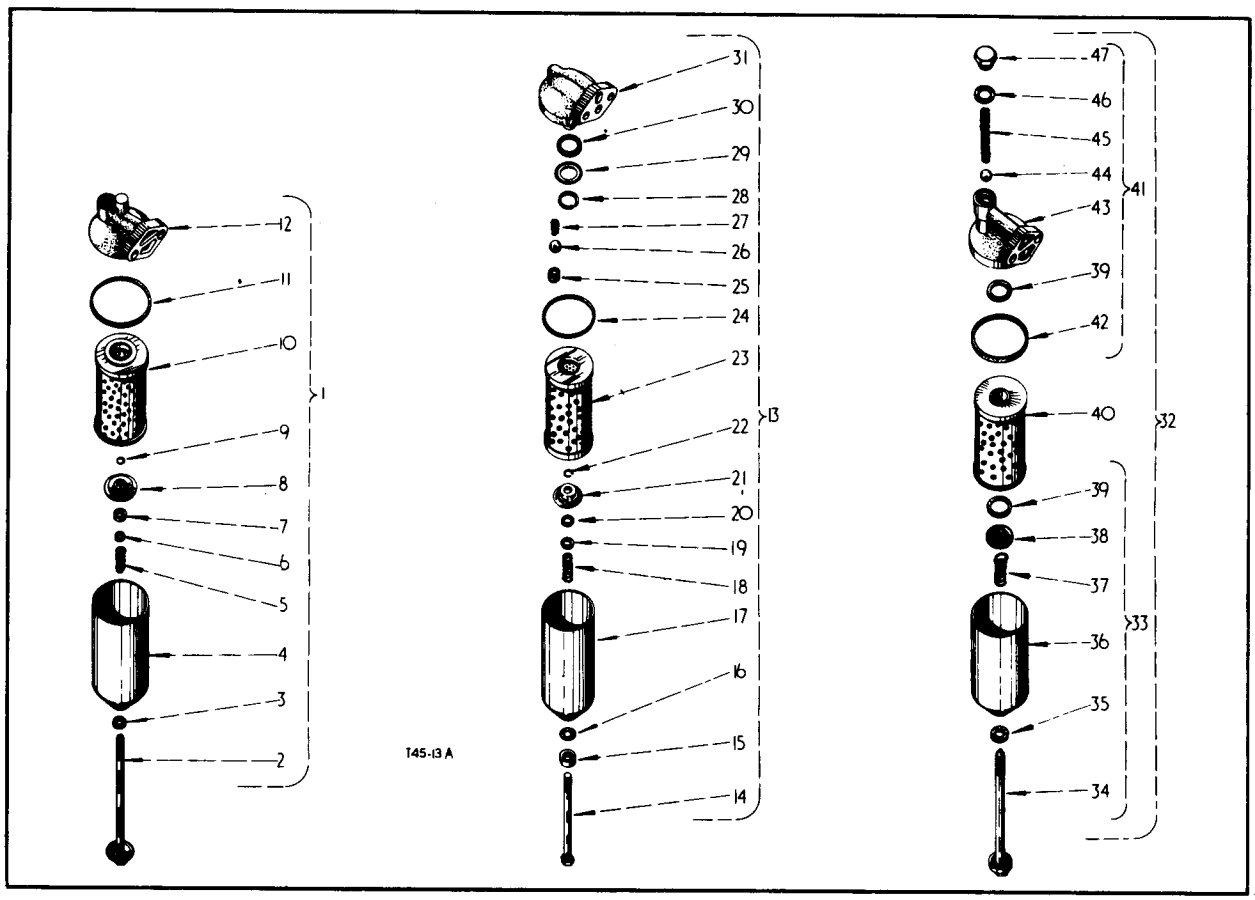
3d. ASSEMBLY

1. "TECALEMIT" FILTER

(a) Install a new seal in the filter head.

(b) Install a new sealing washer on the centre bolt.

(c) Insert the centre bolt into the bowl and assemble the spring, washer, felt washer and pressure plate to it then secure with the circlip.



1. "TECALEMIT" Filter
2. Centre bolt
3. Sealing washer
4. Bowl
5. Pressure plate spring
6. Washer
7. Felt washer
8. Pressure plate
9. Centre bolt circlip
10. Element
11. Head seal
12. Head

13. "PUROLATOR" Filter
14. Centre bolt
15. Centre bolt collar
16. Sealing washer
17. Bowl
18. Spring
19. Plain washer
20. Centre spindle seal
21. Element guide - bottom
22. Circlip
23. Element
24. Head seal
25. Relief valve seat
26. Relief valve ball
27. Relief valve spring
28. Circlip
29. Element guide - top
30. Gasket
31. Head

32. "A.C. DELCO" Filter
33. Bowl assembly
34. Centre bolt
35. Sealing washer
36. Bowl
37. Element retainer spring
38. Lower seal retainer
39. Element seals
40. Element
41. Head assembly
42. Head seal
43. Head
44. Relief valve ball
45. Relief valve spring
46. Valve plug gasket
47. Valve plug

Fig. 8 EXPLODED VIEW OF OIL FILTERS

(d) Place a new element over the centre bolt into the bowl.

NOTE: If a "Purolator" element service package is being used discard the adaptor plates in the package.

(e) Insert the centre bolt into the filter head then tighten the bolt ensuring that the bowl seats evenly on the head seal.

2. "PUROLATOR" FILTER

(a) If removed, install the relief valve spring and ball in the filter head, screw in the relief valve seat and using a suitable punch stake the filter head metal into the slots in the relief valve seat.

(b) Install a new gasket and element guide in the filter head then secure with the circlip.

(c) Install a new seal in the filter head.

(d) Install the centre bolt collar and a new sealing washer on the centre bolt ensuring that the concave side of the sealing washer is away from the bolt head.

(e) Insert the centre bolt into the bowl and assemble the spring, plain washer, sealing washer and bottom element guide to it then secure with the circlip.

(f) Place a new element over the centre bolt into the bowl.

(g) Insert the centre bolt into the filter head then tighten the bolt ensuring that the bowl seats evenly on the head seal.

3. "AC-DELCO" FILTER

(a) Install the relief valve ball and spring in the filter head then tighten the relief valve plug.

(b) Install a new seal in the filter head.

(c) Install a new sealing washer on the centre bolt.

(d) Insert the centre bolt into the bowl then assemble the spring and lower seal retainer to it.

(e) Install the lower element seal on the seal retainer and the upper element seal on the filter.

(f) Place a new element over the centre bolt into the bowl.

NOTE: If a "Purolator" element service package is being used discard the adaptor plates in the package.

(g) Insert the centre bolt into the filter head then tighten the bolt ensuring that the bowl seats evenly on the head seal.

3e. INSTALLATION

(a) Insert the bolts through the filter head, locate a new gasket on the bolts, install the filter on the crankcase then tighten the bolts to the correct torque.

GROUP 5

COOLING SYSTEM

1. DESCRIPTION

1a. WATER PUMP

The coolant in the crankcase is circulated by a centrifugal water pump mounted on the front of the crankcase. The impellor is a press fit on the shaft which forms part of the special bearing on which the shaft runs. This shaft also carries the hub which forms part of the fan belt pulley and the fan is mounted on the front of the hub. The water pump is belt driven from the crankshaft pulley and belt tension is adjustable by means of the pulley flange or an adjusting pulley attachment, which is available for BD-144 series engines. This attachment consists of a jockey pulley running on ball bearings mounted on a bracket which slides in a groove in a special injection pump gear cover.

1b. THERMOSTAT

The expanding bellows type thermostat situated in a grey iron housing, bolted to the cylinder head, begins to open at 170°F (77°C) and is fully open at 199°F (93°C).

2. FAN BELT

2a. REMOVAL

(a) Remove the fan belt as detailed in the relevant Operator's Manual.

2b. INSPECTION AND REPAIR

(a) Inspect the belt for signs of wear, perishing, cracking or oil contamination.

2c. INSTALLATION

(a) Install the fan belt as detailed in the relevant Operator's Manual.

3. FAN

3a. REMOVAL

(a) Remove the four bolts securing the fan to the pulley hub and remove the fan.

3b. INSPECTION AND REPAIR

(a) Inspect the fan for cracks or bent blades.

(b) Carefully straighten any bent blades.

3c. INSTALLATION

(a) Reverse the removal procedure.

4. WATER PUMP

4a. REMOVAL

(a) Remove the fan and generator belts as detailed in the relevant Operator's Manual.

(b) Remove the fan as detailed in para.3a.

(c) Slacken the two hose clips (1-1) then remove the thermostat by-pass hose (2-1).

(d) Remove the four nuts (3-1) and remove the water pump from the crankcase.

4b. DISMANTLING

(a) Bolt a plate similar to that shown in Fig.2 to the four fan mounting holes and secure the plate in a vice.

(b) Using a suitable bolt in the centre hole of the plate drive the shaft out of the pulley hub. The impellor and pump body will come off as one unit.

(c) Remove the bearing retaining screw (1-3) and lockwasher.

(d) Press the spindle bearing shaft (2-3) and impellor out of the water pump body (3-3).

(e) Press the spindle bearing shaft (3-4) out of the impellor (2-4) then remove the seal (7-4) and water flinger (6-4).

4c. INSPECTION AND REPAIR

(a) Check all parts for wear or excessive rust or scale.

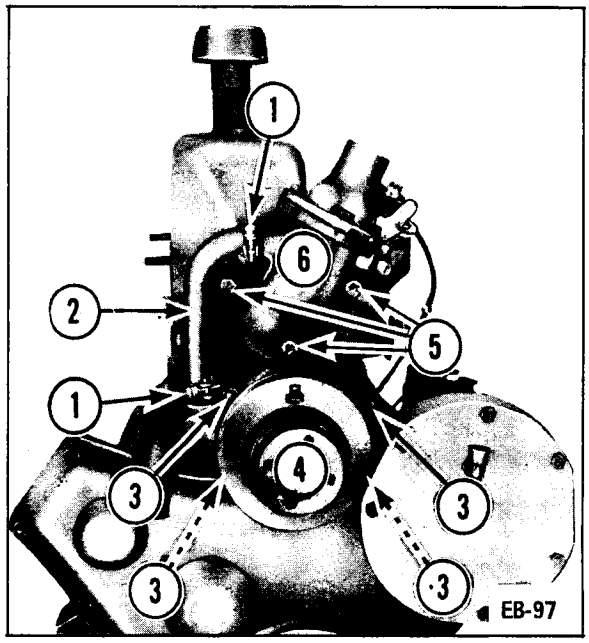


Fig. 1

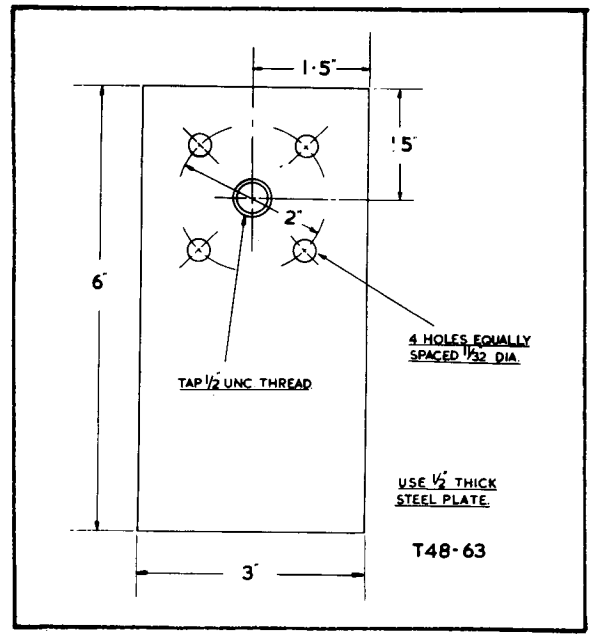


Fig. 2

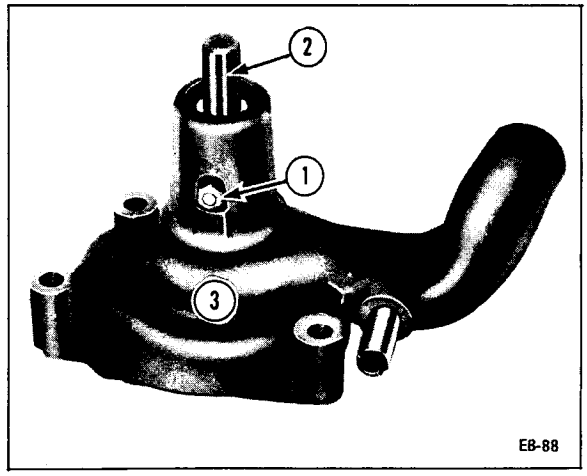


Fig. 3

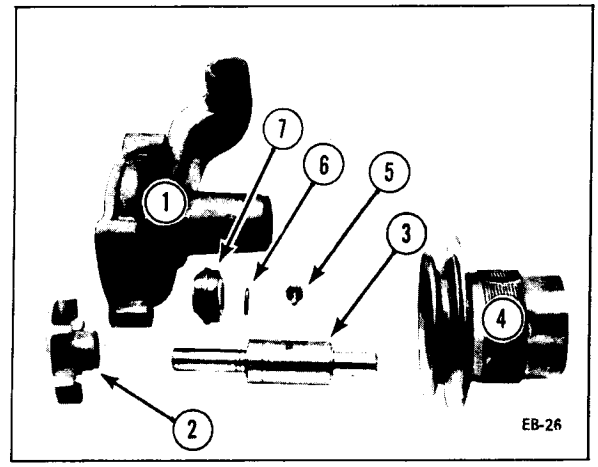


Fig. 4

(b) Check the fit of the spindle bearing shaft in the impellor bore and the pulley hub bore to specifications.

(c) Check the fit of the spindle bearing shaft in the water pump body to specifications.

(d) Check the water flinger and seal for wear or damage.

4d. ASSEMBLY

(a) Install the water flinger and seal on the spindle bearing ensuring that the carbon thrust ring of the seal is away from the bearing.

(b) Press on the impellor ensuring that the face of the impellor hub is flush with the end of the spindle.

(c) Press the spindle bearing shaft into the water pump aligning the groove in the bearing with the bolt hole in the water pump body. Ensure that the impellor is flush with the base of the water pump body (Fig.5).

(d) Install the bearing retaining screw and lockwasher then tighten it to the specified torque.

(e) Press the pulley hub onto the spindle.

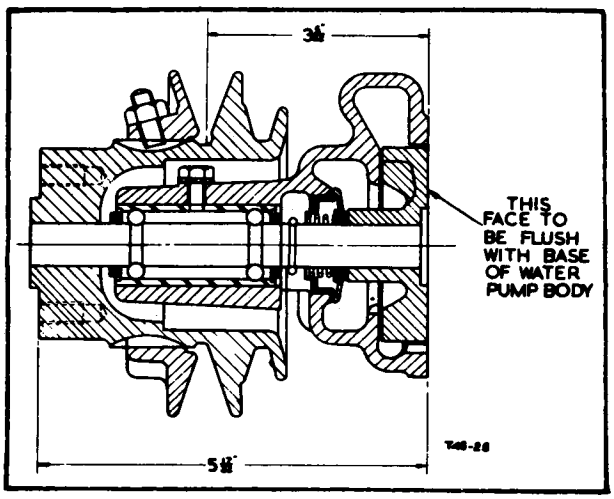


Fig. 5

4e. INSTALLATION

(a) Reverse the removal procedure using a new gasket and tighten the nuts to the correct torque.

5. THERMOSTAT HOUSING

5a. REMOVAL

(a) Remove the thermostat housing as detailed in GROUP 2, para.4a-1 ops. (d) and (e).

5b. DISMANTLING

(a) Remove the three bolts (1-6) and lockwashers then remove the thermostat housing cover (2-6).

(b) Lift out the thermostat (1-7).

5c. INSPECTION AND REPAIR

(a) Clean old gasket material from the mating faces of the housing then inspect the housing for excessive rust or scale.

(b) Insert the thermostat in cold water, heat the water and check the temperature at which the thermostat begins to open to specifications.

5d. ASSEMBLY

(a) Place the thermostat in the housing install the housing cover and tighten the bolts to the correct torque.

5e. INSTALLATION

(a) Using a new gasket install the thermostat housing on the cylinder head and tighten the bolts to the correct torque.

6. FAN BELT ADJUSTING PULLEY

6a. REMOVAL

(a) Remove the retaining bolt then slide the bracket (2-8) out of the slot in the injection pump gear cover (5-8).

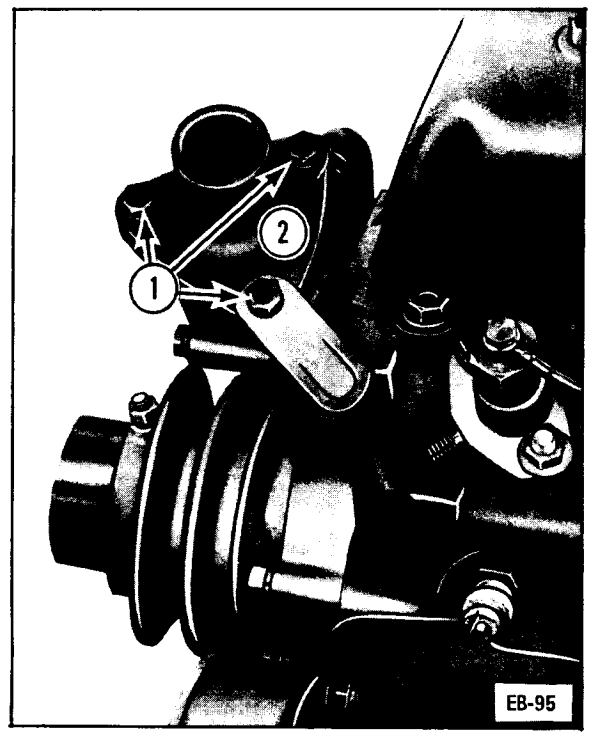


Fig. 6

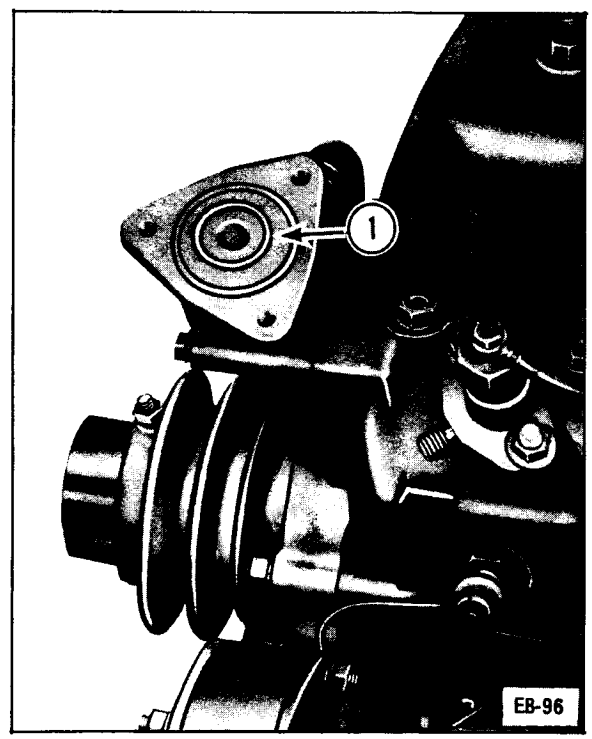


Fig. 7

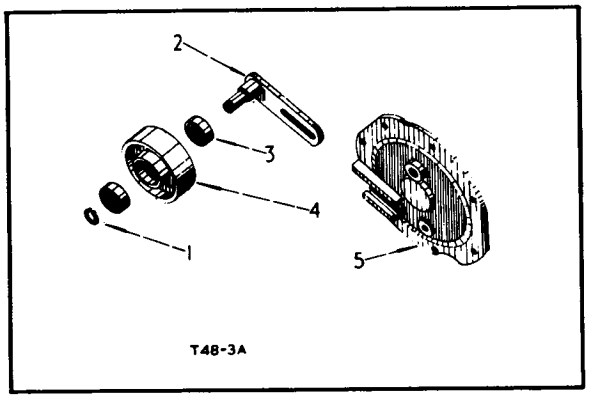


Fig. 8

6b. DISMANTLING

(a) Remove the circlip (1-8) from the shaft then pull off the pulley (4-8) complete with bearings (3-8).

(b) Press the bearings out of the pulley.

6c. INSPECTION AND REPAIR

(a) Inspect the bearings for wear, corrosion or cracking.

(b) Inspect the bracket for straightness and cracks.

(c) Inspect the spindle and pulley for wear.

6d. ASSEMBLY

(a) Press the bearings into the pulley until they are hard against the shoulder in the bore.

(b) Slide the pulley onto the spindle ensuring that the cast letter "P" faces away from the bracket and secure with the circlip.

6e. INSTALLATION

(a) Reverse the removal procedure, and adjust the pulley to give the correct belt tension.

GROUP 6

TIMING GEAR TRAIN, FRONT COVER AND CAMSHAFT

1. DESCRIPTION

1a. GEAR TRAIN

The timing gear train consists of four gears; the crankshaft pinion, the camshaft gear and the idler gear. On diesel engines the fourth gear is the injection pump gear, and on petrol engines it is the governor gear. These gears are mounted on the front face of the engine and are enclosed within the crankcase front cover. Each gear is punch marked for timing purposes.

1b. CAMSHAFT

The camshaft runs in three babbit lined bushes in the right hand side of the crankcase. The camshaft bushes are replaceable and are supplied for service in a semi-finished bored condition and must be line reamed to size after fitting. A gear integral with the camshaft provides the drive for the oil pump.

2. FRONT COVER

2a. REMOVAL

(a) Remove the fan belt as detailed in the relevant Operator's Manual.

(b) Remove the fan as detailed in GROUP 5, para.3a.

(c) Remove the starting crank nut (2-1) and lockwasher.

(d) Pull the fan drive pulley off the crankshaft and remove the key.

(e) Remove the crankcase breather pipe (3-1) if fitted.

(f) Remove the nuts and bolts (4-1) securing the injection pump gear cover (5-1) then remove the cover.

(g) Remove the two bolts (1-1) from the front of the crankcase oil pan.

(h) Remove the bolts (6-1) securing the front cover then remove the cover and gasket.

NOTE: Check the backlash between the gears to specifications if necessary.

2b. DISMANTLING

(a) Press out the oil seal if inspection proves it necessary.

2c. ASSEMBLY

(a) Press in a new oil seal with the lip facing inward until it is flush with the outside face of the front cover.

2d. INSTALLATION

Reverse the removal procedure.

3. TIMING GEARS

3a. REMOVAL

1. DIESEL ENGINES

(a) Remove the front cover as detailed in para.2a.

(b) Remove the three bolts (1-2) then remove the injection pump gear (2-2).

(c) Remove the idler gear shaft bolt (3-2) then remove the idler gear and shaft (4-2).

(d) Using a suitable puller remove the crankshaft pinion (5-2) and key.

(e) Remove the camshaft gear (6-2) as detailed in para.4b.

2. PETROL ENGINES

(a) Remove the front cover as detailed in para.2a.

(b) Remove the governor gear nut (1-3) then remove the governor gear (2-3).

(c) Remove the idler gear shaft bolt (3-3) then remove the idler gear and shaft (4-3).

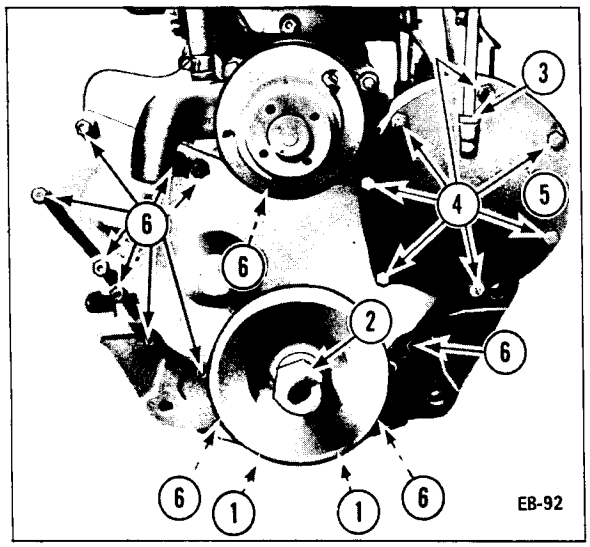


Fig. 1

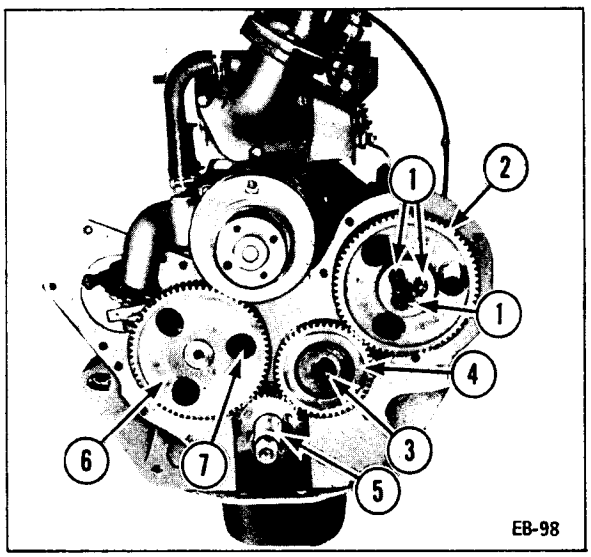
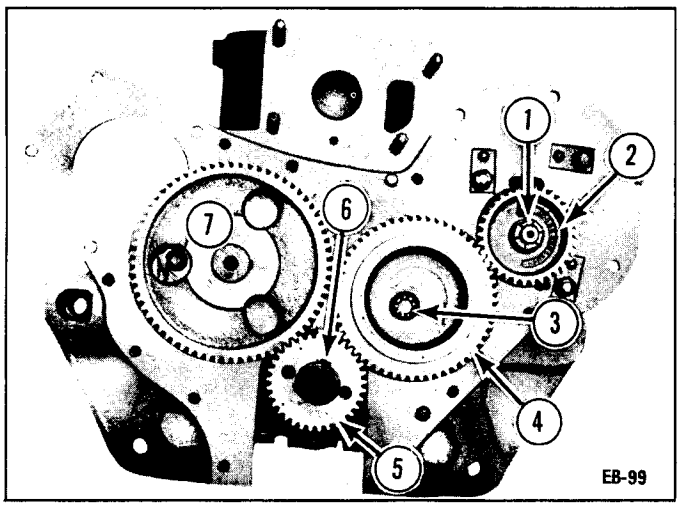


Fig. 2

Fig. 3



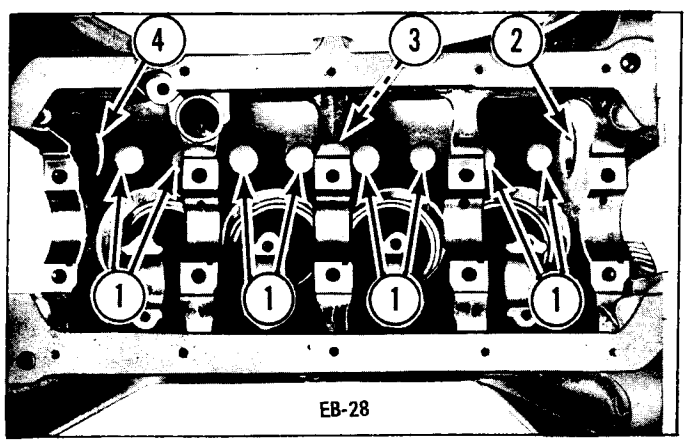


Fig. 4

(d) Using a suitable puller remove the crankshaft pinion (5-3) and key (6-8).

(e) Remove the camshaft gear as detailed in para.4b.

3b. INSPECTION AND REPAIR

(a) Inspect the gears for wear and cracked or chipped teeth. Remove any burrs on the gears with a fine carborundum stone.

(b) Inspect the fan drive pulley for wear or cracking.

(c) Check the fit of the idler gear and shaft to specifications.

(d) Check the condition of the idler gear shaft bolt thread insert in the front of the crankcase. If inspection proves it necessary remove the thread insert and fit a new one as detailed in GROUP 7 para.5.

3c. INSTALLATION

1. DIESEL ENGINES

(a) Fit a new key to the crankshaft then press the crankshaft pinion on to the crankshaft.

(b) Assemble the idler gear and shaft, install it on the crankcase ensuring that the double marks on the idler gear line up with the double marks on the crankshaft pinion. Tighten the bolt to the specified torque.

(c) Install the camshaft and camshaft gear as detailed in para.4d.

(d) Install the injection pump gear ensuring that the double marking on the injection pump gear is in register with the single marking on the idler gear, install the three bolts and tighten to the correct torque.

(e) Install the front cover as detailed in para.2d.

2. PETROL ENGINES

(a) Proceed as detailed in para.3c - 1, ops. (a) to (c).

(b) Assemble the governor gear to the governor shaft then tighten the jam nut to the specified torque.

(c) Install the front cover as detailed in para.2d.

4. CAMSHAFT .

4a. REMOVAL

(a) Remove the valve lever shaft assembly as detailed in GROUP 2 para.3a.

(b) Lift out the valve push rods and identify them so they can be installed in their original positions.

(c) Remove the crankcase front cover as detailed in para.2a.

(d) Remove the oil pump as detailed in GROUP 4, para.2a.

(e) Invert the engine then turn the camshaft until the cored holes in the gear line up with the bolts (7-2) securing the camshaft thrust plate then remove the bolts and lockwashers.

(f) Withdraw the camshaft with gear from the crankcase.

(g) Remove the valve tappets (1-4) and identify them so they can be installed in their original positions.

4b. DISMANTLING

(a) Press the camshaft out of the gear then remove the key and thrust plate from the camshaft.

4c. INSPECTION AND REPAIR

(a) Inspect the cam lobes and camshaft journals for wear to specifications.

(b) Inspect the oil pump drive gear, if excessive wear is found, the camshaft must be replaced.

(c) Place the camshaft between centres and with a dial indicator against the centre journal check that

the run-out does not exceed 0.002 inch.

(d) Check the camshaft gear and thrust plate for wear which will produce excessive end clearance.

(e) Check the camshaft running clearance against the dimensions given in specifications. If inspection proves it necessary, remove the camshaft bearings as detailed in para.5a.

(f) Inspect the valve tappets for wear to specifications.

4d. ASSEMBLY

(a) Install the thrust plate on the camshaft.

(b) Fit a new key to the camshaft then press on the camshaft gear to leave a clearance of 0.008 - 0.017 inch between the gear hub rear face and the thrust plate. Ensure that the thrust plate is located against its abutment shoulder when checking this clearance (Fig. 5).

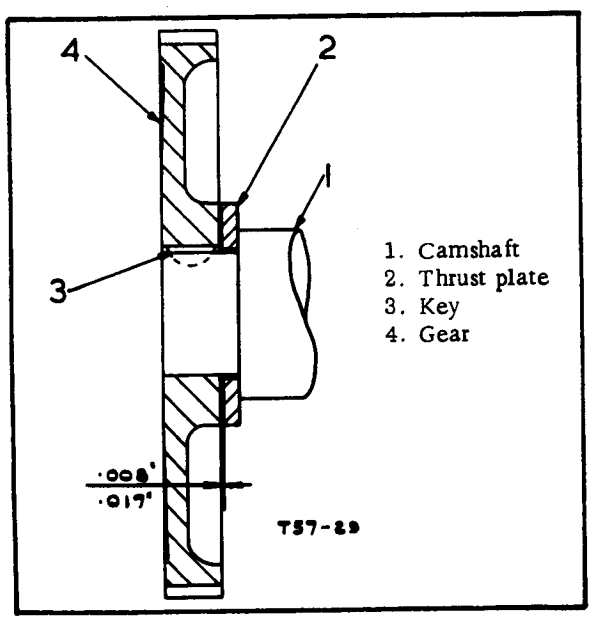


Fig.5 CAMSHAFT (CURRENT)

NOTE: On early engines the camshaft gear is pressed up to the thrust plate and there is no clearance between the thrust plate and abutment shoulder (Fig.6).

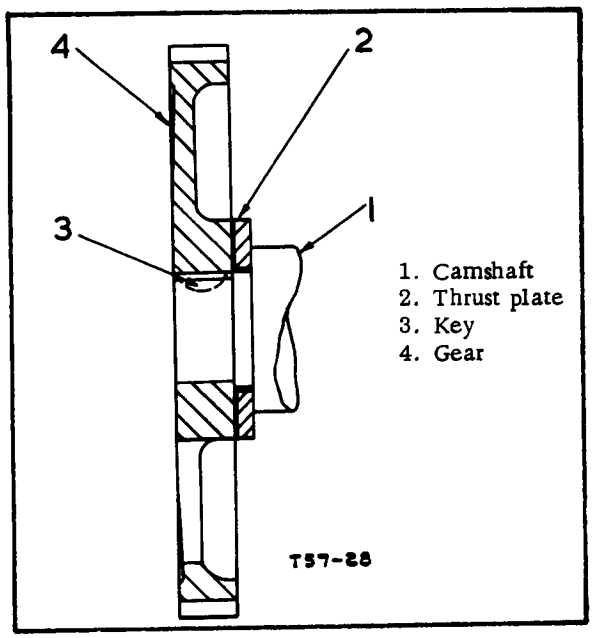


Fig.6 CAMSHAFT (EARLY TYPE)

4e. INSTALLATION

(a) Install the valve tappets in their original positions.

(b) Coat the camshaft and camshaft bearings with clean engine oil.

(c) Install the camshaft in the crankcase taking care not to damage the bearings and engage the camshaft gear with the crankshaft pinion ensuring that the single timing marks are in register.

(d) Secure the thrust plate to the crankcase with the bolts and lockwashers and tighten the bolts to the specified torque.

(e) Invert the engine and install the oil pump as detailed in GROUP 4 para.2e.

(f) Install the front cover as detailed in para.2d.

(g) Install the valve push rods in their original positions.

(h) Install the valve lever shaft assembly as detailed in GROUP 2 para.3e.

5. CAMSHAFT BEARINGS

5a. REMOVAL

(a) Remove the camshaft as detailed in para.4a.

(b) Remove the flywheel as detailed in GROUP 7, para.2a.

(c) Use a long bar from the front of the crankcase and drive out the expansion plug (1-7).

(d) Remove the camshaft bearings (2, 3 & 4-4) from the crankcase.

5b. INSTALLATION

(a) Press the centre bearing into position aligning the hole in the bearing with the hole in the crankcase.

(b) Press the front and rear bearings into position ensuring that the edge marked "FRONT" is to the front of the crankcase and that the holes in the bearings line up with those in the crankcase.

NOTE: Ensure that the rear bearing is pressed in flush with the front of the bore in the crankcase.

(c) Line ream the bearings to the dimensions in specifications.

(d) After reaming, blow out the crankcase and oilways to remove all swarf.

(e) Install the rear bearing expansion plug using a good quality sealer on the plug and seat.

(f) Install the flywheel as detailed in GROUP 7, para.2c.

(g) Install the camshaft as detailed in para.4e.

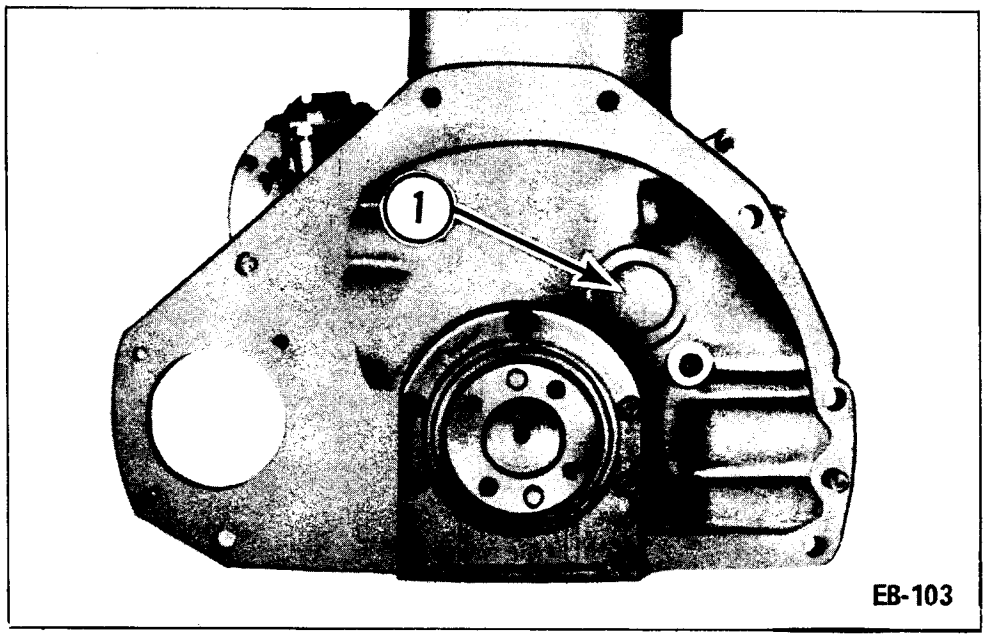


Fig. 7

GROUP 7

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL

1. DESCRIPTION

The crankshaft is supported in five main bearings with the end thrust being taken on the rear one. The bearings are of the steel backed insert type and do not require fitting on assembly. The bearing caps are not interchangeable and each one is stamped with its location in the crankcase, No.1 being at the front. The bearing caps are secured to the crankcase by "Place" bolts which do not require any locking mechanisms, on early engines the caps were secured by bolts and locking wire.

Semi-finished main bearing caps are available for service, however, it is necessary to have facilities to line bore and ream the caps to the dimensions given in specifications.

Mounted on the front of the crankshaft is the crankshaft pinion which drives the timing gear train, and the fan drive pulley. The flywheel is mounted on the rear of the crankshaft and is secured by four bolts with tab washers. Two dowels are fitted in the crankshaft flange for correct location of the flywheel. The starting ring gear which is replaceable is a shrink fit on the flywheel.

2. FLYWHEEL

2a. REMOVAL

(a) Bend back the locktabs (1-3) then remove the four bolts (2-3) and locktabs.

(b) Using a suitable sling to support it lever the flywheel off the dowels.

2b. INSPECTION AND REPAIR

(a) Inspect the flywheel ring gear for excessive wear, chipped and broken teeth.

(b) If inspection proves it necessary replace the flywheel ring gear as follows:-

(1) Remove the ring gear by heating with a torch or splitting with a chisel and driving off.

(2) Heat a new ring gear to 500 - 550°F and install it ensuring that it is hard against the shoulder on the flywheel. The ring gear must be installed with the lead on the teeth toward the crankcase on diesel engines (1-1) and away from the crankcase on petrol engines (1-2).

(c) Inspect the clutch friction face for ridges, scores, cracks and burrs.

(d) Using a straight edge and feeler gauges check the friction face for hollows or high spots. The friction face must be flat and true within 0.006 inch. If necessary, the friction face should be ground to this condition. If suitable grinding equipment is not available the flywheel can be mounted in a lathe and the friction face dressed with emery cloth. If the surface is very rough take a fine cut with a lathe tool before dressing the friction face with emery cloth.

2c. INSTALLATION

(a) Install the flywheel on the crankshaft lining up the dowel holes.

(b) Install the bolts and tab washers then tighten the bolts to the specified torque.

(c) Mount a dial indicator on the crankcase and check that friction face run-out does not exceed 0.001 inch per 1-1/2 inches of radius. If run-out exceeds this figure remove the flywheel and check the mounting faces on the flywheel and crankshaft for burrs or foreign matter.

(d) If run-out is within the figure in op.(c) bend up the tabs to secure the bolts.

3. CRANKSHAFT BEARINGS

3a. REMOVAL

(a) Remove the oil pump as detailed in GROUP 4, para.2a.

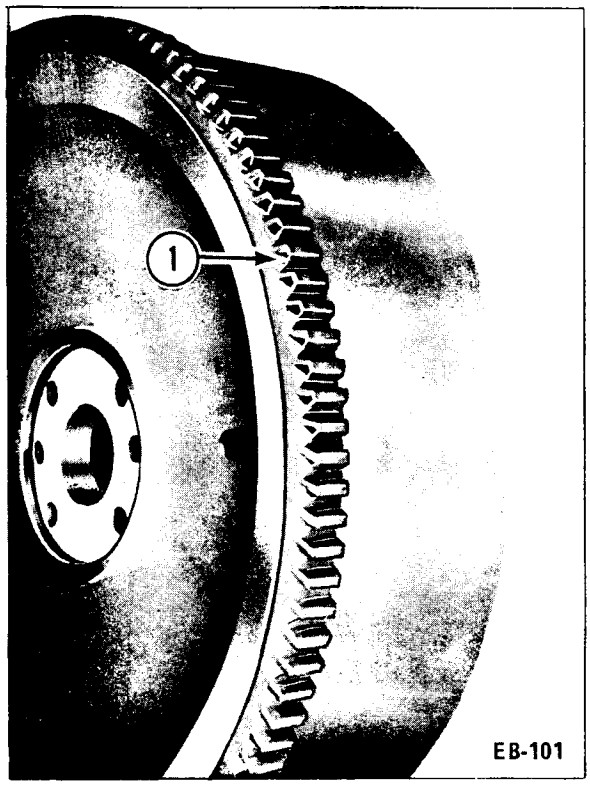


Fig. 1

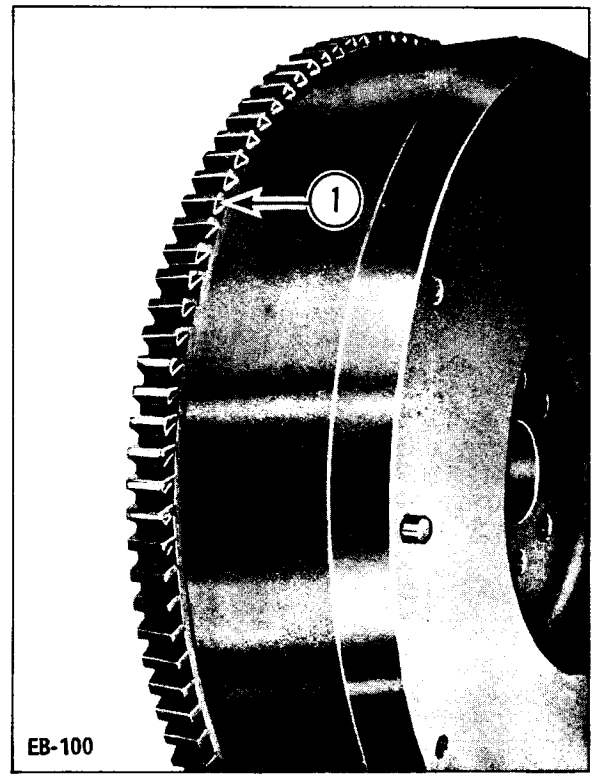


Fig. 2

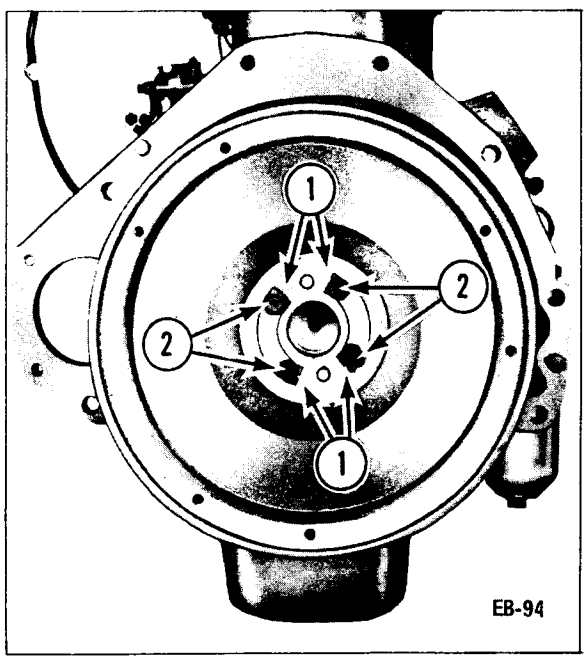


Fig. 3

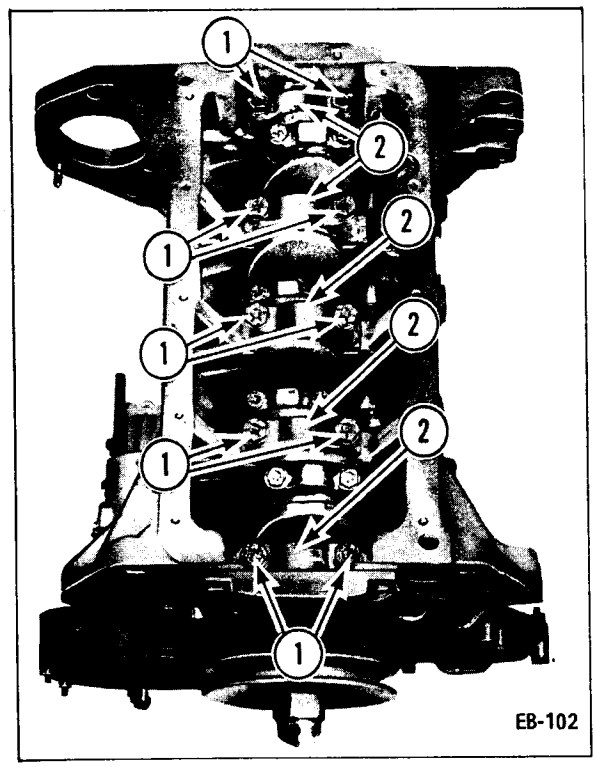


Fig. 4

(b) Invert the engine.

(c) Remove the bearing cap bolts (1-4) then remove the bearing caps (2-4) and bearing inserts.

(d) Remove the bearing inserts from the caps and identify them if they are to be re-used.

(e) Remove the bearing inserts from the crankcase and identify them if they are to be re-used.

3b. INSPECTION AND REPAIR

(a) Inspect the bearing inserts for signs of wear or damage.

3c. INSTALLATION

(a) Install the upper half bearing inserts.

(b) Assemble the lower half bearing inserts to the bearing caps.

(c) Install the bearing caps, identification numbers to the camshaft side, and tighten the bolts to the specified torque.

(d) Remove one bearing cap and bearing half insert.

(e) Place a length of 0.005 inch thick virgin lead wire along the full width of the bearing half insert, install the bearing cap and tighten the bolts to the specified torque.

(f) Remove the bearing cap and check the lead wire to determine the bearing running clearance. Repeat this check on the remaining bearings.

(g) If the clearance is not within the specified limits the crankshaft will require regrinding (refer to Fig. 5).

(h) When the clearance is satisfactory lubricate the bearings then tighten the four front bearing caps to the specified torque.

(i) Hold the crankshaft toward the FRONT of the crankcase so that the crankshaft thrust face is tight against the rear of the rear main bearing.

(j) Tap the rear main bearing cap toward the REAR of the crankcase so that the rear thrust face is tight against the crankshaft thrust face.

(k) Tighten the rear main bearing cap bolts to the specified torque and check the crankshaft end clearance at both sides of the bearing cap to specifications.

(l) Invert the engine and install the oil pump as detailed in GROUP 4, para.2e.

4. CRANKSHAFT

4a. REMOVAL

(a) Remove the crankcase front cover as detailed in GROUP 6, para.2a.

(b) Remove the flywheel as detailed in para.2a.

(c) Remove the crankshaft bearing caps as detailed in para.3a.

(d) Remove the connecting rod bearing caps and inserts then push the pistons to the top of their travel.

(e) Remove the seven bolts (1-6) and remove the crankshaft rear oil seal retainer (2-6).

(f) Lift the crankshaft out of the crankcase.

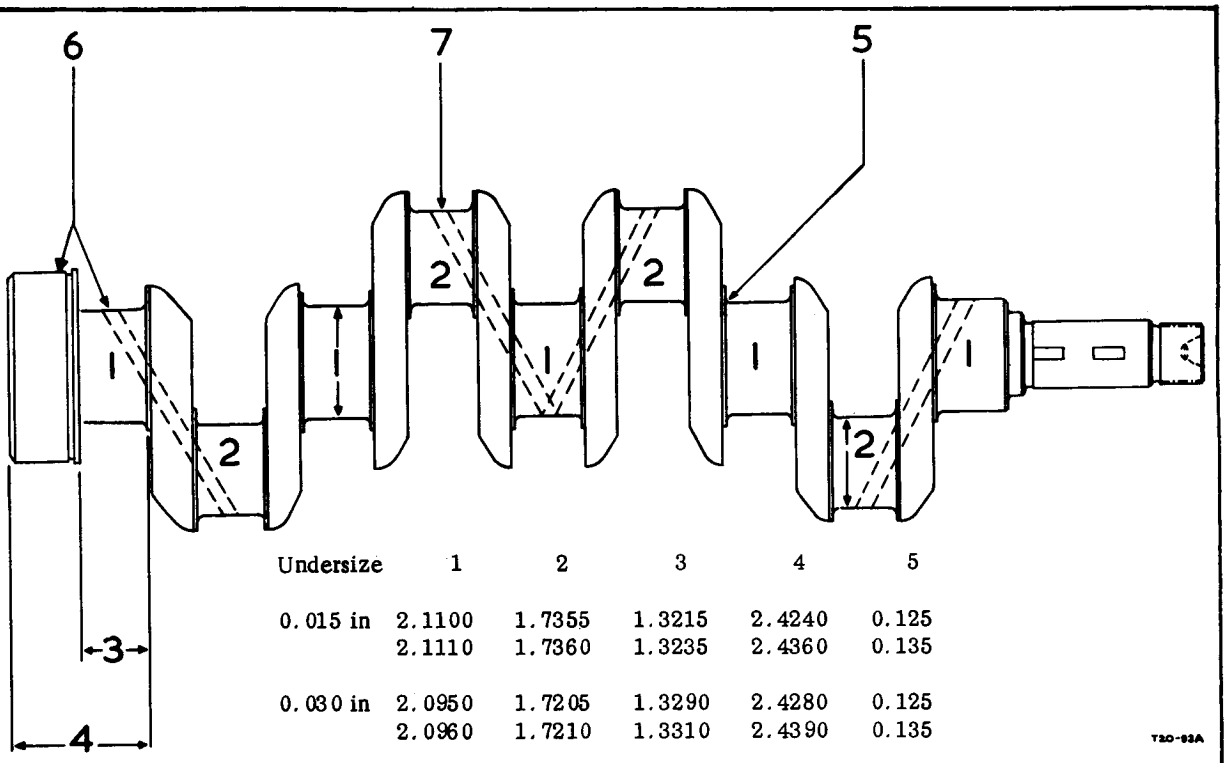
4b. DISMANTLING

(a) Remove the crankshaft pinion and clutch shaft pilot bearing if inspection proves this necessary.

(b) Remove the oil seal from the rear oil seal retainer.

4c. INSPECTION AND REPAIR

(a) Check the main journals and crankpins for wear and taper. Grind if necessary to the dimensions shown in Fig.5.



Undersize	1	2	3	4	5
0.015 in	2.1100	1.7355	1.3215	2.4240	0.125
	2.1110	1.7360	1.3235	2.4360	0.135
0.030 in	2.0950	1.7205	1.3290	2.4280	0.125
	2.0960	1.7210	1.3310	2.4390	0.135

6. Must be concentric within 0.004 inch T.I.R.

7. Holes must be clean and free of chips and burrs after grinding. Remove all sharp corners.

NOTE: Maximum allowable taper on crankpins and journals is 0.00015 inch per inch of length and they must not be more than 0.0005 inch out of round.

Fig. 5 UNDERSIZE LIMITS FOR CRANKSHAFT REGRINDING

(b) Check the dowels for wear or damage, replace if necessary pressing into the dimension shown in Fig. 7.

(c) Check the clutch shaft pilot bearing for wear or damage, replace if necessary pressing into the dimension shown in Fig. 7.

(d) Check that the oilways are clear.

4d. ASSEMBLY

(a) Install the clutch shaft pilot bearing if it was removed.

(b) Install the dowels if they were removed.

(c) Install a new key and the crank shaft pinion if they were removed.

(d) Press a new oil seal into the rear oil seal retainer with the lip toward the front of the crankcase. The seal must be pressed hard against the shoulders of the retainer.

4e. INSTALLATION

(a) Install the upper half bearing inserts and lubricate them.

(b) Carefully install the crankshaft and spin it by hand.

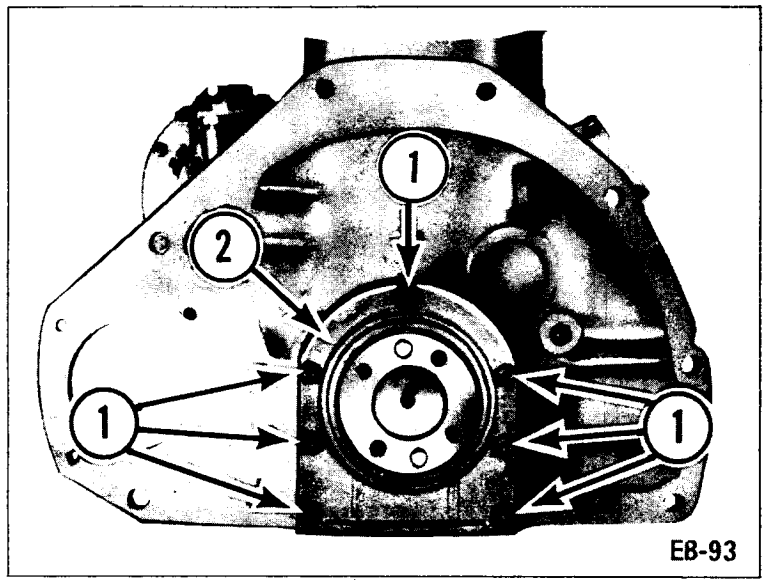


Fig. 6

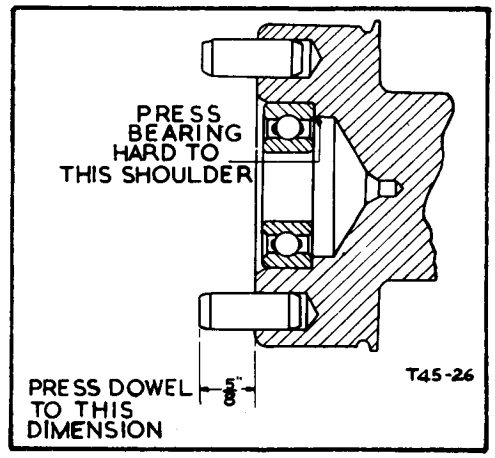


Fig. 7

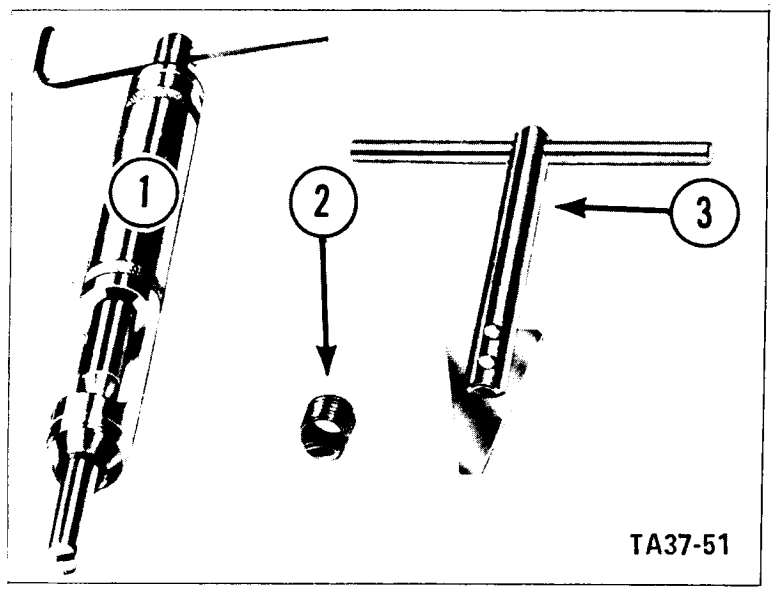


Fig. 8

(c) Install the main bearing caps as detailed in para.3c, ops. (b) to (k)

(d) Install the connecting rods, connecting rod bearings and bearing caps to the crankshaft with the identification numbers to the camshaft side then tighten the bolts to the specified torque.

(e) Check the connecting rod side clearance to specifications.

(f) Use jointing compound and fit a new horseshoe gasket to the rear face of the crankcase, lining up the holes in the gasket with the bolt holes.

(g) Apply a light coating of grease to the oil seal and fit the oil seal retainer over the end of the crankshaft taking care not to damage the lip of the seal. If possible use a sleeve for this operation. Ensure that the seal garter spring is in position.

(h) Locate the retainer on the dowels, install the bolts and to ensure even seating of the gasket, tighten the bolts by stages to the specified torque.

NOTE: The bottom face of the retainer, after installation, must be in line with the bottom face of the crankcase within 0.020 inch.

(i) Trim the horseshoe gasket flush with the bottom of the crankcase.

(j) Install the flywheel as detailed in para.2c.

(k) Install the oil pump as detailed in GROUP 4, para.2e.

(l) Invert the engine.

(m) Install the crankcase front cover as detailed in GROUP 6, para.2d.

5. HELI-COIL THREAD INSERTS

5a. REMOVAL

(a) Place the extractor (3-8) into the insert and turn in an anti-clockwise direction.

5b. INSTALLATION

NOTE: Never use an insert that has been removed.

(a) Place a new insert (2-8) in the driver (1-8) with the driving lug to the bottom.

(b) Screw the insert into the tool guide until it is flush with the end of the tool.

(c) Place the driver over the tapped hole and turn the handle clockwise until the insert leaves the tool, then break off the driving lug. Ensure that inserts are driven into the specified depth.

GROUP 8

GOVERNOR

BC-144 Engine

1. DESCRIPTION

The governor is a flyweight, variable speed type, driven through the idler gear by the crankshaft pinion. It is designed to maintain engine speeds within reasonably constant limits, under varying load conditions, by proportioning the fuel to the load. The governor depends upon centrifugal force for its action, developed by weights (6-1) rotating about a shaft (7-1). A spring (5-1) tends to counteract the outward movement of the weights. The movement of the weights is transferred to the carburettor throttle by the control lever (4-1) and linkage.

As the engine starts, its speed builds up and the governor weights move out to a maximum position determined by an idling screw stop (8-1) on the rockshaft lever. This movement closes the carburettor throttle.

Increase in engine speed is obtained by a clockwise movement of the hand throttle control which, through the speed change lever (1-1) extends the governor spring and increases the spring force acting against the governor weights. This causes the weights to close thus opening the carburettor throttle.

Under maximum load and governed speed conditions the governor spring is fully extended by the hand throttle control and the governor weights closed to give "wide-open" carburettor throttle. Any decrease in engine load will increase engine speed thus opening the governor weights, increasing centrifugal force acting against the spring and closing the carburettor throttle to reduce engine speed.

2. GOVERNOR

2a. REMOVAL

(a) Disconnect the governor and throttle control rods at the governor.

(b) Remove the crankcase front cover as detailed in GROUP 6.

(c) Remove the nut (1-2) then pull the governor drive gear (2-2) off the shaft.

(d) Remove the bolts (3-2) securing the governor and remove the governor.

2b. DISMANTLING

(a) Break the seal wire and remove the bolts securing the cover (27-3) then remove the cover and gasket (26-3).

(b) Disconnect and remove the governor spring (22-3).

(c) Slacken the pinch bolt on the governor spring lever (25-3) and remove the lever from the shaft (15-3).

(d) Remove the key (16-3) and oil seal (17-3) from the speed change lever shaft (15-3) then remove the shaft (9-3) from the housing.

(e) Remove the socket headed cap-screw and key (24-3) from the rockshaft lever (23-3), withdraw the shaft (30-3) then remove the rockshaft lever from the housing.

(f) Remove the bearing (3-3), carrier and weights assembly (4-3) from the housing. The governor sleeve (12-3) thrust bearing (13-3), and thrust washer (10-3) may come away with the shaft. If not lift these out of the housing.

(g) Drive out the weight retaining pins (6-3) and remove the weights (7-3) from the weight carrier (5-3).

2c. INSPECTION AND REPAIR

(a) Examine the housing for cracks.

(b) Examine the needle roller bearings in the housing for pitting or wear. If necessary, press out the old bearings using a suitable mandrel and press in new bearings to the dimensions shown in Fig.4. The closed end needle bearing must be installed in the opposite side to the governor cover opening and with its end plate outward.

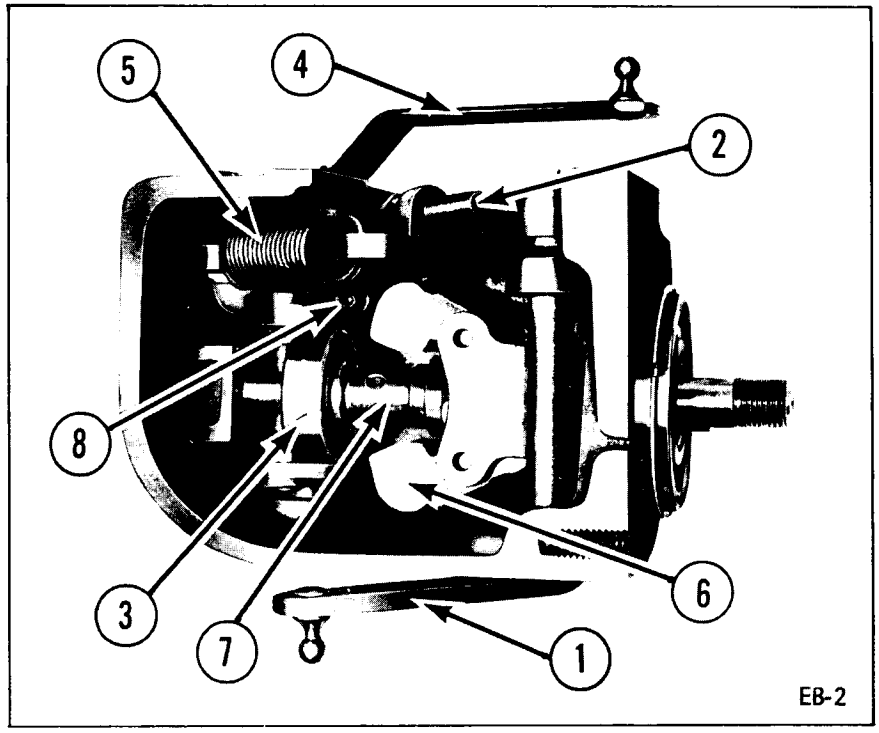


Fig. 1

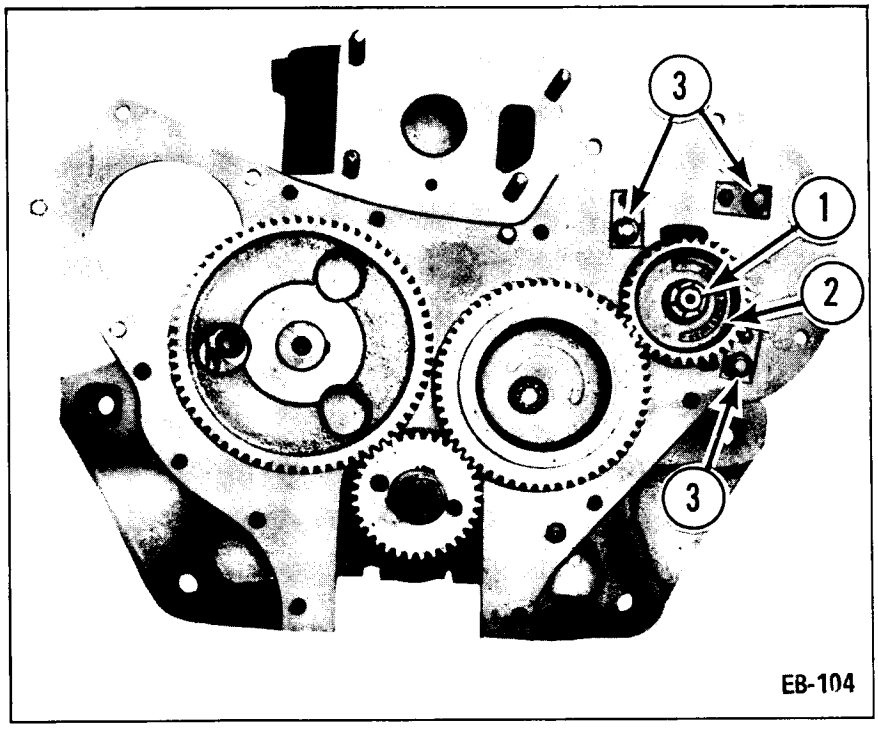


Fig. 2

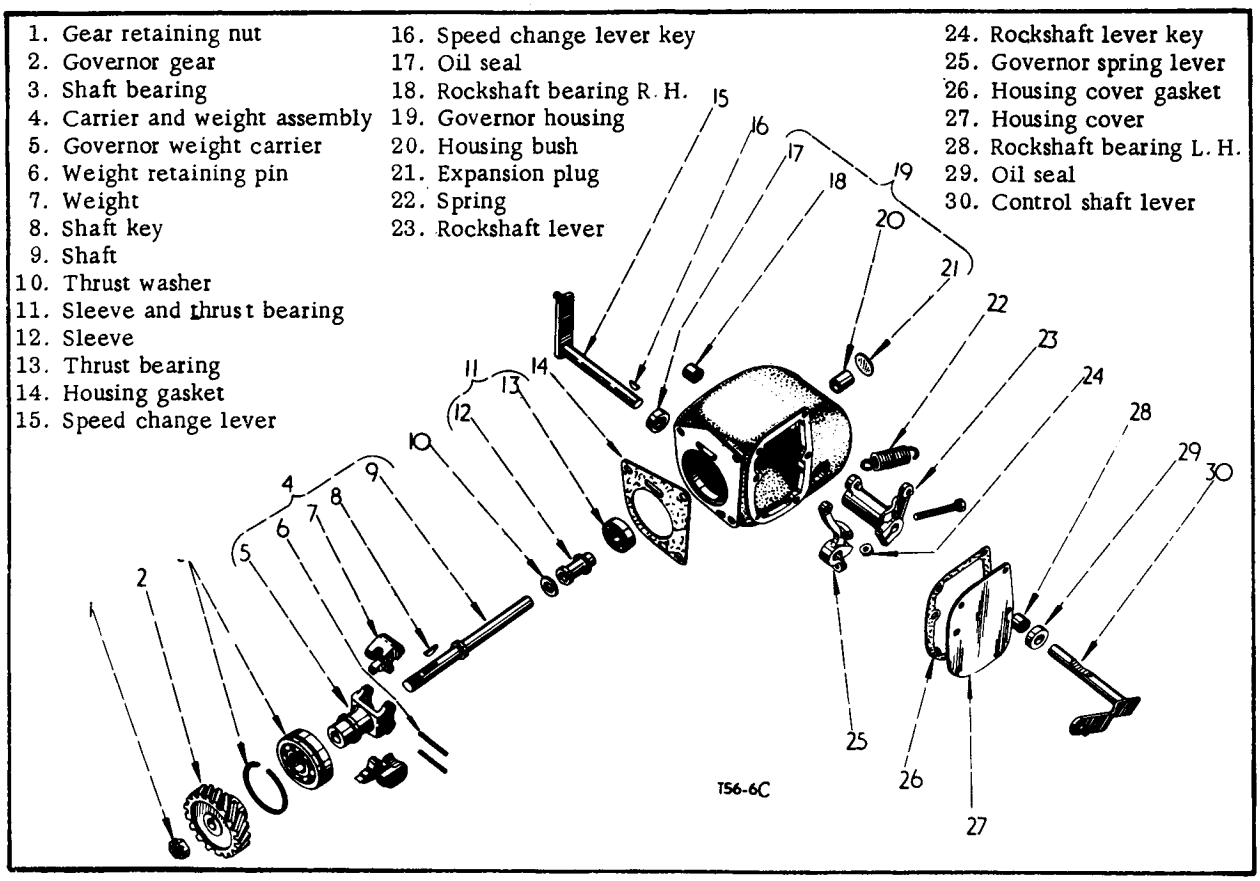


Fig. 3 EXPLODED VIEW OF GOVERNOR

(c) Examine the shaft bushing in the housing for wear. If necessary drive the core plug out of the housing, press out the old bush, press in a new bush and core plug as shown in Fig. 5 and ream the bush to specifications. A good grade sealer must be used when installling the core plug and its bore must be clean and true.

(d) Examine the thrust washer and bearing for excessive wear.

(e) Examine the rockshaft lever thrust pins for excessive wear, replace if inspection proves it necessary.

(f) The governor weights should not require replacement, but if this has to be done they must be replaced as a matched pair.

2d. ASSEMBLY

(a) Reverse the dismantling procedure.

2e. INSTALLATION

(a) Reverse the removal procedure and adjust the governor as detailed in para. 2f.

2f. ADJUSTMENTS

1. LOW IDLING SPEED STOP

(a) Remove the governor cover and gasket.

(b) Close the governor control lever right down.

(c) Slacken the locknut on the low idling speed stop screw (1-6).

(d) Adjust the screw until the governor spring is just free then lock the stop screw.

(e) Install the governor cover and gasket.

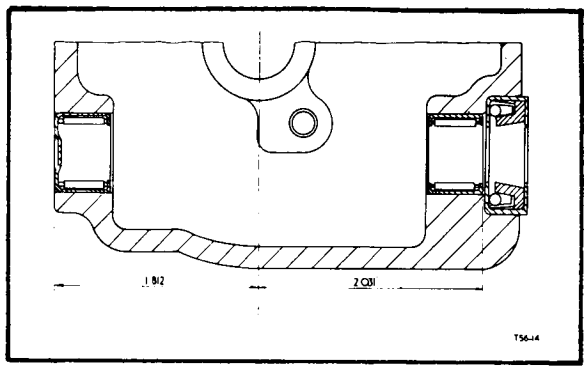


Fig. 4

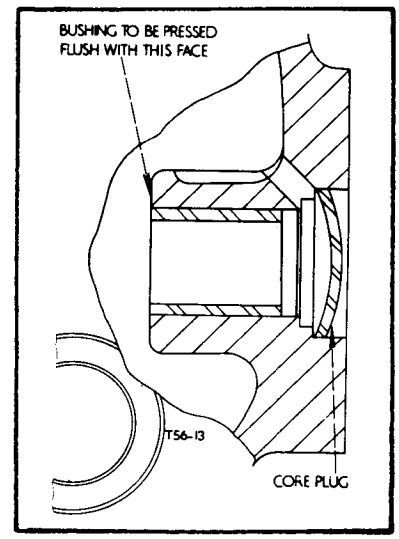


Fig. 5

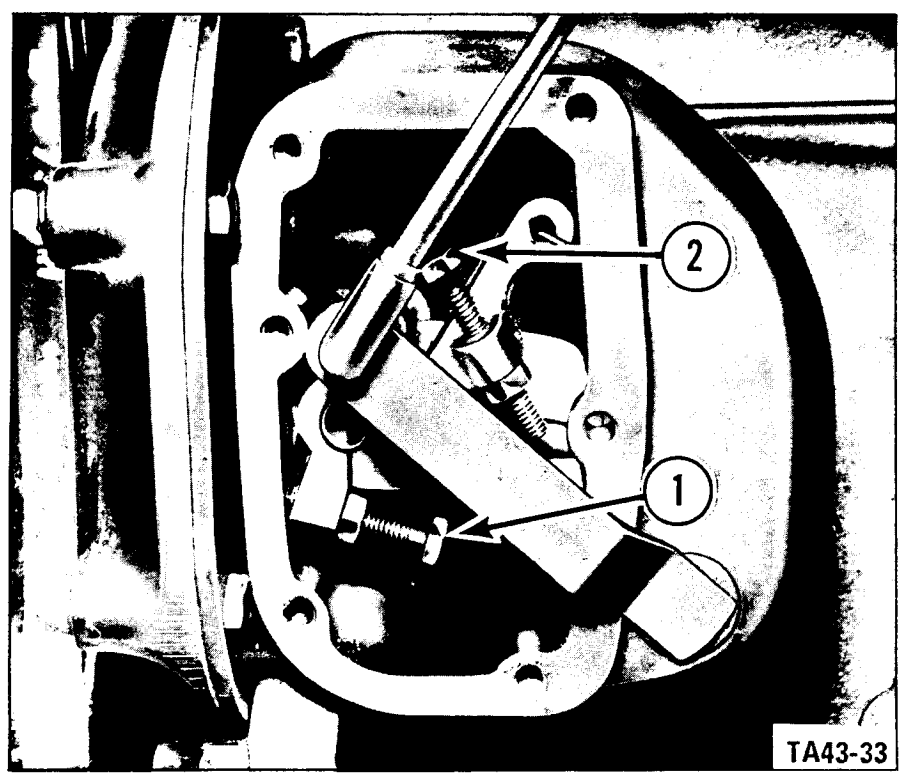


Fig. 6

2. HIGH IDLING SPEED STOP

(a) Remove the governor cover and gasket.

(b) Run the engine until it is at its correct operating temperature.

(c) Set the governor control lever in the fully open position.

(d) Slacken the locknut on the high idling speed stop screw (2-6).

(e) Use a tachometer or "Strobotorch" and adjust the stop until the specified rev/min reading is obtained.

(f) When the specified reading is obtained lock the stop screw then install the governor cover and gasket.

GROUP 9

CARBURETTOR

BC-144 Engine

1. DESCRIPTION

The carburettors are of the down-draught type. Their design incorporates an automatic stangler linked with the throttle to provide an enriched mixture for starting and a fast idle. 30VNN series carburettors are not fitted with an accelerating pump or economy device. 30VNP series carburettors are fitted with the accelerating pump but not the economy device. The fuel level is controlled by a lever type float mechanism acting on a needle valve. All jets are housed in a detachable emulsion block mounted in the float chamber.

1a. ADJUSTMENTS

There are three principal adjustments provided in these carburettors. They are:-

(1) The volume control screw (1-1) for the regulation of the slow running mixture.

(2) The throttle stop screw (2-1) to control the slow running.

(3) The strangler/throttle interconnection (6-1) to adjust the amount the throttle opens when the strangler (5-1) is closed for cold starting.

1b. OPERATION

The fuel inlet (1-2) is located at the top of the float chamber. From here, fuel passes into the float chamber via the needle seating where the flow is controlled by the needle (2-2) and the float (1-3). As the petrol level rises the float lifts and by means of the float lever (3-3) and needle, closes the needle seating when the correct level has been reached. When the engine is running, fuel is drawn from the float chamber, the float descends and more fuel flows through the needle seating so that the correct fuel level is automatically maintained while the carburettor is in operation.

The fuel then passes to the emulsion block (2-3) which houses the main, compensating and slow running jets (1, 2 & 5-4), together with the two calibrated ventilation plugs (4 & 6-4) which act as airbleeds to the slow running jet and capacity well respectively.

1c. COLD STARTING

Pulling out the strangler control (choke) operates the cam lever at the side of the carburettor and allows the spring loaded strangler flap to close. At the same time the interconnection rod between the cam lever and throttle spindle automatically cracks open the throttle sufficient to give a fast idle.

Immediately the engine fires the speed will build up, and the increased depression thus created will open the strangler flap admitting more air and consequently weakening the mixture.

1d. SLOW-RUNNING

When the throttle (6-2) is in the slow-running position the mixture is supplied by the slow-running jet (5-4) which obtains its fuel from the metered side of the main jet (1-4) through a calibrated restriction. This fuel is partly emulsified by air supplied by an air bleed hole in the air intake, and the resulting mixture is drawn down a vertical channel to the slow-running orifice which is controlled by the volume control screw (5-2). A secondary air bleed (6-4) is provided over the slow-running jet.

Adjustments for slow-running are made by the volume control screw (1-1) and the throttle stop screw (2-1). When screwed inward the throttle stop screw opens the throttle and increases the engine speed. When screwed outward it decreases the engine speed.

The quality of the slow-running mixture is controlled by the slow-running jet (5-4) and the slow-running air bleed (6-4).

The quantity of the slow-running mixture is controlled by the volume control screw (1-1). This is situated at the edge of the carburettor flange on the engine side of the throttle, and has a conical tip which permits a greater or less amount of mixture to be drawn in by the engine. The screw should be turned inward to weaken the mixture and turned outward to richen the mixture.

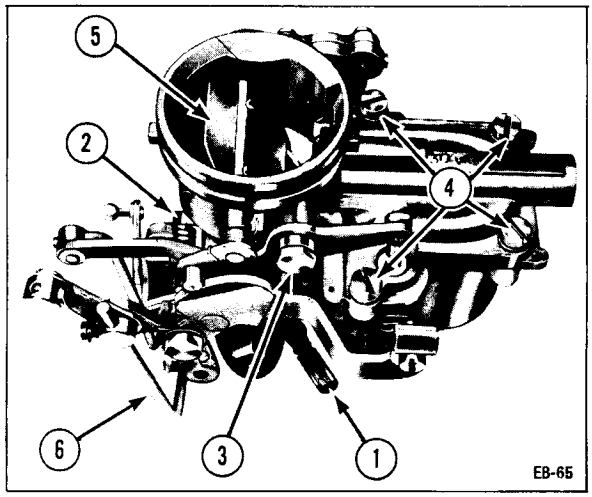


Fig. 1

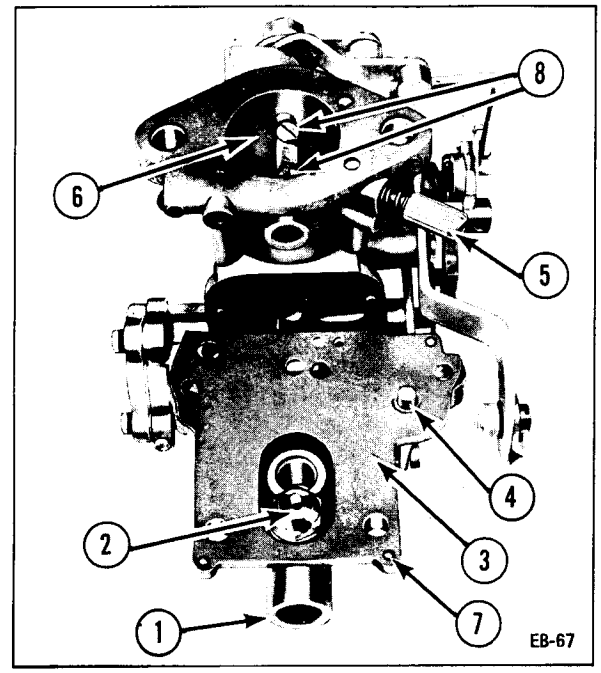


Fig. 2

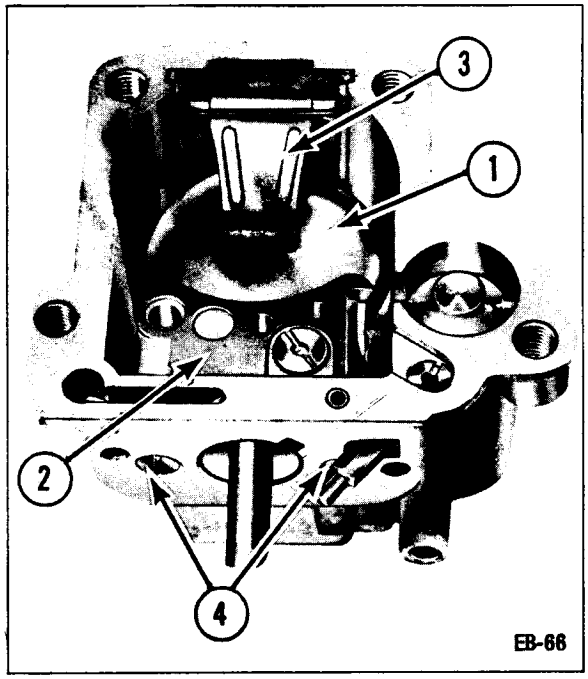


Fig. 3

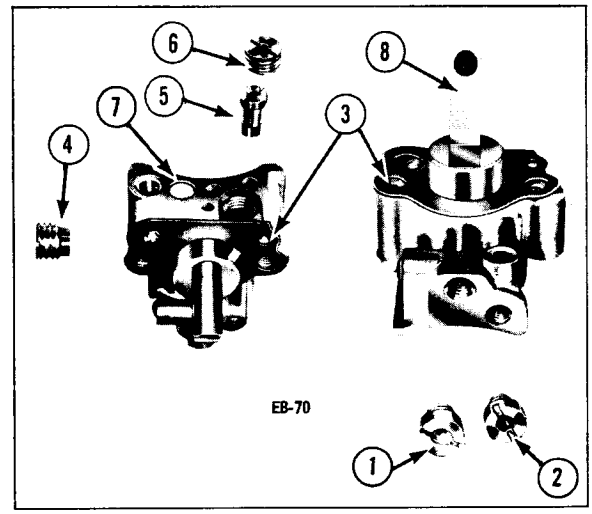


Fig. 4

Two small holes, known as progression holes, at the edge of the throttle communicate with the vertical channel leading down to the volume control screw. The purpose of these holes is to aid the transfer of the fuel supply at low throttle openings, and to furnish a smooth and progressive action during these periods. They are not adjustable and must not be tampered with.

As the throttle continues to open, the engine depression at the beak (8-4) of the emulsion block (7-4) will draw fuel from the capacity well and the channels above the main and compensating jets. At the same time air will be admitted by the air bleed. The resulting mixture will be drawn into the main jet channel, through the choke tube, past the throttle and into the inlet manifold.

Gradually, as the fuel level drops, a number of small holes in the side of the main jet channel will be exposed. These will admit more air, emulsifying the mixture which, when it arrives at the emulsion block beak will be still further atomised as it meets the stream of air being drawn through the choke tube.

1e. MAIN JET

The mixture at speeds above slow-running is provided by the main jet and the compensating jet. These jets feed simultaneously into the beak (8-4) which protrudes into the choke tube at its smallest diameter.

The main jet will influence power and speed. When the drilling or passage above the main jet is exhausted of fuel, the output will be related to the depression existing in the choke tube and in the main channel of the emulsion block.

1f. COMPENSATING JET

The output of the compensating jet is complementary to that of the main jet, both feeding into the main channel of the emulsion block. The head of the channel into which the compensating jet screws is ventilated to atmosphere by means of the main air bleed, while the fuel and air flow from the compensating jet is through the restriction near the base of the drilling in which the compensating jet screws. Thus, when fuel above the compensating jet is exhausted on acceleration, an emulsion of fuel and air will be drawn into the main channel of the emulsion block through this restriction.

The compensating jet will feed fuel at all times, other than slow-running to the main outlet of the emulsion block, thus any variation to the size of this jet will have an influence on mixture strength throughout the throttle range. It is the combined ouput of the main and compensating jets that provide the mixture strength to give the best performance of which the engine is capable.

Altering the size of the compensating jet will not have as great an influence on mixture strength as altering the size of the main jet.

1g. SLOW-RUNNING JET

This jet has a calibrated hole and meters the fuel to both the slow-running hole on the engine side of the throttle, and to the progression holes at the throttle edge. Half size slow-running jets are unnecessary as the volume control screw in the throttle barrel enables the mixture strength to be regulated to suit the engine.

1h. SLOW-RUNNING AIR BLEED

This bleed screws into the emulsion block immediately above the slow-running jet, and usually has a calibrated hole which determines the degree of ventilation to the slow-running jet. In some instances it is undrilled.

Fitting a larger air bleed will weaken the slow-running mixture by reducing the depression on the slow-running jet.

1i. MAIN AIR BLEED

This screws into the side of the emulsion block, and controls the ventilation to the compensating jet and also to the three small cross channels drilled into the main channe of the emulsion block, just above the main jet.

Increasing the ventilation by fitting a larger air bleed will weaken the mixture by reducing the depression on the main and compensating jets. By varying the size of the main air bleed it is possible to alter the mixture ratio between low and high speeds at part and full throttle openings.

Any alteration to the size of the main air bleed will affect the mixture strength over the whole speed range, but will have a greater effect at high speeds, when the depression in the waist of the choke tube is at its maximum.

1j. INTERCONNECTION FOR COLD STARTING

The degree of throttle opening when the strangler flap closes may be varied between certain limits. A rod secured by a screw in the strangler lever swivel enables this adjustment to be made.

1k. FUEL LEVEL

This is set at the factory 18mm down from the top of the float chamber at a pressure of 2-1/2 lb/in^2

It should be explained that this level is that which would result when the float chamber is in position on the carburettor, with the float arm holding the needle closed against the pressure of the fuel in the fuel line. When the float chamber is removed from the carburettor the level will drop due to the float rising when freed.

In these circumstances the fuel level should be 22.5mm below the top of the float chamber if the float is left in position. If the float is removed the level should fall to 33mm below the top of the float chamber.

Bending the float arm down will lower the level, bending it up will raise it. Variations to the thickness of the washer beneath the needle valve and seating will also alter the fuel level.

1l. NEEDLE VALVES AND SEATINGS

These are calibrated in millimetres, the size being stamped on one of the flats of the hexagon.

1m. ACCELERATING PUMP (30VNP ONLY)

The purpose of this is to prevent any hesitation in accelerating that might otherwise occur when a carburettor is adjusted to provide the leanest mixture at part throttle cruising. To obtain economical running at such speeds, a controlled and metered supply of fuel is required when the throttle is suddenly opened this is supplied by the accelerating pump.

When the pump piston (1-5) is at the top of its stroke, the cylinder is charged with fuel admitted from the float chamber through the check valve in the bottom of the pump well. Upon the throttle being opened the piston is forced down by the piston pin (4-2) and a stream of fuel is discharged from the pump discharge valve (5-5) through the horizontal pump jet (3-5) and into the air stream. The piston is returned to the charged position ready for the next stroke by the spring (2-5).

A calibrated hole called the pump leak is in the wall of the pump well in line with the pump jet. The purpose of the pump leak is to allow excess fuel to flow back into the float chamber at the same time as fuel as being discharged from the pump jet, this permits a reasonable size of pump jet to be used without making the amount of fuel discharged excessive.

1n. PUMP JET (30VNP ONLY)

This jet (3-5) meters the amount of fuel injected into the choke when the accelerating pump is operated.

2. ZENITH 30VNN and 30VNP CARBURETTORS

2a. REMOVAL

(a) Disconnect the fuel pipe at the carburettor.

(b) Disconnect the governor to throttle control rod at the carburettor.

(c) Remove the two nuts and washers securing the carburettor to the manifold then lift off the carburettor and gasket.

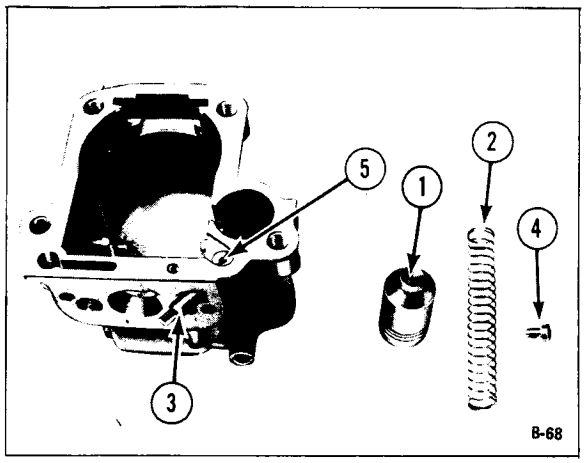


Fig. 5

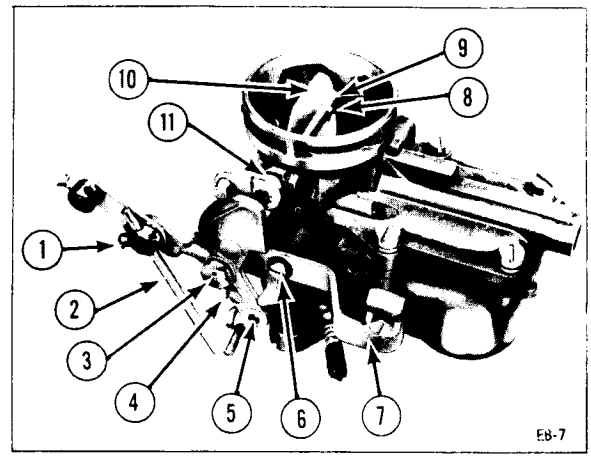


Fig. 6

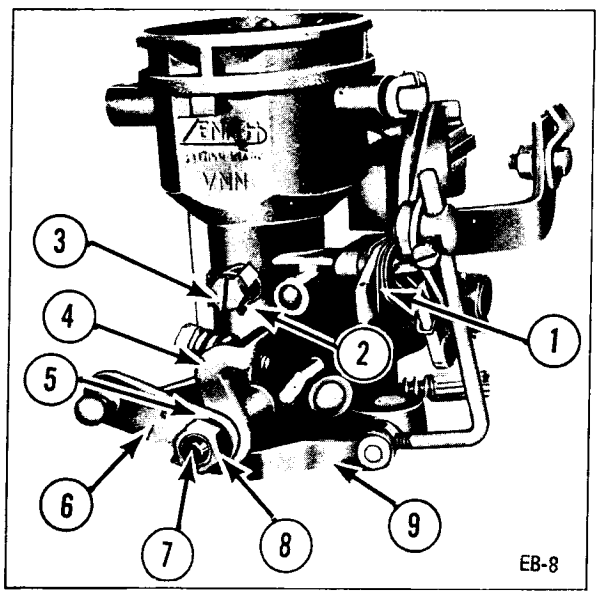


Fig. 7

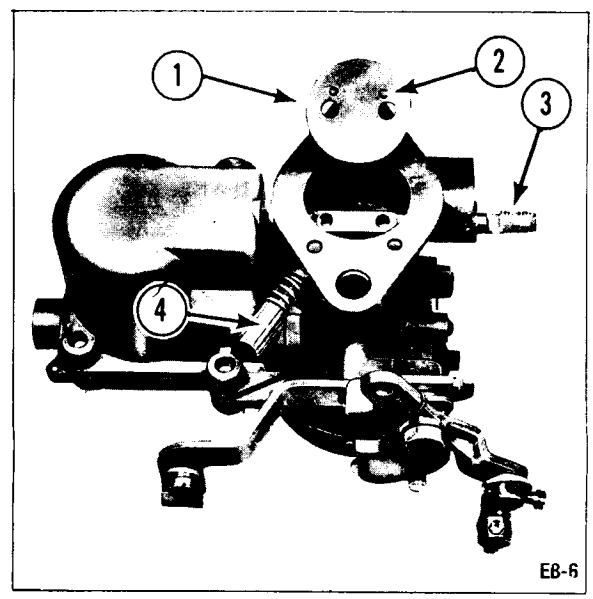


Fig. 8

2b. INSTALLATION

(a) Reverse the removal procedure using a new gasket.

3. FLOAT CHAMBER

3a. REMOVAL

(a) Remove the four screws and lock-washers (4-1) securing the float chamber.

(b) Withdraw the float chamber horizontally until the beak (8-4) clears the choke tube then remove the float chamber, and gasket.

3b. DISMANTLING

1. VNN SERIES

(a) Remove the float arm (3-3).

(b) Remove the float (1-3).

(c) Remove the two screws (4-3) then remove the emulsion block (2-3) and gasket (3-4) from the float chamber.

(d) Remove the main and compensating jets (1 & 2-4) from the emulsion block. The main jet has the larger thread diameter.

(e) Remove the slow-running air bleed (6-4) and slow-running jet (5-4) from the emulsion block.

(f) Remove the main air bleed (4-4) from the emulsion block.

(g) Remove the needle valve (2-2) from underneath the float chamber cover.

(h) Remove the drive screws.(7-2) from the float chamber cover using a screwing action then remove the gasket (3-2).

2. VNP SERIES

(a) Proceed as detailed in para.3b-1 ops. (a) to (h).

(b) Hold the piston in position against the spring pressure then remove the piston retaining screw (4-5).

(c) Remove the piston (1-5) and return spring (2-5).

(d) Remove the check valve from the bottom of the pump well.

(e) Remove the pump discharge valve (5-5).

(f) Remove the pump jet (3-5).

(g) Remove the pump pivot screw (3-1) and withdraw the piston rod.

3c. INSPECTION AND REPAIR

(a) Inspect all jets for wear. DO NOT use pieces of wire to clean the jets.

(b) Inspect the needle valve for correct seating.

(c) Check the float for leaks by shaking it. Replace if inspection proves it necessary.

(d) Inspect the accelerating pump piston and return spring for wear or damage.

3d. ASSEMBLY

(a) Reverse the dismantling procedure using new gaskets.

3e. INSTALLATION

(a) Reverse the removal procedure.

4. STRANGLER ASSEMBLY

4a. REMOVAL

(a) Loosen the screw (1-6) then remove the interconnection rod (2-6).

(b) Remove the strangler lever pivot screw (3-6).

(c) Disconnect the return spring (4-6) and remove the strangler lever (5-6).

(d) Remove the screw (6-6) and washer then remove the bracket (7-6).

(e) Remove the two screws (8-6) and remove the strangler flap (10-6) from the spindle (9-6).

(f) Partially withdraw the spindle (9-6) from the body and remove the spindle washer from the end of the spindle.

(g) Withdraw the spindle and remove the automaticity spring (11-6).

4b. INSTALLATION

(a) Insert the spindle into the body with the automaticity spring and spindle washer in position.

(b) Load the automaticity spring sufficiently to hold the strangler flap in the closed position when it is assembled.

(c) With the operating lever pointing away from the float chamber insert the strangler flap into the spindle with the large flat end downward.

(d) Allow the strangler to close and press on its smaller side to centralize the flap.

(e) Install two new screws (8-6) and peen the ends.

(f) Install the strangler control bracket and secure with the screw and washer.

(g) Install the return spring on the strangler lever and secure the lever with the pivot screw.

(h) Install the interconnection rod and tighten the screw (1-6).

5. THROTTLE

5a. REMOVAL

(a) Remove the nut (8-7) and shake-proof washer (5-7) from the spindle.

(b) Remove the throttle stop (4-7) and throttle lever (6-7).

(c) Remove the throttle spindle washer and interconnection lever (9-7).

(d) Remove the two screws (8-2) then remove the throttle (6-2) from the spindle.

(e) Withdraw the spindle (7-7) from the body.

5b. INSTALLATION

(a) Insert the spindle (3-8) into the body.

(b) Place the throttle (1-8) in position through the slot in the spindle. When assembling the throttle, the spindle should be positioned with the larger cut-out toward the volume control screw (4-8) and the throttle inserted with the indentations (2-8) toward the volume control screw.

(c) Turn the spindle and throttle to the fully closed position, then press down on the upper half of the throttle to centralize it.

(d) Secure the throttle with two new screws and peen the ends of the screws.

(e) Assemble the interconnection lever spindle washer, throttle stop and operating lever in that order then secure with the shakeproof washer and nut. Adjust as detailed in para.7.

6. CHOKE TUBE

6a. REMOVAL

(a) Remove the float chamber as detailed in para.3a.

(b) Remove the strangler assembly as detailed in para.4a.

(c) Bend back the tabs on the lock-washer (2-7) then remove the screw (3-7).

(d) Withdraw the choke tube through the top of the body.

6b. INSTALLATION

(a) Install the choke tube with the slot to the float chamber.

(b) Use a new tab washer and insert the screw. DO NOT TIGHTEN the screw.

(c) Install the strangler assembly as detailed in para.4b.

(d) Install the float chamber as detailed in para.3e.

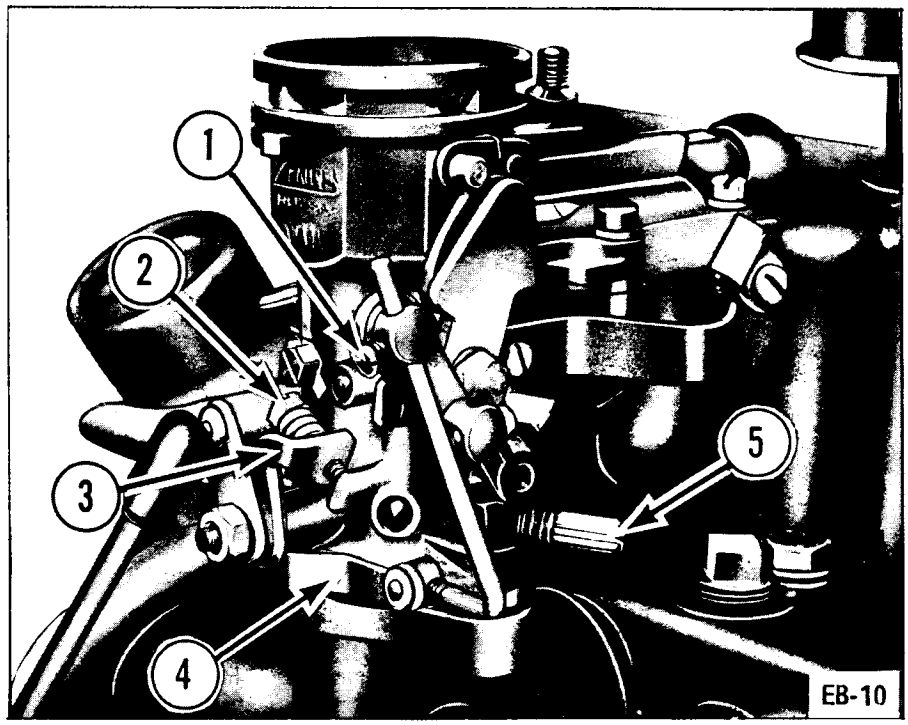


Fig. 9

(e) Using a short length of wire, hooked at one end, pull the choke tube upward then tighten the screw and bend up the locking tabs.

7. ADJUSTMENTS

7a. STRANGLER-THROTTLE INTERCONNECTION

(a) Slacken the locking screw (1-9).

(b) Close the strangler.

(c) Adjust the throttle stop screw (2-9) until there is a clearance of 0.8 to 1.00 mm gauged at the edge of the throttle flap on the slow-running side.

(d) When the clearance is correct tighten the locking screw (1-9).

7b. SLOW-RUNNING

(a) Start the engine, allow it to reach normal operating temperature then close the throttle.

(b) Adjust the throttle stop screw to give a slight increase in slow-running speed.

(c) Adjust the volume control screw (5-9) to give the smoothest slow-running with the fastest speed.

(d) Adjust the throttle stop screw to give the specified slow-running speed (low idle).

7c. GOVERNOR TO THROTTLE CONTROL ROD

(a) Set the throttle stop screw (2-9) four full turns from the fully closed throttle position.

(b) Fit one end of the rod to the throttle lever.

(c) Hold the throttle lever against the stop, start the engine and adjust the free end of the rod to fit the ball on the governor control lever when the lever is in its "idle" position (weights fully open).

GROUP 10

L. P. G. ATTACHMENT

BC-144 Engine

10

Issued 5/69

1. DESCRIPTION

The L.P.G. attachment consists of four basic units:-

(a) Fuel storage cylinder.

(b) Fuel filter and lock-off valve.

(c) Vapouriser regulator.

(d) Carburettor.

WARNING: BEFORE REMOVING ANY PART OF THE L.P.G. SYSTEM OTHER THAN THE STORAGE CYLINDER IT IS ABSOLUTELY ESSENTIAL THAT ALL LIQUID OR VAPOURISED FUEL IS EXPELLED FROM THE SYSTEM.

TO DO THIS CLOSE THE MAIN SUPPLY VALVE AT THE STORAGE CYLINDER AND START THE ENGINE. IF THE ENGINE WILL NOT START, DISCONNECT THE FUEL FEED AT THE CARBURETTOR AND WITH THE IGNITION SWITCHED ON, PRESS THE PIN ON THE PRIMING SOLENOID, AND ALLOW FUEL TO FLOW ALONG THE CARBURETTOR FEED PIPE AND OUT TO ATMOSPHERE.

(a) FUEL STORAGE CYLINDER

This is used to store fuel in a liquefied form, under pressure. The fuel will remain as a liquid until the pressure is released and its temperature increased.

Fuel feed is via a shut-off valve and self-sealing coupling. A gauge adjacent to the shut-off valve indicates the amount of fuel in the tank.

For instructions on changing the tank refer to the relevant machine Operator's Manual.

(b) FUEL FILTER AND LOCK-OFF VALVE

The filter element is contained in a bowl, through which the liquid flows. Inpurities and deposits are trapped in the element.

The-lock-off valve is solenoid operated, and is in the closed position until energised by switching on the ignition circuit. This obviates the need to close the main fuel valve at the storage cylinder whenever the engine is stopped.

(c) VAPOURISER REGULATOR

Fuel flows as a liquid under pressure from the filter and lock-off valve into the first stage of the vapouriser regulator, where the pressure is released, and the temperature rises to the existing atmospheric temperature At this stage the liquid is beginning to vapourise. The fuel then passes through a heated tube which ensures total vapourisation. The heat necessary for this operation is supplied by the engine cooling system. From here the fuel passes to the second stage regulator and thence to the carburettor in quantities which are decided by the demands of the engine.

(d) CARBURETTOR

The carburettor is a device which mixes air and fuel in the correct quantities. When the throttle is opened, manifold depression increases, thus drawing in larger quantities of air at a greater speed. Fuel feed is to a jet which is located in the side of the venturi. As the air speed and volume increases, the suction at the jet also increases, thus drawing in more fuel.

At idling speed (when the throttle is closed) a duct allows fuel to by-pass the jet and the throttle butterfly thus maintaining a fuel supply to the engine.

2. FUEL FILTER AND LOCK OFF VALVE

2a. REMOVAL

(a) Close the main fuel feed valve at the cylinder.

(b) Expel all fuel from the system (as previously described).

(c) Disconnect the electrical supply at the snap connector.

(d) Remove the fuel feed and outlet connections.

(e) Remove the two nuts and bolts which secure the unit to the frame.

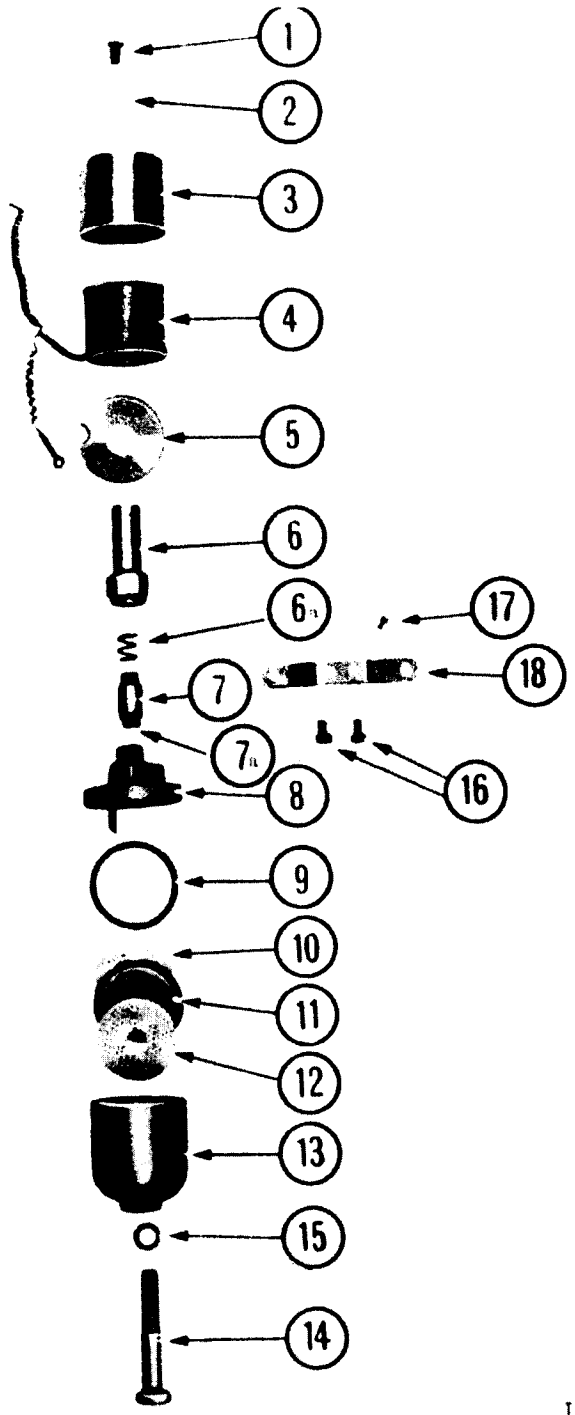


Fig.1.

2b. DISMANTLING

1. LOCK-OFF VALVE

(a) Remove the screw (1-1) and its washer (2-1).

(b) Lift off the cover (3-1).

(c) Disconnect the earth connection by removing the screw (17-1).

(d) Lift off the solenoid coil (4-1) and aluminium disc (5-1).

(e) Remove the two screws (16-1) which secure the mounting bracket (18-1).

(f) Using two spanners, slacken the sleeve (6-1) in the body (8-1).

(g) Turn the body upside down, and screw out the sleeve (6-1) which will contain the valve core (7-1) and spring (6a - 1).

2. FILTER

(a) Remove the bolt (14-1) and its "O" ring (15-1).

(b) Separate the bowl (13-1) from the main body (8-1).

(c) Remove the "O" ring (9-1) from its groove in the main body (8-1).

(d) Remove the filter element which consists of 2 perforated discs (10 & 12-1) and one felt disc (11-1)

2c. INSPECTION AND REPAIR

(a) When testing the solenoid coil (4-1), energy consumption should be 25 watts.

(b) Clean the felt disc (11-1) by shaking out dust particles.

(c) Blow dust from the perforated discs (10 & 12-1) with compressed air.

(d) Examine the valve pad (7a-1). If damaged change the assembly.

2d. ASSEMBLY

Reverse the dismantling procedure, after ensuring that all items are perfectly clean.

2e. INSTALLATION

Reverse the removal procedure. Ensure that fuel flow through the unit is in the direction indicated by the arrow.

3. VAPOURISER REGULATOR

3a. REMOVAL

(a) Close the fuel shut-off valve at the storage cylinder.

(b) Expel all fuel from the system (as previously described).

(c) Drain the engine cooling system.

(d) Disconnect the water inlet and outlet pipes.

(e) Disconnect the fuel feed and outlet pipes.

(f) Disconnect the electrical supply at the snap connector.

(g) Remove the nut which secures the unit to the frame.

3b. DISMANTLING

NOTE: Prior to dismantling a vapouriser regulator which is suspected of being faulty, it should be tested in accordance with the instructions contained in para.3f of this group

1. SECOND STAGE REGULATOR

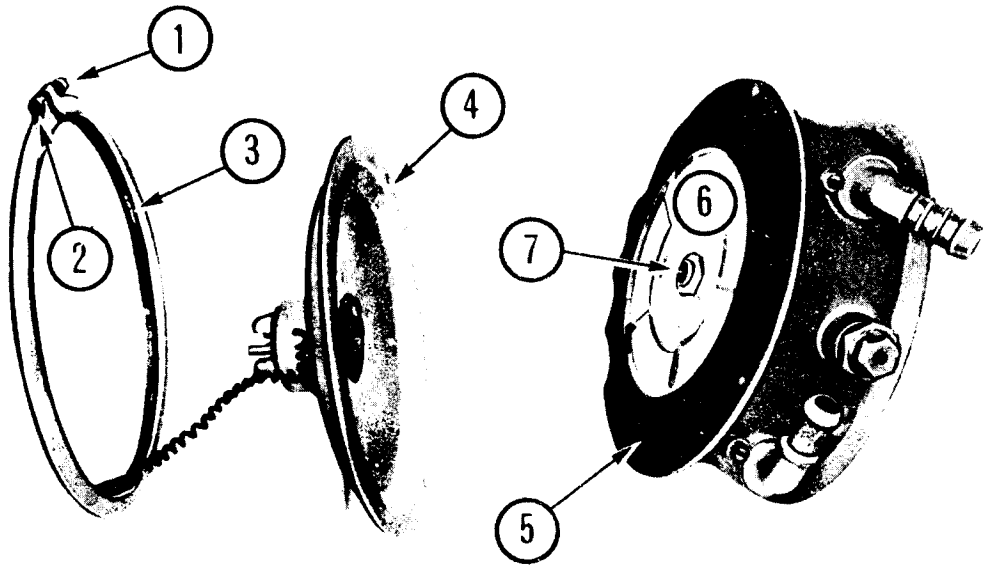
(a) Remove the nut (1-2) and socket headed screw (2-2).

(b) Remove the clamping ring (3-2).

(c) Lift off the cover (4-2).

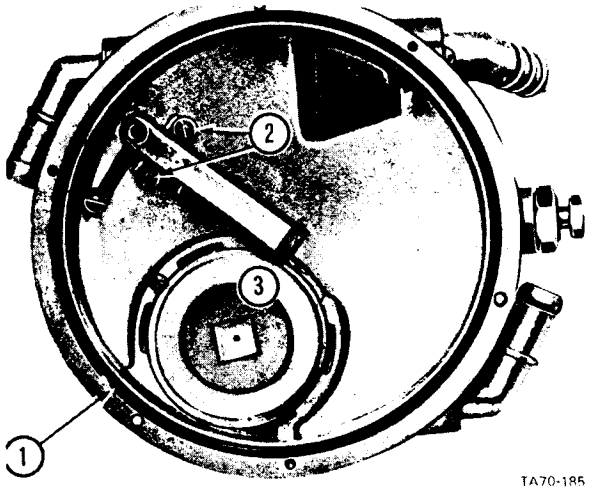
(d) Lift off the second stage diaphragm (5-2) complete with its stiffening plates (6-2).

(e) Lift the "O" ring (1-3) from its groove.



TA70-184

Fig.2.



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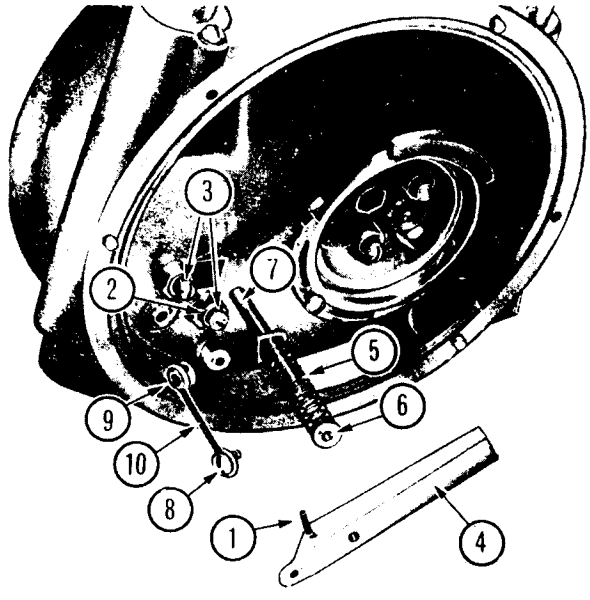

TA70-186

Fig.4.

(f) Slacken the two screws (2-3) and ease the fulcrum pin (1-4) from the groove (2-4) under the washers (3-4), while gently pushing down on the lever (4-4) in order to retain the spring (5-4).

(g) Ease off the lever (4-4) and spring locating button (6-4).

(h) Remove the spring (5-4) and adjusting rod (7-4).

(i) Remove the screw (8-4) and lift off the valve pad (9-4) complete with its sprung lever (10-4).

(j) If inspection proves necessary, dismantle the diaphragm by removing the nut (7-2) and lifting the outer stiffening plate (6-2) and diaphragm (5-2) from the bolt, leaving the inner stiffening plate in position.

2. FIRST STAGE REGULATOR

Access to the first stage regulator is through the second stage regulator chamber.

(a) Proceed as in para.3b, sub para 1 operations (a) to (e)

(b) Using a 1/2" drive in the square provided, unscrew the cover plate (3-3). This is under spring tension.

(c) As the cover plate is removed, the aluminium disc (1-5) and spring (2-5) will fall out.

(d) Lift out the anti-friction ring (3-5).

(e) Remove the nut (4-5), upper diaphragm plate (5-5), diaphragm (6-5) and lower diaphragm plate (1-6).

(f) Remove the screws (2-6) and their washers.

(g) Lift out the regulator lever (2-7) complete with its fulcrum pin (1-7) and valve pad assembly (3-7).

(h) Remove the rubber washer (4-6) from the diaphragm stud.

3. VAPOURISER

(a) Wind the spring (1-8) over the head of the adjusting button (2-8).

(b) Slacken the grub screw on the adjusting button spindle and lift off the button (2-8).

(c) Remove the nut (3-8) and socket headed screw (4-8).

(d) Lift off the clamping ring (5-8), cover (6-8) and sealing diaphragm (1-9) to expose the heat chamber.

(e) The secondary vapouriser pipe (2-9) must be removed first by inserting a fine screwdriver under the point where the pipe bosses (3 & 4-9) meet the case, and gently and evenly levering out the bosses, complete with "O" rings (4 & 5-10).

(f) Remove the locknut (5-9), and using a spanner on the flats provided, unscrew the union, (1-10) complete with its "O" rings (2 & 3-10). This will free the feed end of the primary vapouriser pipe (8-10).

(g) Lift out the other end of the pipe by inserting a fine screwdriver under the point where the boss (6-9) meets the housing and gently levering out. The pipe will come away complete with its "O" ring (6-10).

4. PRIMING SOLENOID

(a) Remove the end cover which houses the priming solenoid. Refer to para. 3b sub. para 1 operations (a) to (e)

(b) Remove the retainer clip (1-11) by pressing down on the projections and rotating the clip until it is clear of the case.

(c) Remove the sleeve (2-11), spring (3-11) and solenoid core (4-11) complete with priming pin (5-11).

(d) Disconnect the earth lead.

(e) Turn over the cover and the solenoid coil (6-11) will fall from the housing

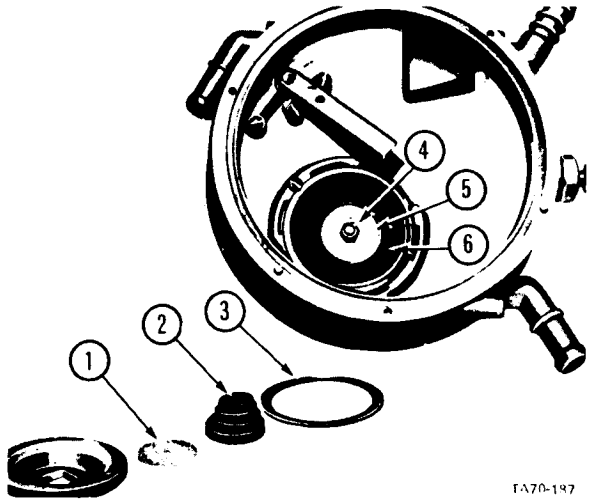

Fig.5.

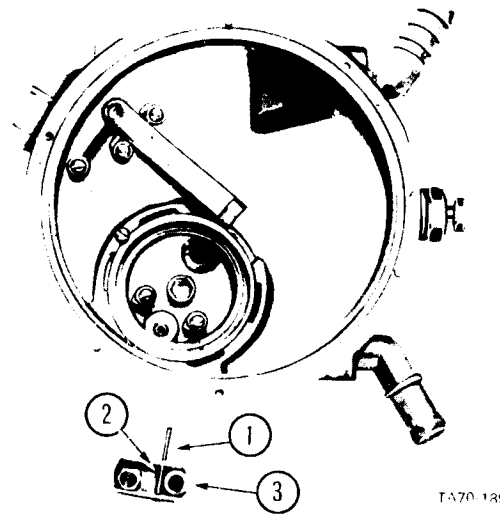

Fig.7.

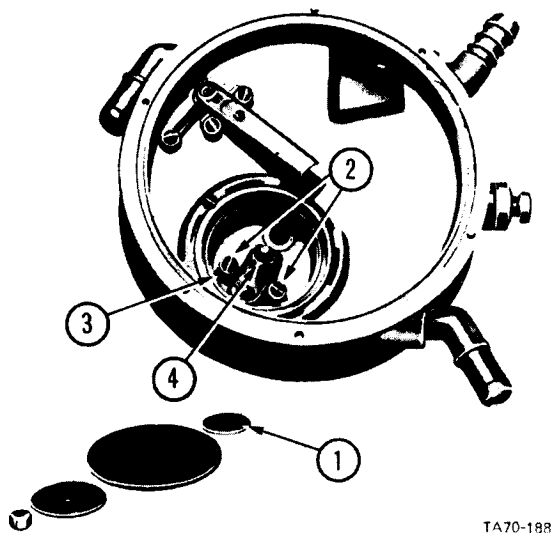

Fig.6.

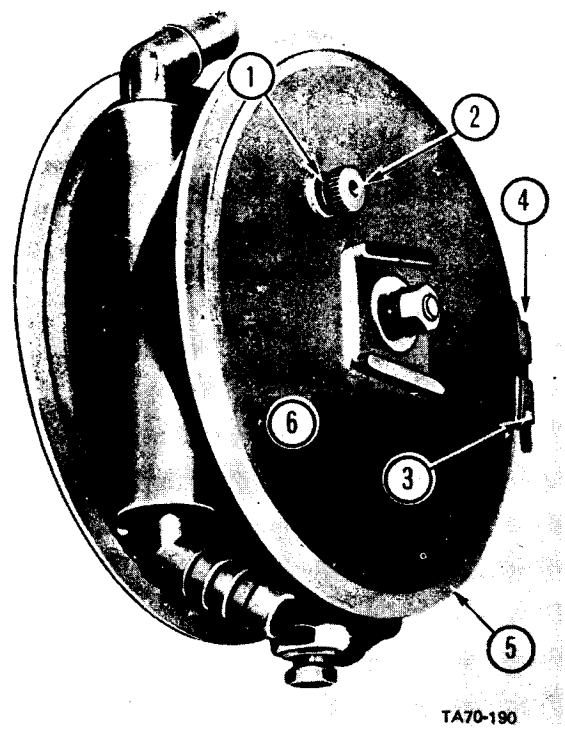

Fig.8.

3c. INSPECTION AND REPAIR

(a) The second stage valve pad must be changed whenever the screw (8-4) has been removed or even slackened.

(b) Inspect the first stage valve pad (3-7) for damage.

NOTE: Change the valve pads by levering from their housings, using a pin or sharp pointed knife.

(c) Inspect the valve seats (7 & 9-10). These must be clean and free from damage. The openings must have no sharp edges. If faulty the vapouriser pipes must be changed

(d) Inspect the diaphragms (5-2) and (6-5) for punctures.

(e) Inspect the lever fulcrum pins (1-4) and (1-7) for wear and distortion.

(f) A faulty solenoid will be self evident before removing the vapouriser from the machine. Under normal circumstances, the solenoid will be heard to click open when the priming button on the instrument panel is pressed. Before rejecting a solenoid coil, ensure that the core moves freely in the coil and that the spring is intact.

(g) Inspect all 'O' rings for damage. Do not remove small 'O' rings from their grooves, unless they are to be changed. Apply a light smear of petroleum jelly to the 'O' rings to facilitate assembly.

(h) Ensure that the "O" ring housings are free from burrs and damage.

(i) Inspect the vapouriser chamber sealing diaphragm (1-9) for punctures.

3d. ASSEMBLY

Ensure that all components are perfectly clean and reverse the dismantling procedure. The second stage diaphragm (5-2) and cover (4-2) can only be fitted in one position due to the uneven spacing of the locating dowels.

3e. INSTALLATION

Reverse the removal procedure and SLOWLY TURN ON THE FUEL SUPPLY.

3f. ADJUSTMENTS

1. VAPOURISER REGULATOR

This unit should be tested and adjusted, using compressed air at a pressure of not less than 40 lb/in^2 as the operating medium. If a compressed air supply is not available, it can be done on the engine, provided the water in the heat chamber is hot.

(a) Apply the air supply to the gas feed union. If checking on the engine, turn on the fuel supply, and open the lock-off valve by switching on the ignition. Ensure that the engine will not start by disconnecting the S W lead at the ignition coil.

(b) Apply a detergent bubble to the gas outlet pipe.

(c) Turn the adjusting screw (2-8) anti-clockwise until the detergent bubble begins to expand.

(d) Turn the adjusting screw clockwise until expansion of the detergent bubble ceases.

(e) Press the solenoid priming pin and allow gas or air to flow through the regulator.

(f) Release the priming pin. Gas or air should stop flowing. (Check with detergent bubble).

(g) If gas or air still flows after operation (f), turn the adjusting screw fully clockwise and repeat ops (c), (d), (e) and (f).

2. SOLENOID PRIMING PIN

(a) Lightly press the priming pin (1-12) until it contacts the diaphragm centre bolt. Free movement of the pin should be 1/16" to 3/32" before contacting the centre bolt.

(b) Screw the pin clockwise to reduce free movement and anti-clockwise to increase free movement.

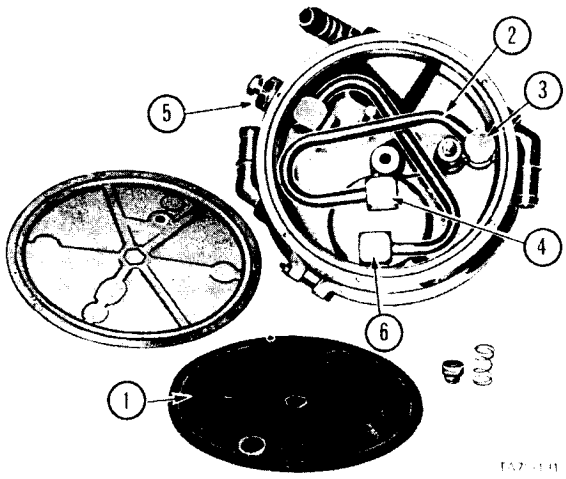

Fig.9.

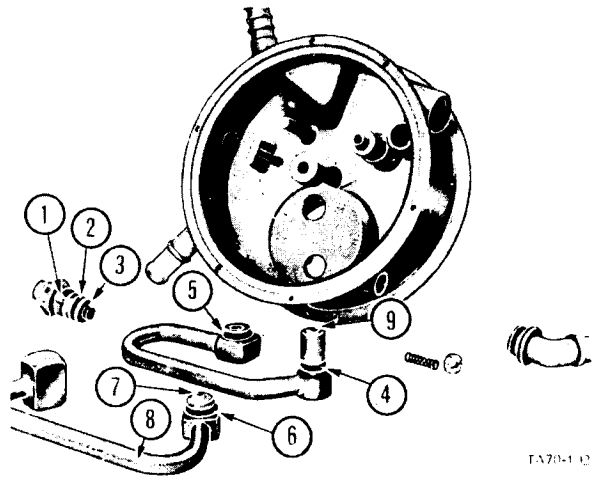

Fig.10.

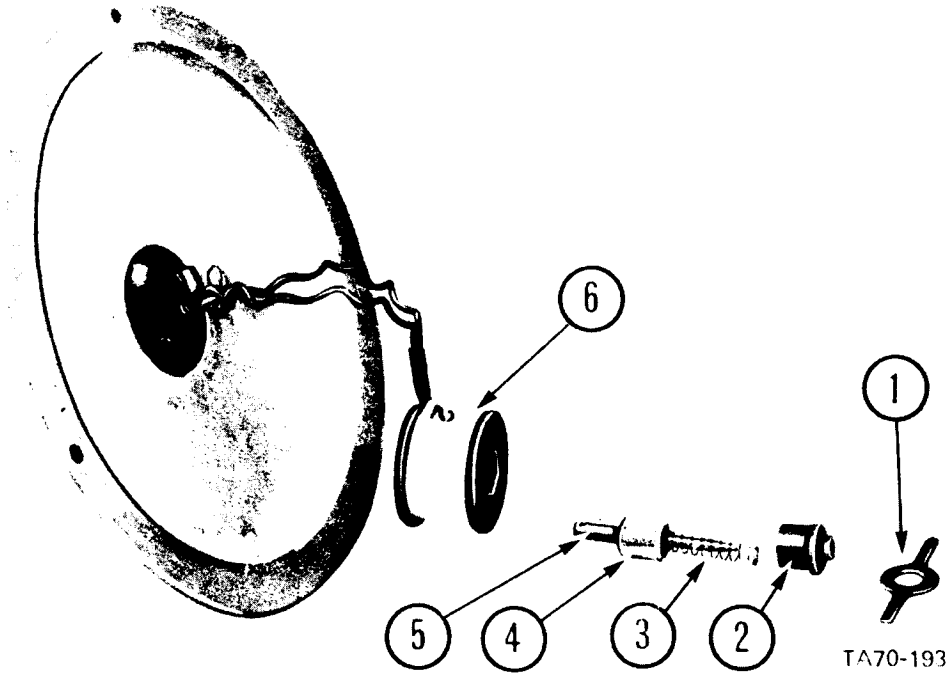

Fig.11.

(c) There should then be 1/8" more movement after the pin contacts the diaphragm centre bolt.

4. CARBURETTOR

4a. REMOVAL

(a) Close the main fuel feed valve at the storage cylinder.

(b) Expel all fuel from the system as previously detailed.

(c) Disconnect the governor control rod at the carburettor.

(d) Slacken the two hose clips on the aircleaner connection and slide the rubber hose upward until it is clear of the carburettor venturi.

(e) Disconnect the fuel feed pipe.

(f) Remove the two nuts and washers which secure the carburettor to the manifold.

(g) Lift off the carburettor and gasket.

4b. DISMANTLING

(a) Remove the four screws (2-13) which secure the fuel feed block to the body (1-13). This will expose the jet.

(b) If inspection proves necessary, unscrew the jet from the body.

(c) Remove the four screws (3-13) which secure the throttle butterfly housing (4-13) to the main body (1-13).

(d) If inspection proves it necessary remove the throttle spindle by removing the two screws which secure the butterfly plate (5-13) to the spindle and sliding out the plate, removing the spindle nut (6-13) and lifting off the plates, noting the hole in the govenor plate (7-13) in which the peg on the low idle stop plate (8-13) engages, then withdrawing the spindle from the body, complete with the nut at the opposite end of the spindle

4c. INSPECTION AND REPAIR

(a) Inspect the jet for wear.

(b) Check the throttle spindle for slackness in the body.

(c) Check the mounting flange for distortion, either by placing a steel rule across its longest length, or by placing on a surface table and checking with feeler gauges. Correct any warping by rubbing on a sheet of fine emery cloth on a surface table, or by filing with a smooth file. Thoroughly clean after this operation.

(d) Ensure that the slow running feed passages are clear.

4d. ASSEMBLY

Reverse the dismantling procedure.

4e. INSTALLATION

Using a new gasket, reverse the removal procedure. SLOWLY TURN ON THE FUEL SUPPLY.

4f. ADJUSTMENTS

(a) Start the engine and warm up to normal operating temperature.

(b) Adjust the slow running screw (9-13) so that the engine runs as slowly as possible.

(c) Adjust the volume control screw (10-13) until the engine increases speed and runs evenly.

(d) Reduce the speed with the slow running screw (9-13) and repeat op. (c)

(e) Finally adjust the slow running screw until the engine speed is within the range 500 to 525 rev/min.

NOTE: It is essential that these adjustments are made with the aircleaner fitted.

Fig.12.

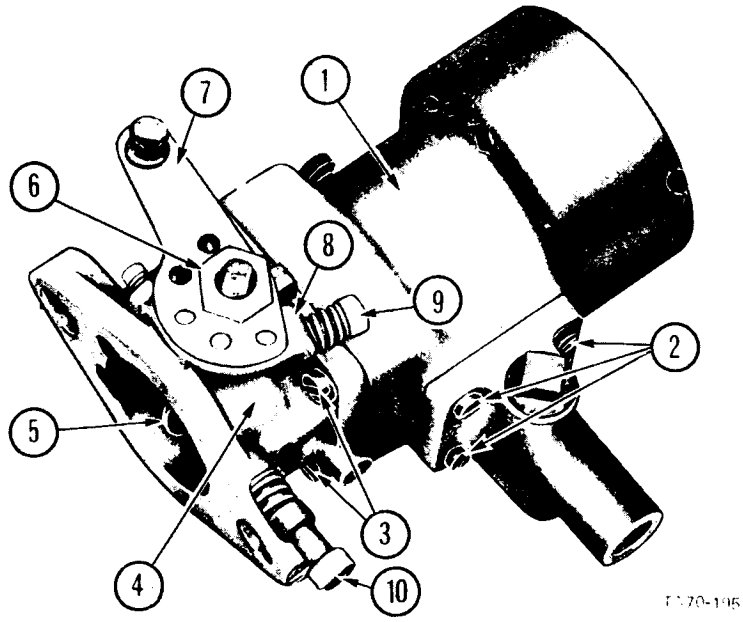

Fig.13.

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