

UNIVERSAL ATOMIC DIESEL

MODEL 20 5416 (16 H.P.)

PARTS MANUAL



Universal Motors

This copy of the Universal Motors Owners Manual has been re-created using images computer scanned from a manual rather than original artwork

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WHEN ORDERING PARTS, SPECIFY MODEL AND SERIAL NUMBER OF ENGINE.

This information is absolutely essential for the correct execution of your order. We do not hold ourselves responsible for errors or delays where this is lacking.

SERIAL NUMBER LOCATIONS

Stamped on upper left hand corner of block - ignition side - facing flywheel end (front of engine).

Stamped in block directly above flywheel housing, under front oil filler.

On engine nameplate located on reverse gear housing cover.

On engine nameplate located on engine manifold.

RETURNED PARTS

Parts may be returned for credit subject to authorization by the factory, factory inspection and acceptance upon receipt, and a 15% Re-Stocking charge.

A return goods authorization number must be requested from the factory prior to returning the parts.

All return shipments must be fully PREPAID and clearly marked with shipper's name and address.

LOSS OR DAMAGE IN TRANSIT

Our responsibility ceases upon delivery of shipments to the common carrier. Any claims for loss or damage in transit must be filed with the transportation company.

SHORTAGE CLAIMS

All claims for shortage must be filed within ten (10) days after receipt of

shipment and must be accompanied by packing list.

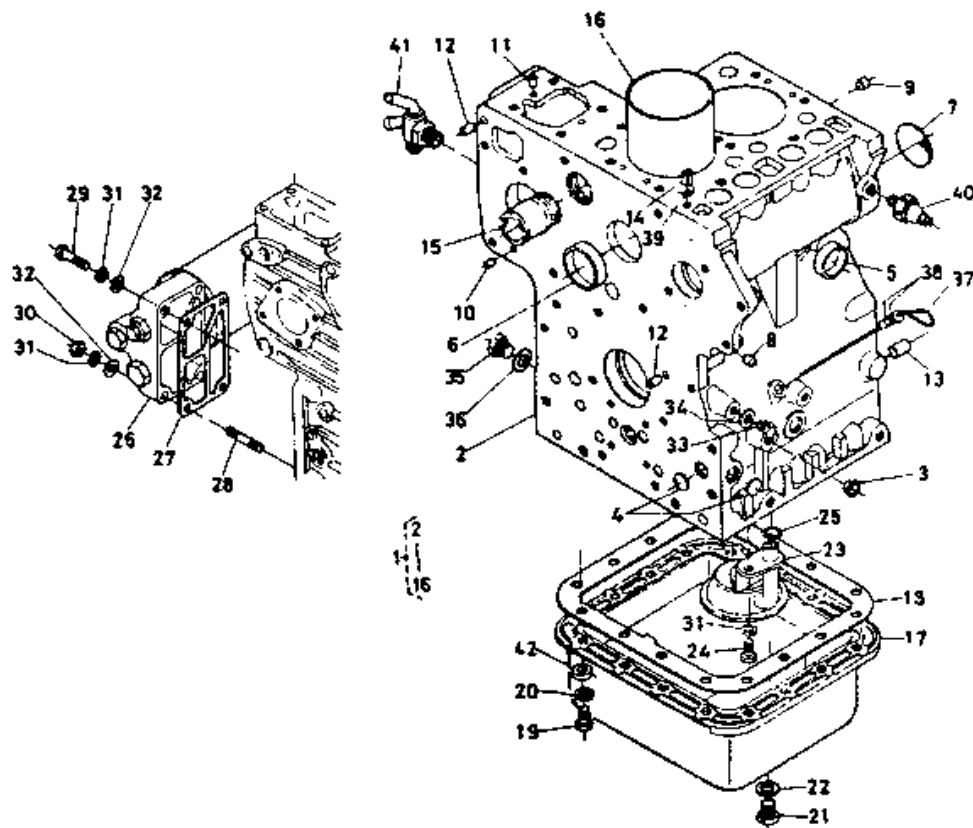
ALL ORDERS FOR REPAIR PARTS MUST BE PLACED THROUGH OUR DISTRIBUTOR/DEALER IN YOUR AREA.

MEDALIST - UNIVERSAL MOTORS
P.O. BOX 2508
OSHKOSH, WI 54903

(414)231-4100 Cable UNIMOT

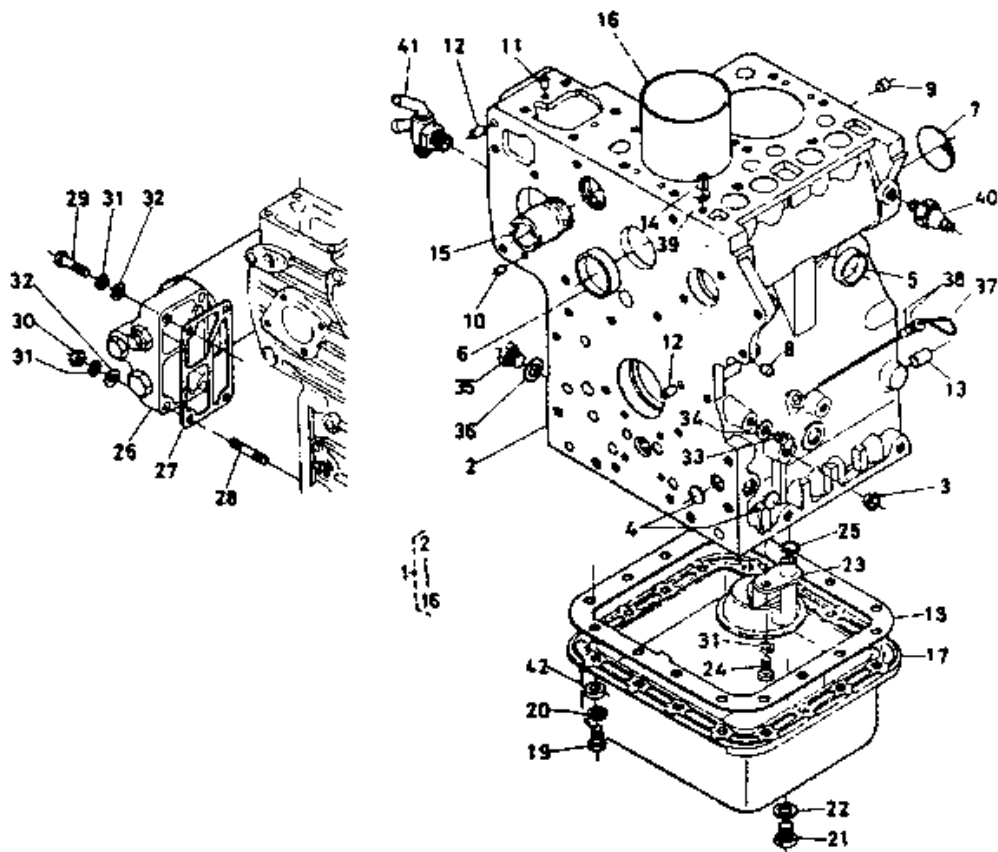
ATTENTION - SERVICE DEPT.

CRANKCASE GROUP



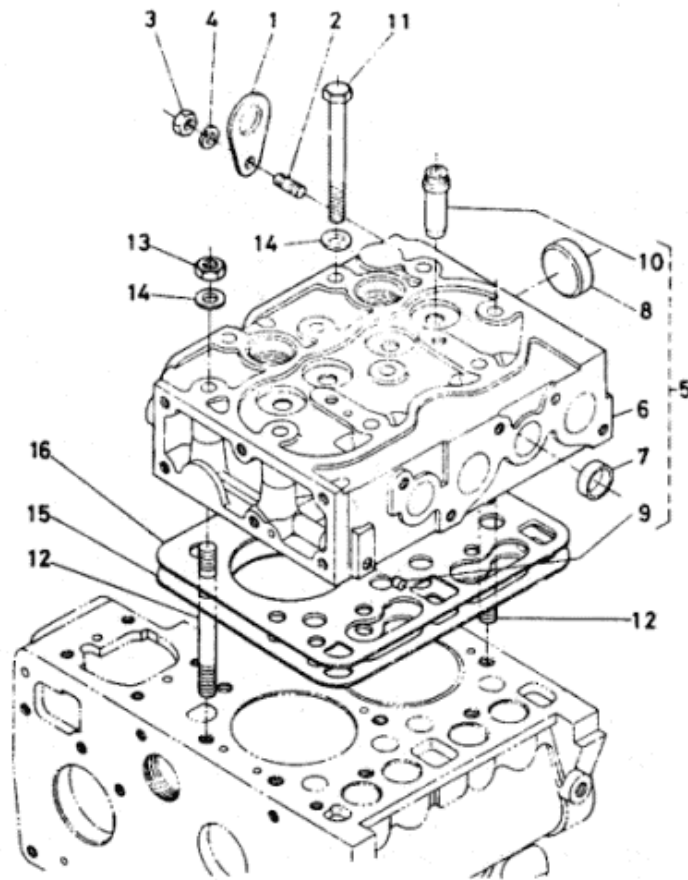
ITEM	PART NO.	DESCRIPTION	UNIT
1	248650	Crankcase Assembly	1
2		Crankcase	1
3		Plug	6
4		Plug, Expansion	3
5		Cap, Sealing	3
6		Cap, Sealing	2
7		Plug, Expansion	1
8		Plug, Pin	4
9		Plug, Pin	1
10		Pin, Straight	2
11		Pin, Straight	2
12		Pin, Straight	2
13		Pin, Straight	1
14		Pin, Pipe	1
15		Pin, Water	1
16	298856	Liner, Cylinder	2
17	298651	Oil Pan	1
18	298652	Oil Pan Gasket	1
19		Bolt	16
20		Washer, Spring	16
21	298653	Plug	1

CRANKCASE GROUP



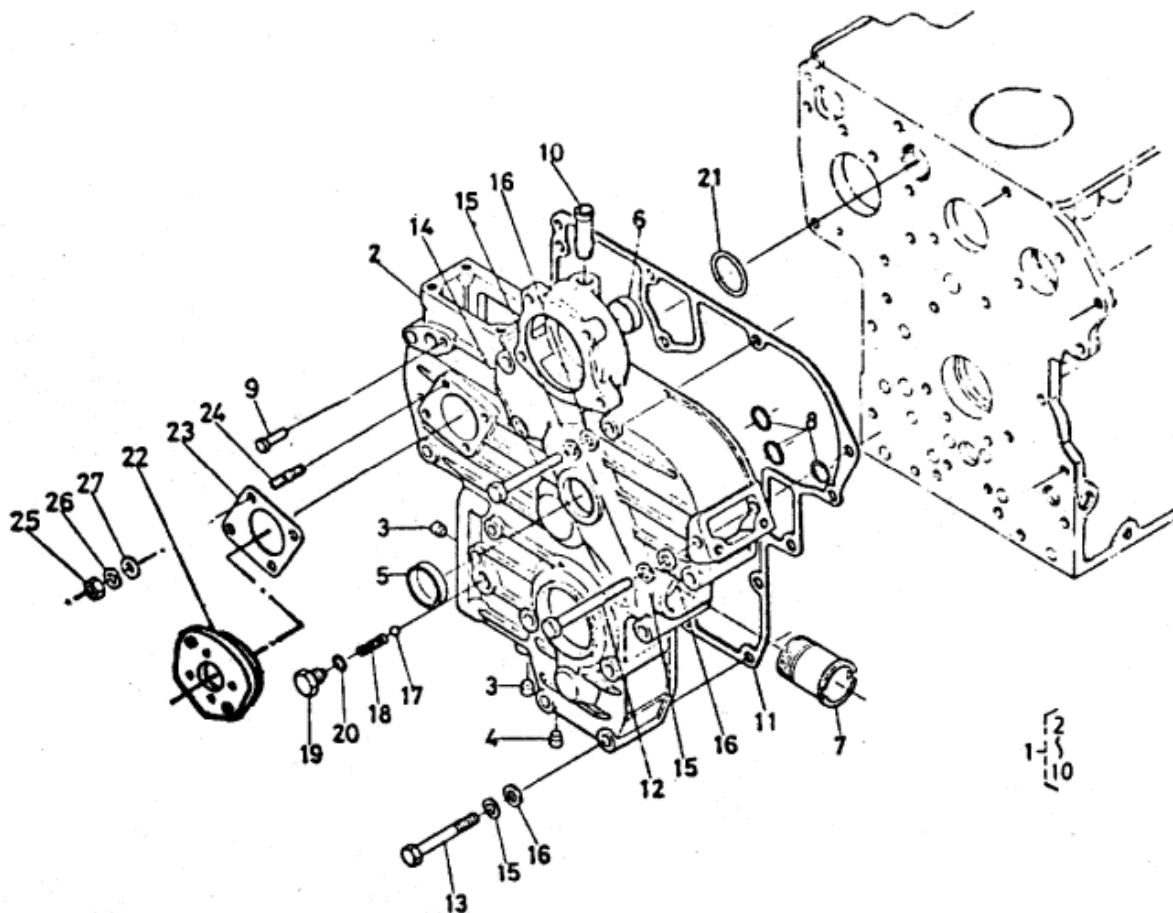
ITEM	PART NO.	DESCRIPTION	UNIT
22	298654	Gasket	1
23	248655	Oil Filter	1
24		Bolt	1
25	298657	O Ring	1
26	298656	Oil Filter Assembly	1
27		Gasket	1
28		Stud	1
29		Bolt	3
30		Nut	1
31		Washer, Spring	5
32		Washer, Plain	4
33	298658	Plug	1
34	298659	Gasket	1
35	298660	Plug	1
36		Gasket	1
37	298661	Dipstick	1
38	298662	O Ring	2
39	298665	O Ring	1
40	298663	Switch, Oil	1
41	298664	Cock, Drain	1
42		Washer, Plain	16

CYLINDER HEAD GROUP



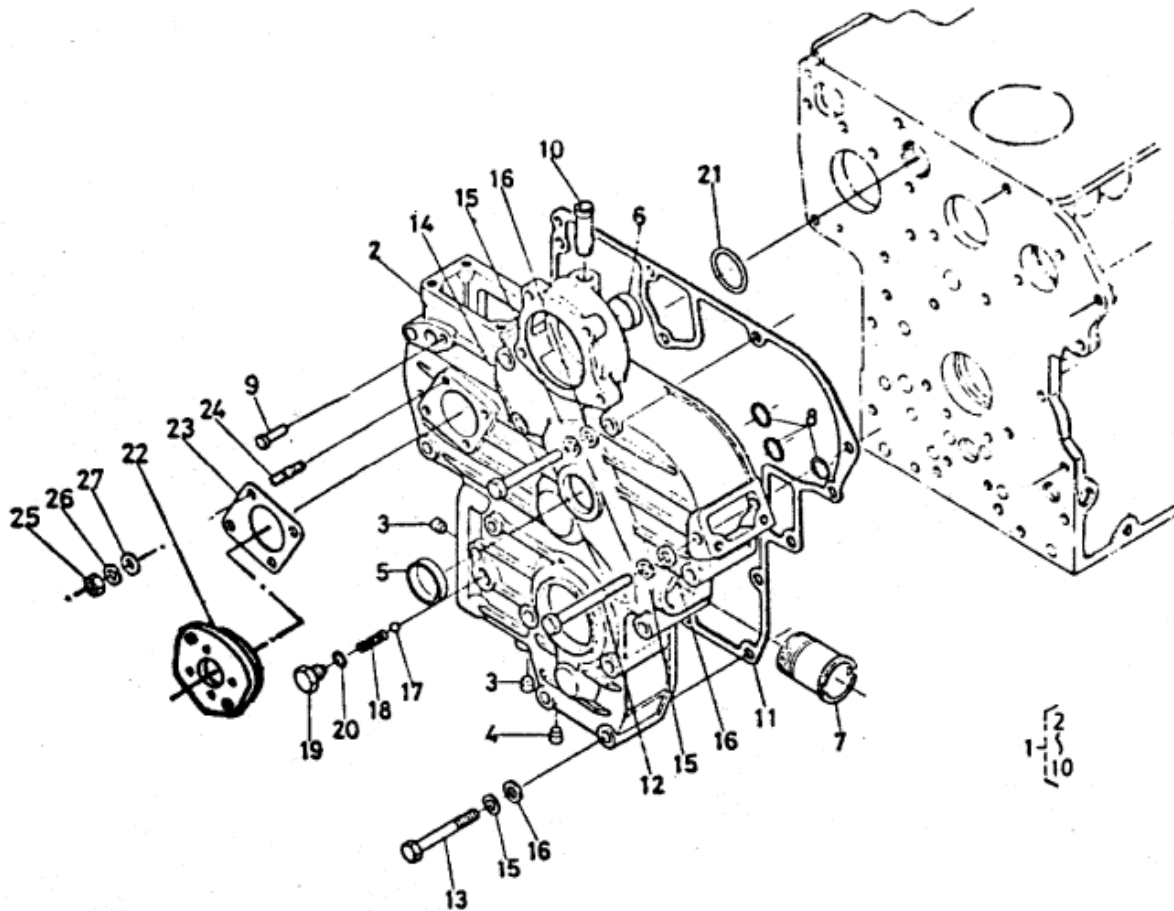
ITEM	PART NO.	DESCRIPTION	UNIT
1	298666	Hook, Engine	2
2		Stud	2
3		Nut	2
4		Washer, Spring	2
5	298667	Cylinder Head Assembly	1
6		Cylinder Head	1
7		Cap, Sealing	2
8		Cap, Sealing	1
9		Plug, Pin	2
10		Guide, Valve	4
11	298668	Bolt, Cylinder Head	8
12	298669	Stud, Cylinder Head	2
13	298670	Nut, Cylinder Head	2
14	298671	Washer, Plain	10
15	298672	Gasket, Cylinder Head	1
16	298673	Shim, Cylinder Head Gasket	1
17			
18			
19	256736	Complete Gasket Set	2

GEAR CASE GROUP

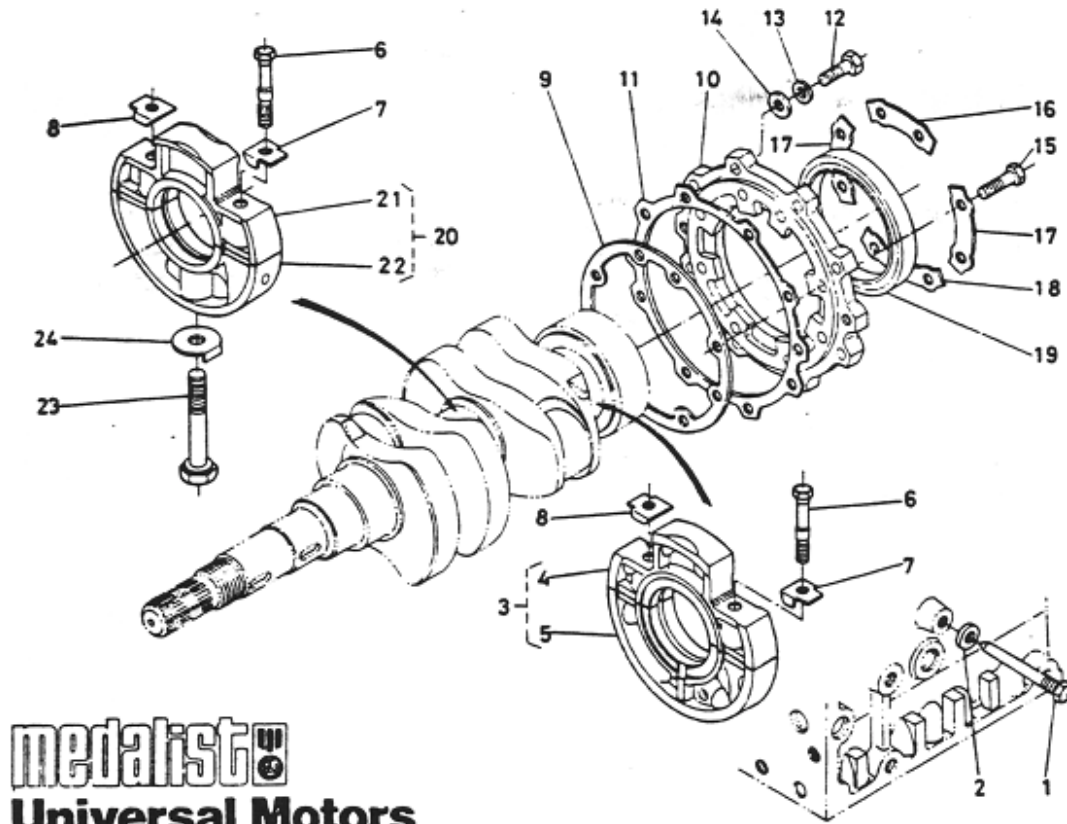


ITEM	PART NO.	DESCRIPTION	UNIT
1	298674	Gear Case Assembly	1
2		Gear Case	1
3		Plug, Pin	2
4		Plug, Pin	1
5		Cap, Sealing	1
6		Cap, Sealing	1
7		Pipe, Water	1
8		O Ring	3
9		Pin, Start Spring	1
10		Pipe, Water Return	1
11	298675	Packing, Gear Case	1
12		Bolt	1
13	298676	Bolt	10
14		Bolt	3
15		Washer, Spring	14
16		Washer, Plain	14
17	298677	Ball	1
18	298678	Spring	1
19	298679	Cap	1
20	298680	O Ring	1
21	298681	O Ring	1

GEAR CASE GROUP

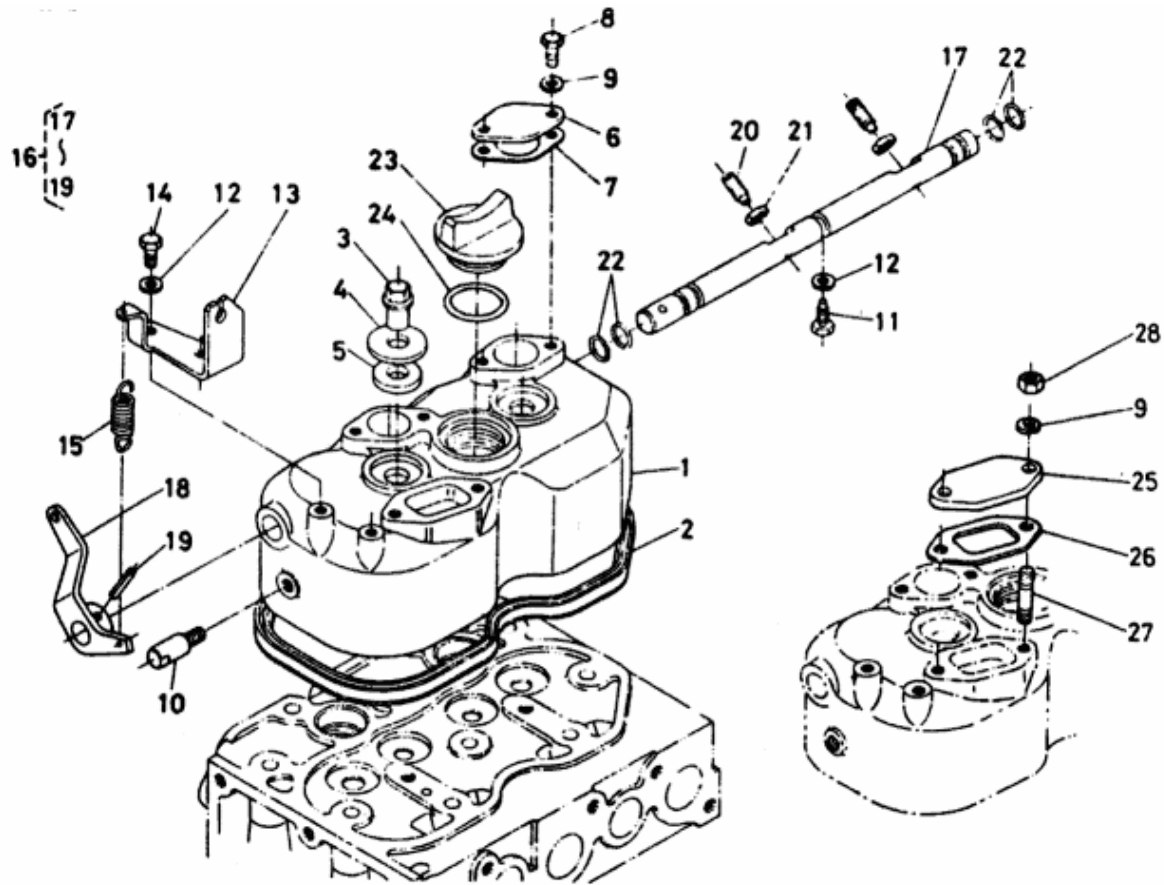
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BEARING CASE GROUP



ITEM	PART NO.	DESCRIPTION	UNIT
1			
2			
3	298685	Bearing Case Assembly	1
4		Case, Main Bearing 1	1
5		Case, Main Bearing 2	1
6	298686	Bolt 1	4
7	298687	Washer 1	2
8	298688	Washer 2	2
9	298689	Gasket	1
10	298690	Cover, Bearing	1
11	298691	Gasket, Cover	1
12		Bolt	8
13		Washer, Spring	8
14		Washer, Plain	8
15		Bolt	8
16	298692	Washer, Cover 1	1
17	298693	Washer, Cover 2	2
18	298694	Washer, Cover 3	1
19	298695	Seal, Oil	1
20	298696	Bearing Case Assembly 1	1
21		Case, Bearing 1-1	1
22		Case, Bearing 1-2	1
23	298697	Bolt 2	1
24	298698	Washer 3	1

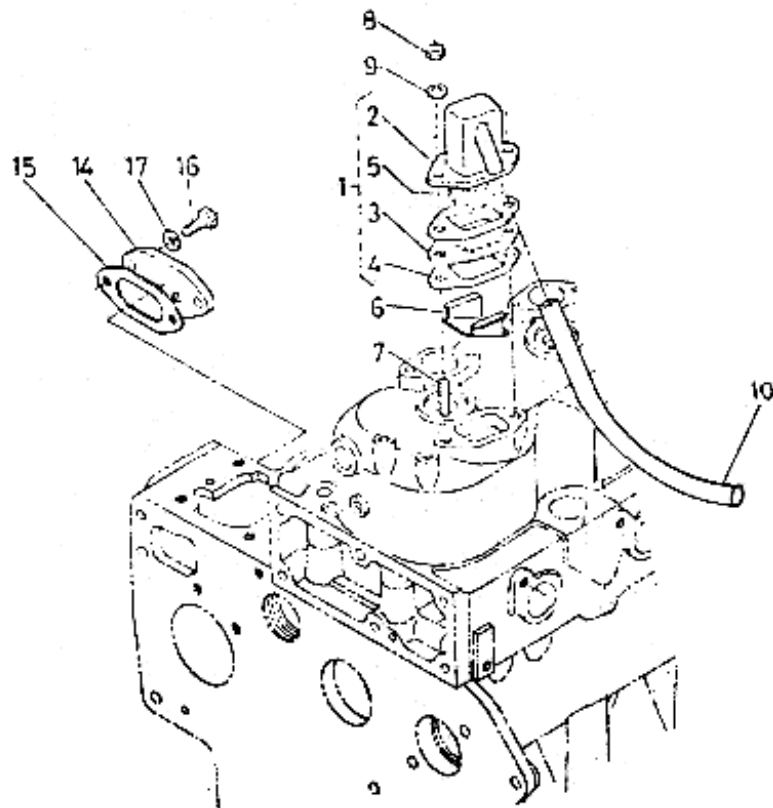
HEAD COVER GROUP



ITEM	PART NO.	DESCRIPTION	UNIT
1	298724	Cover, Cylinder head	1
2	298725	Gasket, Head Cover	1
3	298726	Nut, Head Cover	2
4	298727	Washer, Head Cover	2
5	298728	Gasket, Nut	2
6	298729	Cover, Decompression Hole	2
7	298730	Gasket Cover	2
8		Bolt	4
9		Washer, Spring	6
10	298731	Stopper, Decompression Shaft	1
11	298732	Bolt	1
12		Washer, Spring	3
13	298733	Holder, Decompression Wire	1
14		Bolt	2
15	298734	Spring, Decompression	1
16	298735	Decompression Shaft Assembly	1
17		Shaft, Decompression	1
18		Lever, Decompression	1
19		Pin, Spring	1
20	298736	Bolt, Decompression	2
21	298737	Nut, Decompression	2
22	298738	O Ring	4
23	298739	Plug, Oil Filler	1
24	298740	O Ring	1

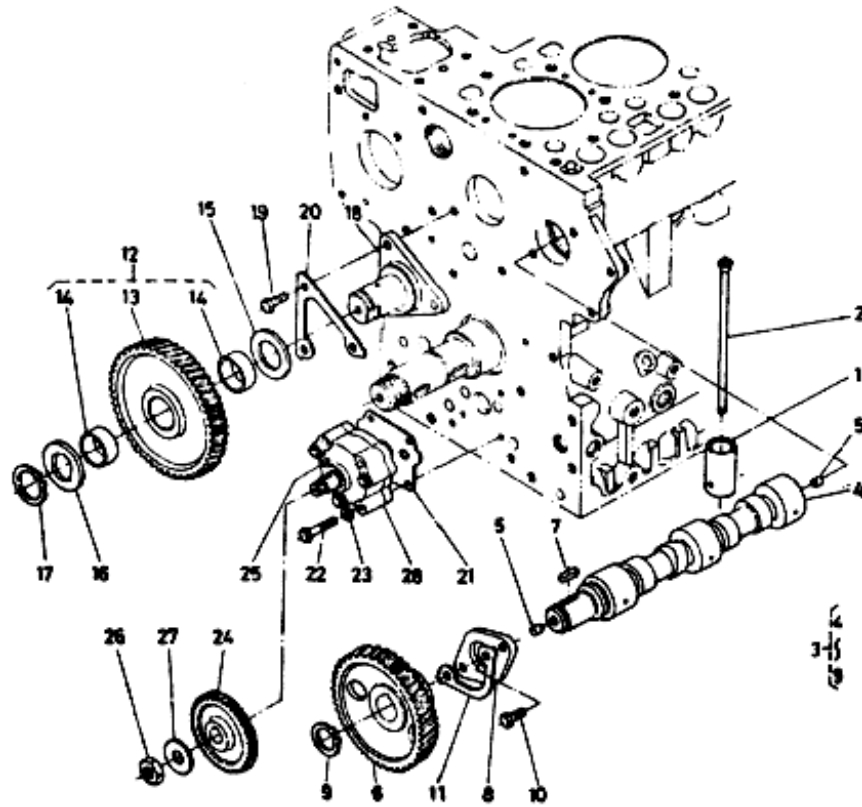
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BREATHER GROUP



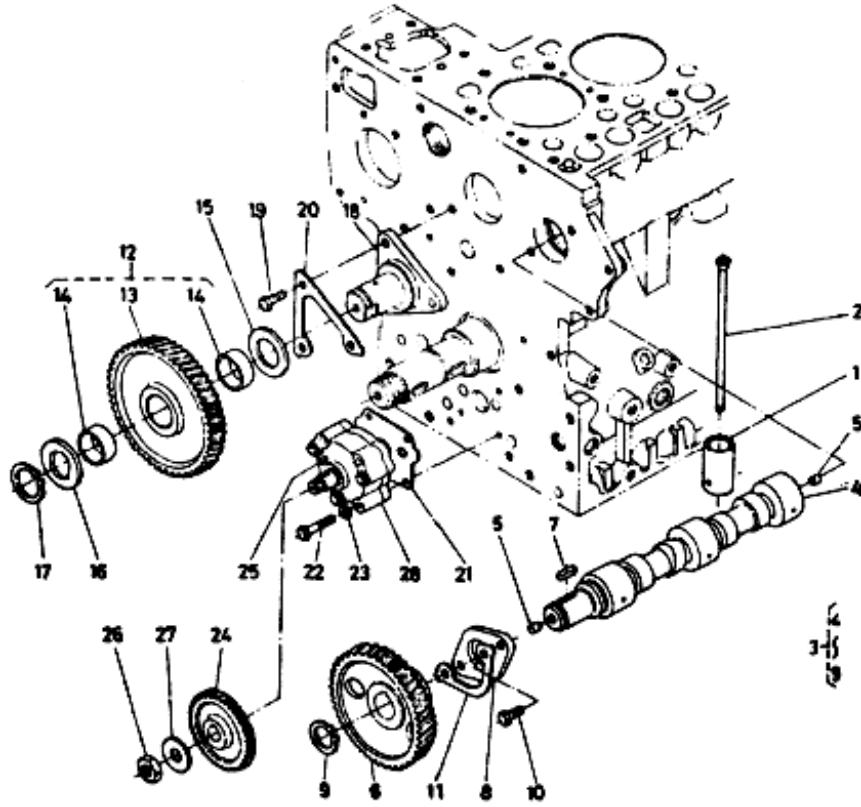
ITEM	PART NO.	DESCRIPTION	UNIT
1		Breather Assembly	1
2	298699	Breather	1
3	298700	Plate, Element	1
4	298701	Packing, Cover	2
5	298702	Element, Breather	1
6	298703	Oil Shield, Breather	1
7		Stud	2
8		Nut	2
9		Washer, Spring	2
10	298704	Hose, Breather	1
11			
12			
13			
14		Cover	1
15		Packing, Cover	1
16		Bolt	2
17		Washer, Spring	2

CAMSHAFT GROUP

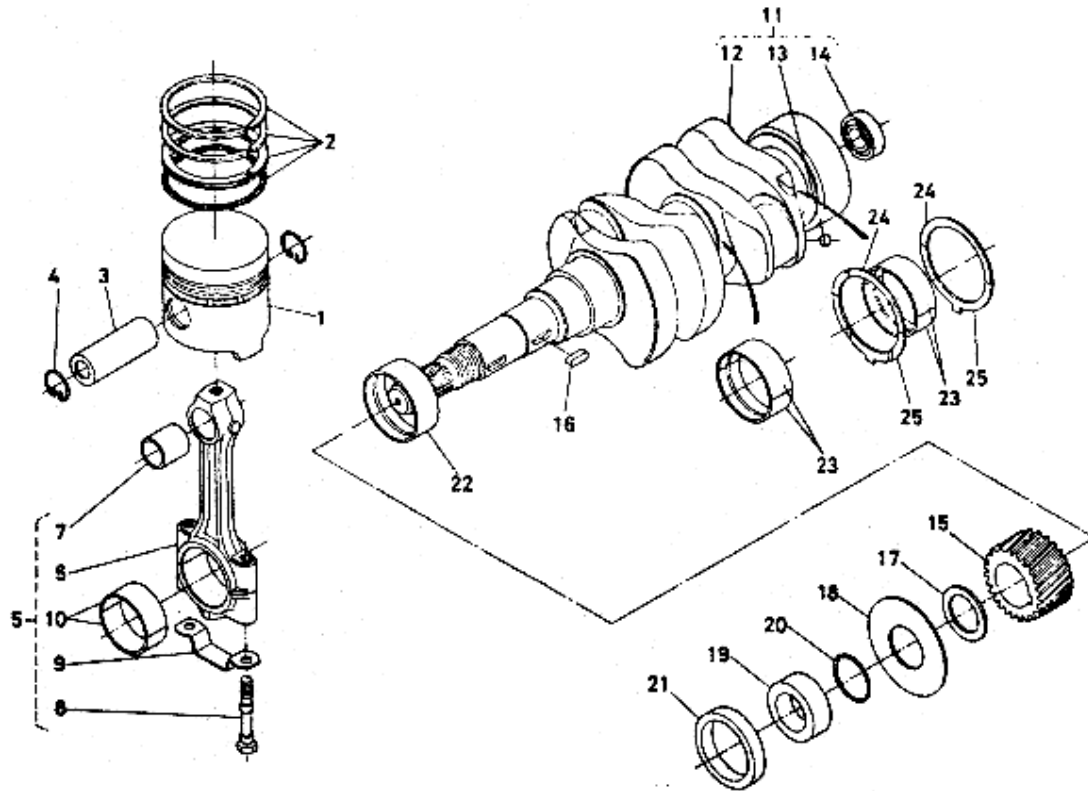


ITEM	PART NO.	DESCRIPTION	UNIT
1	298741	Tappet	4
2	298742	Rod, Push	4
3		Camshaft Assembly	1
4	298743	Camshaft	1
5	298744	Plug, Pin	2
6	298745	Gear, Camshaft	1
7	298746	Key, Feather	1
8	298747	Stopper, Camshaft	1
9	298748	Circlip, External	1
10		Bolt	2
11	298749	Washer, Stopper	1
12	298750	Idle Gear Assembly	1
13		Idle Gear	1
14		Bushing, Idle Gear	2
15	298751	Collar 1, Idle Gear	1
16	298752	Collar 2, Idle Gear	1
17	298753	Circlip, Idle Gear	1
18	298754	Shaft, Idle Gear	1
19		Bolt	3
20	298755	Washer, Idle Gear Shaft	1
21	298756	Gasket, Oil Pump	1

CAMSHAFT GROUP

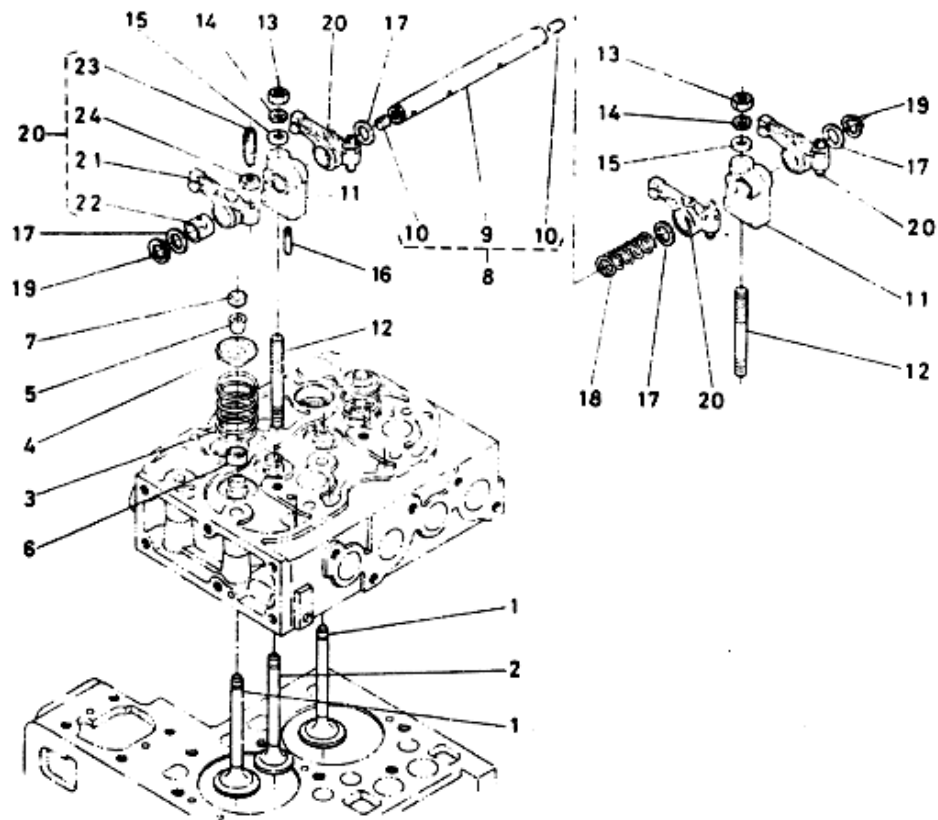
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PISTON, CRANKSHAFT GROUP



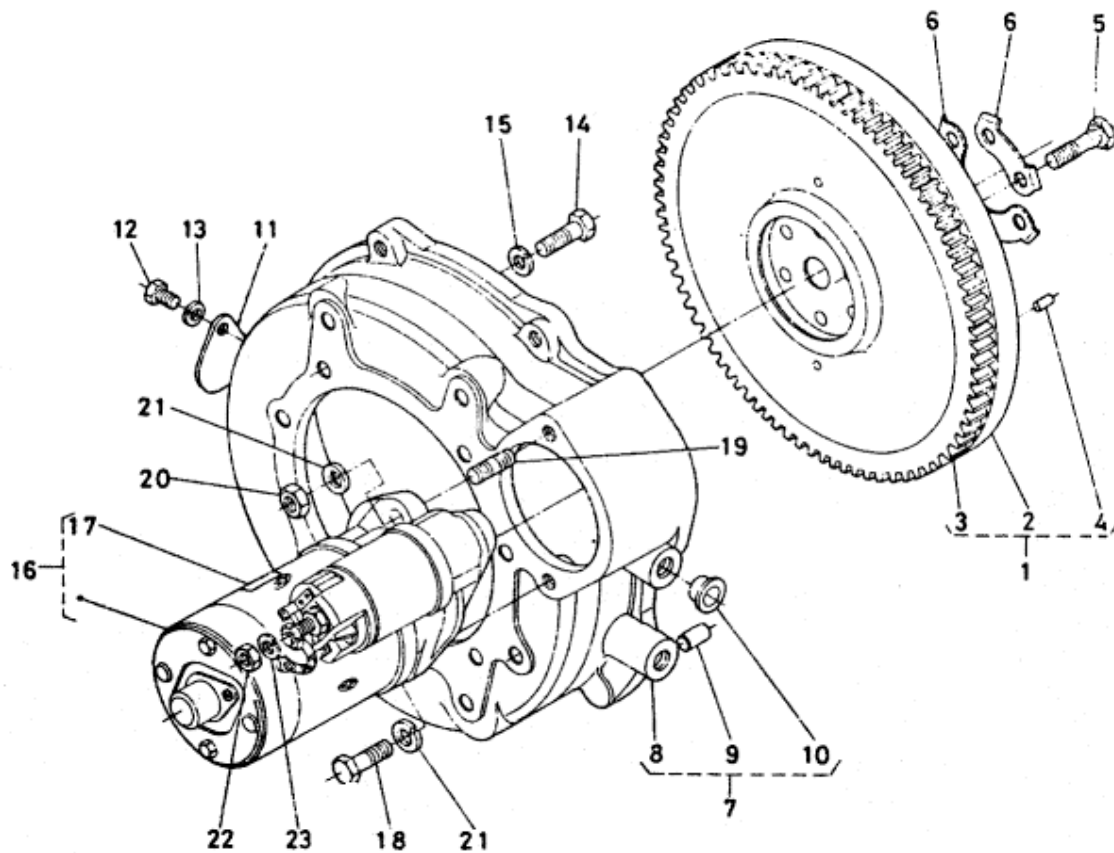
ITEM	PART NO.	DESCRIPTION	UNIT
1	298762	Piston	2
2	298763	Piston Ring Assembly	2
3	298764	Piston Pin	2
4	298765	Circlip, Piston Pin	4
5	298766	Connecting Rod Assembly	2
6		Connecting Rod	1
7		Bushing, Piston Pin	1
8		Bolt, Connecting Rod	2
9		Washer, Rod Bolt	1
10	298767	Metal, Crank Pin	2
11	298768	Crankshaft Assembly	1
12		Crankshaft	1
13		Plug Pin	2
14		Bearing, Ball	1
15	298769	Gear, Crankshaft	1
16		Key, Feather	1
17	298770	Collar, Crank-Gear	1
18	298771	Oil Slinger	1
19	298772	Collar, Crankshaft	1
20	298773	O Ring	1
21	298774	Oil Seal	1
22	298775	Metal, Crankshaft	1
23	298776	Metal, Crankshaft	4
24	298777	Metal, Side	2
25	298778	Metal, Side	2

VALVE, ROCKER ARM GROUP



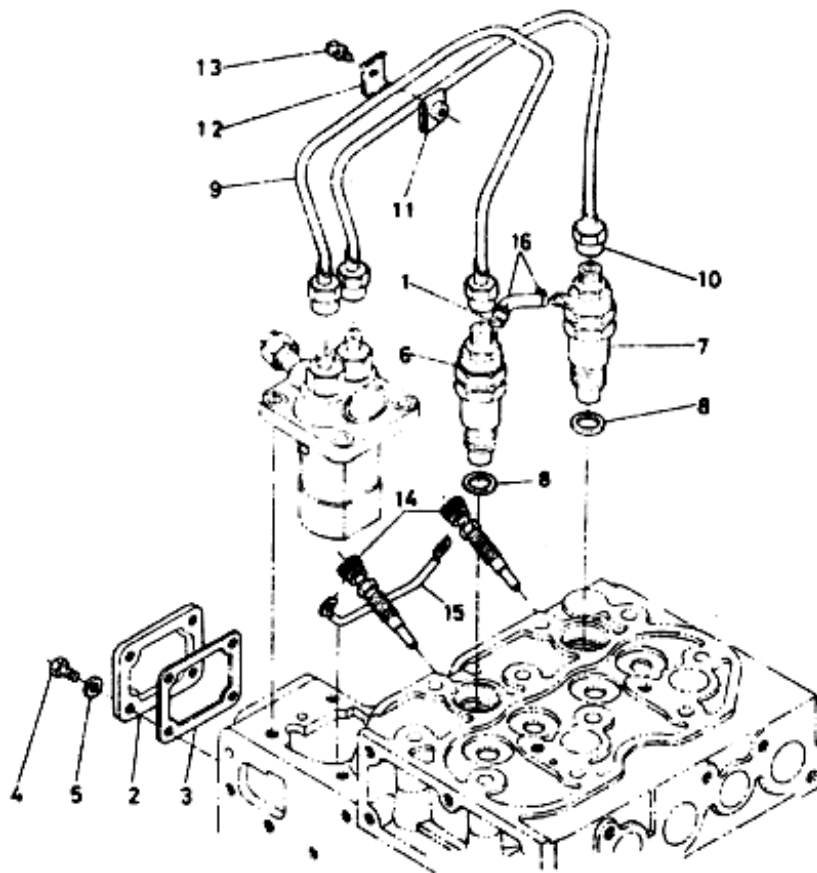
ITEM	PART NO.	DESCRIPTION	UNIT
1	298709	Inlet Valve	2
2	298710	Exhaust Valve	2
3	298711	Valve Spring	4
4	298712	Retainer, Valve Spring	4
5	298713	Collet, Valve Spring	8
6	298714	Seal, Valve Stem	4
7	298715	Cap, Valve	4
8	298716	Rocker Arm Shaft Assembly	1
9		Shaft, Rocker Arm	1
10		Set Screw	2
11	298717	Bracket, Rocker Arm	2
12	298718	Stud	2
13		Nut	2
14		Washer, Spring	2
15		Washer, Plain	2
16	298719	Set Screw	1
17	298720	Washer	4
18	298721	Spring, Rocker Arm	1
19	298722	Circlip, External	2
20	298723	Rocker Arm Assembly	4
21		Rocker Arm	1
22		Bushing	1
23		Screw, Adjusting	1
24		Nut	1

FLYWHEEL GROUP



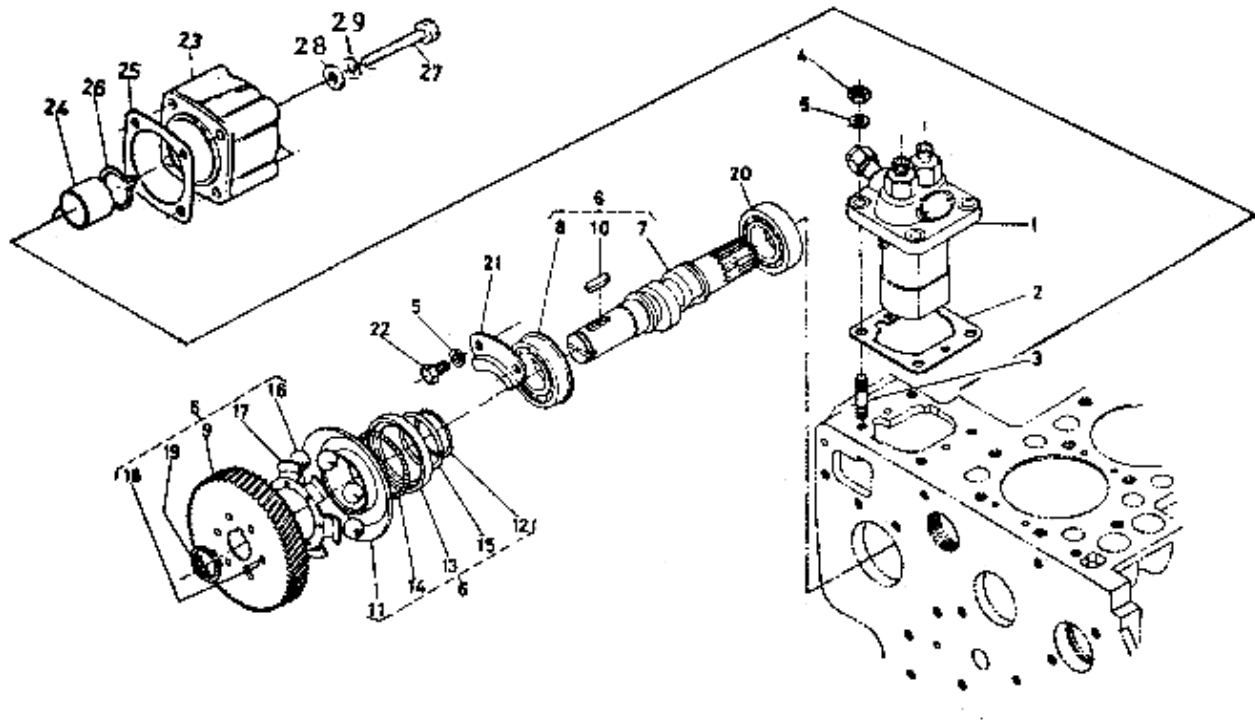
ITEM	PART NO.	DESCRIPTION	UNIT
1	298779	Flywheel Assembly	1
2		Flywheel	1
3		Ring Gear	1
4		Pin, Straight	3
5	298780	Bolt, Flywheel	6
6	298781	Washer, Flywheel	3
7	298782	Flywheel Housing Assembly	1
8		Housing, Flywheel	1
9		Pin, Straight	2
10		Plug	4
11		Cover	1
12		Bolt	1
13		Washer, Spring	1
14		Bolt	11
15		Washer, Spring	11
16	298783	Starter Assembly (See Starter Assembly Section)	1
17		Mark, Form	1
18		Bolt	1
19		Stud	1
20		Nut	1
21		Washer, Spring	2
22		Nut	1
23		Washer, Spring	1

NOZZLE HOLDER GROUP



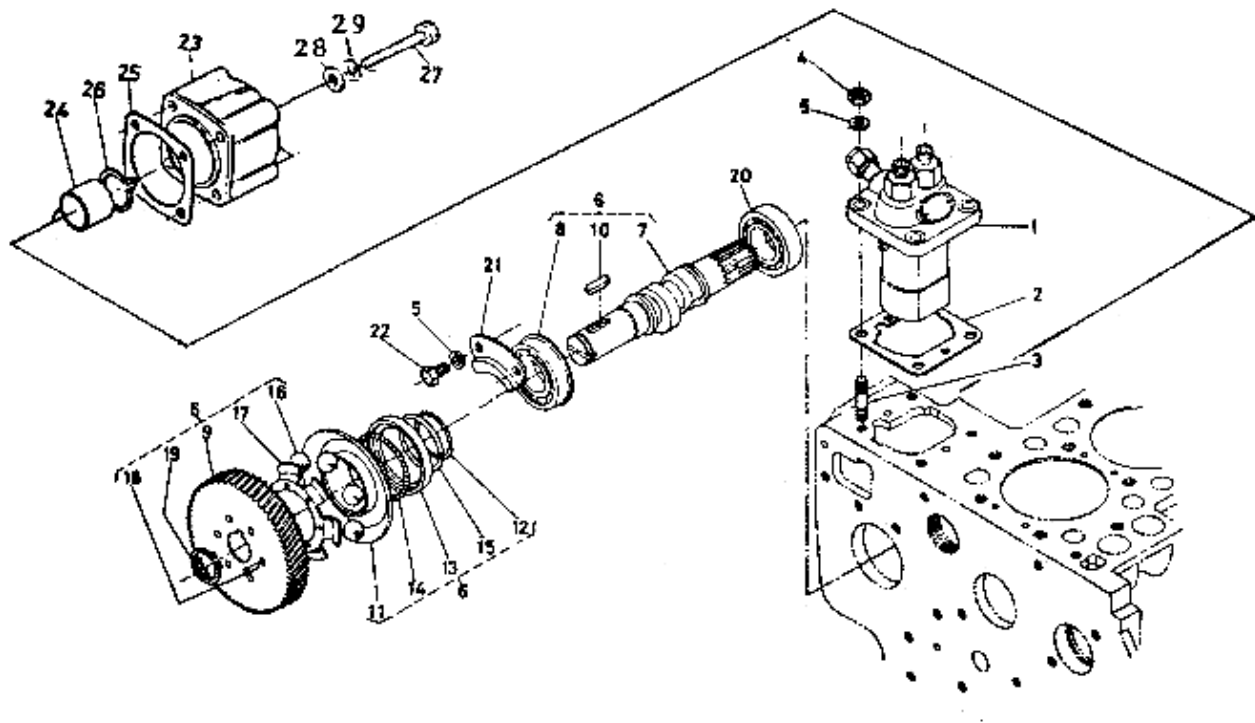
ITEM	PART NO.	DESCRIPTION	UNIT
1	298784	Pipe, Fuel Over Flow	1
2	298785	Cover, Injection Pump	1
3	298786	Gasket, Pump Cover	1
4		Bolt	4
5		Washer, Spring	4
6	298787	Nozzle Holder Assembly	1
7	298788	Nozzle Holder Assembly	1
8	298789	Gasket	2
9	298790	Pipe, Injection	1
10	298791	Pipe, Injection	1
11	298792	Clamp, Pipe	1
12	298793	Clamp, Pipe	1
13	298794	Screw, With Washer	1
14	298795	Glow Plug	2
15	298796	Cord, Glow Plug	1
16	298797	Clip, Pipe	2

FUEL CAMSHAFT GROUP

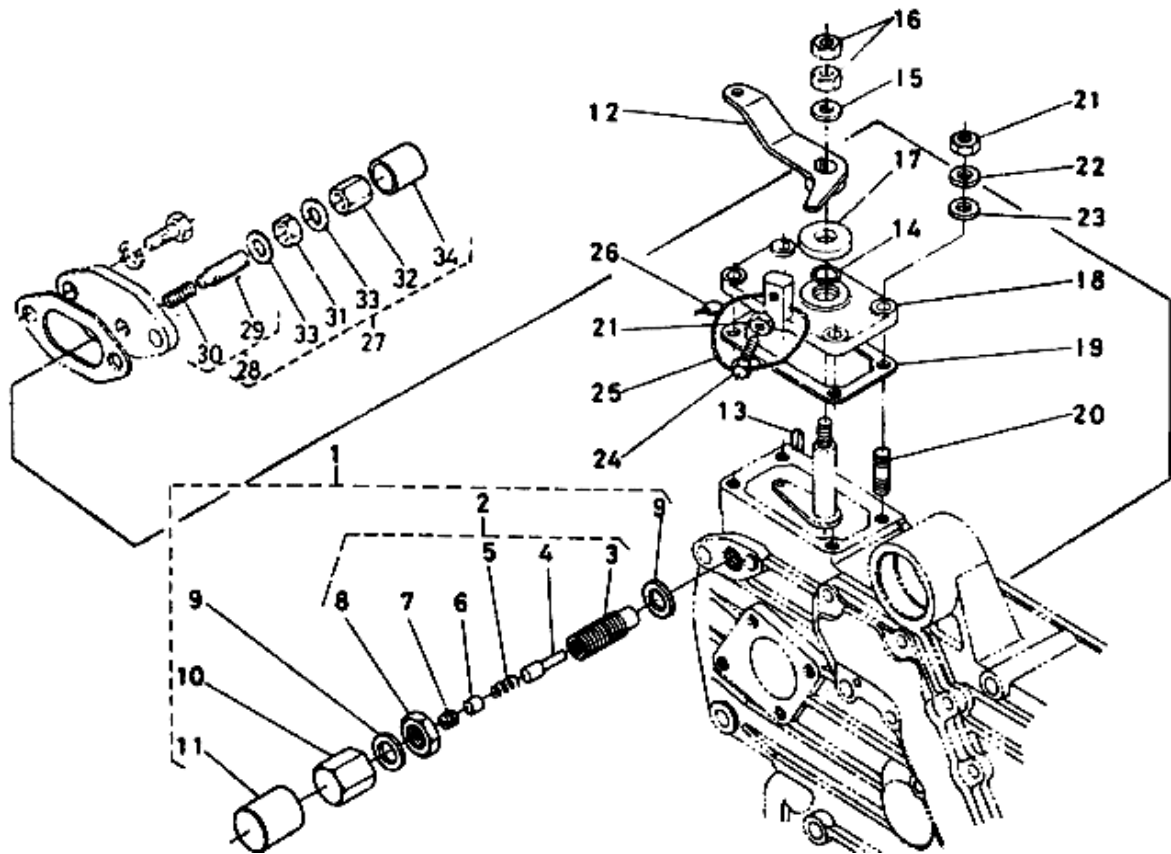


ITEM	PART NO.	DESCRIPTION	UNIT
1	298798	Injection Pump Assembly	1
2	298799	Shim, Injection Pump	5
3	298800	Stud	4
4		Nut	4
5		Washer, Spring	6
6		Fuel Camshaft Assembly	1
7		Camshaft, Fuel	1
8	298816	Bearing, Ball	1
9		Injection Pump Gear	1
10	298801	Key, Feather	1
11	298802	Sleeve, Governor	1
12	298803	Circlip, Sleeve	1
13	298804	Case, Governor Ball	1
14	298805	Ball	39
15	298806	Circlip, Ball Case	1
16	298807	Ball	6
17	298808	Guide, Governor Ball	1
18	298809	Rivet	6
19	298810	Circlip, External	1
20	298811	Bearing, Ball	1
21	298812	Stopper, Fuel Camshaft	1
22		Bolt	2
23	298813	Cover, Fuel Camshaft	1
24	298815	Collar	1

FUEL CAMSHAFT GROUP

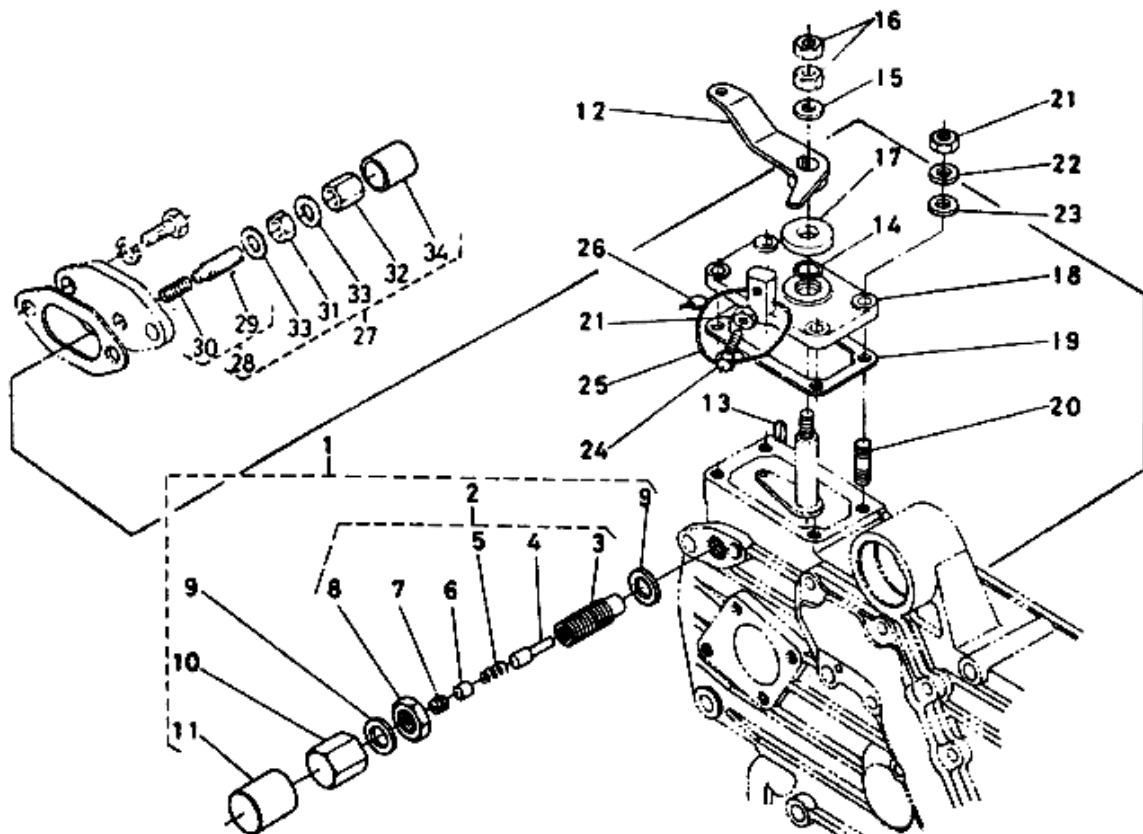
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SPEED CONTROL PLATE GROUP



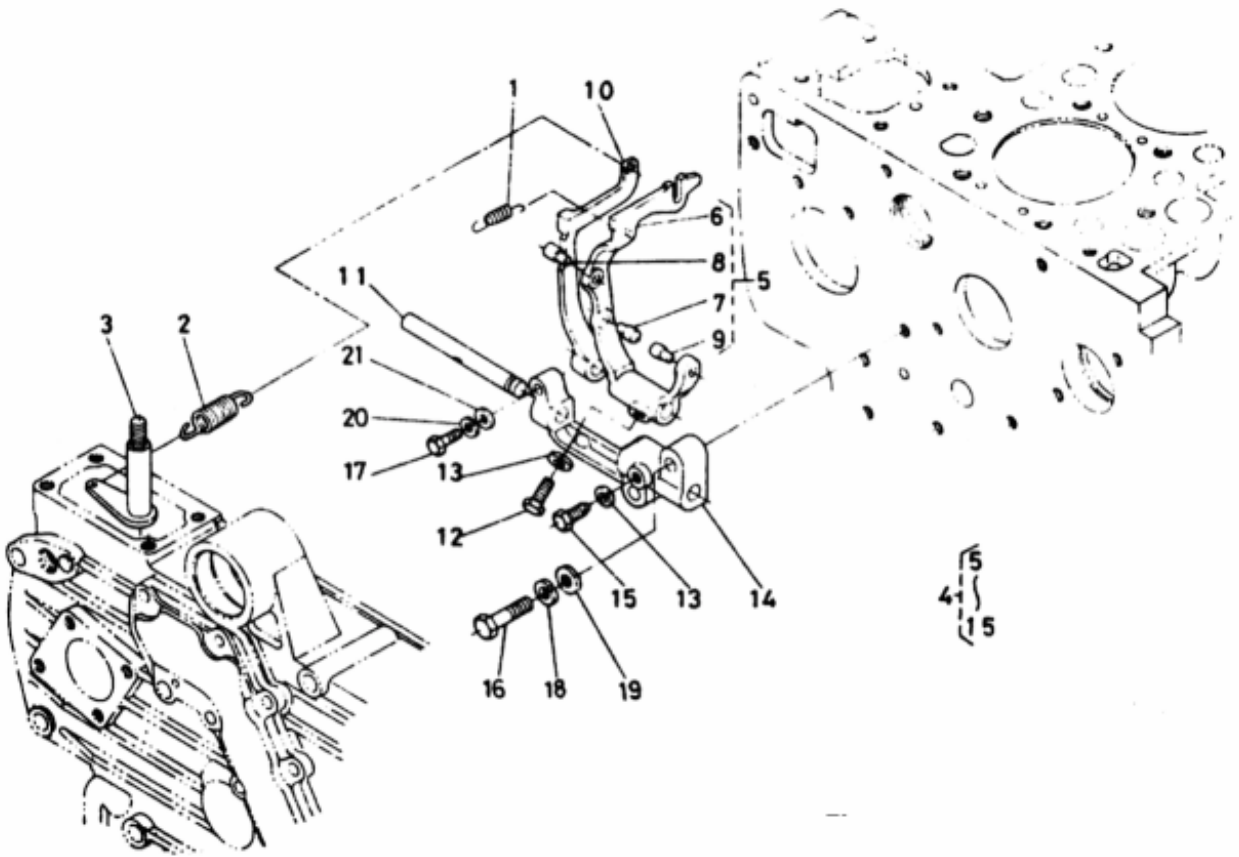
ITEM	PART NO.	DESCRIPTION	UNIT
1		Assembly Apparatus, Fuel	1
2	298818	Assembly Apparatus, Fuel	1
3		Body	1
4		Pin	1
5		Spring	1
6		Spacer	1
7		Screw, Set	1
8		Nut, Lock	1
9		Gasket	2
10		Nut, Cap	1
11		Cap	1
12	298819	Lever, Speed Control	1
13	298820	Key, Feather	1
14	298821	O Ring	1
15		Washer, Plain	1
16		Nut	2
17	298822	Plate, Friction	1
18	298823	Plate, Speed Control	1
19	298824	Gasket, Control Plate	1
20	298825	Stud	4
21		Nut	5
22		Washer, Spring	4
23		Washer, Plain	4
24	298826	Stopper	1

SPEED CONTROL PLATE GROUP



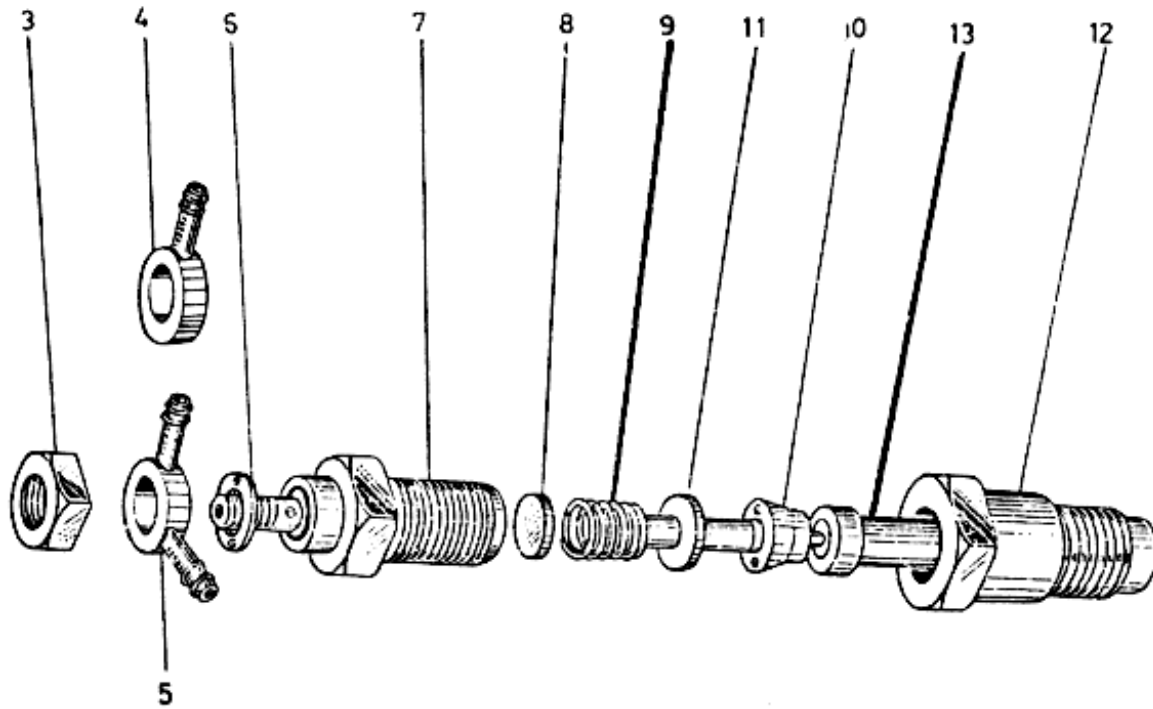
ITEM	PART NO.	DESCRIPTION	UNIT
25		Wire	1
26		Lead, Sealing	1
27		Assembly Apparatus, Idle	1
28		Assembly Bolt, Adjusting	1
29		Bolt, Adjusting	1
30		Spring	1
31		Nut	1
32		Nut Cap	1
33	299786	Packing – Gasket	2
34		Cap	1

GOVERNOR GROUP



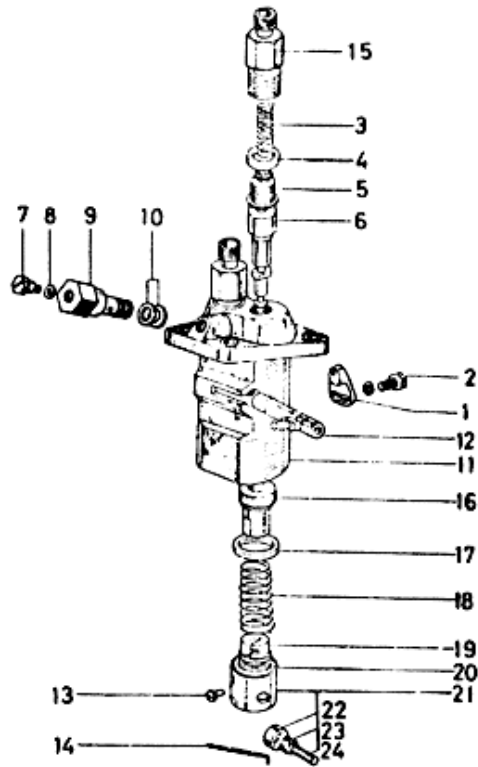
ITEM	PART NO.	DESCRIPTION	UNIT
1	298828	Spring, Start	1
2	298829	Spring, Governor	1
3		Governor Lever Assembly	1
4		Lever, Fork Assembly	1
5	298830	Lever, Fork Assembly	1
6		Lever, Fork	1
7		Pin, Fork Lever	1
8		Pin, Fork Lever	1
9		Pin, Fork Lever	1
10	298831	Lever, Fork	1
11	298832	Shaft, Fork Lever	1
12	298833	Bolt, Lever Shaft	1
13		Washer, Spring	2
14	298834	Holder, Fork Lever	1
15	298835	Bolt	1
16		Bolt	2
17		Bolt	1
18		Washer, Spring	2
19		Washer, Plain	2
20		Washer, Spring	1
21		Washer, Plain	1

NOZZLE HOLDER GROUP



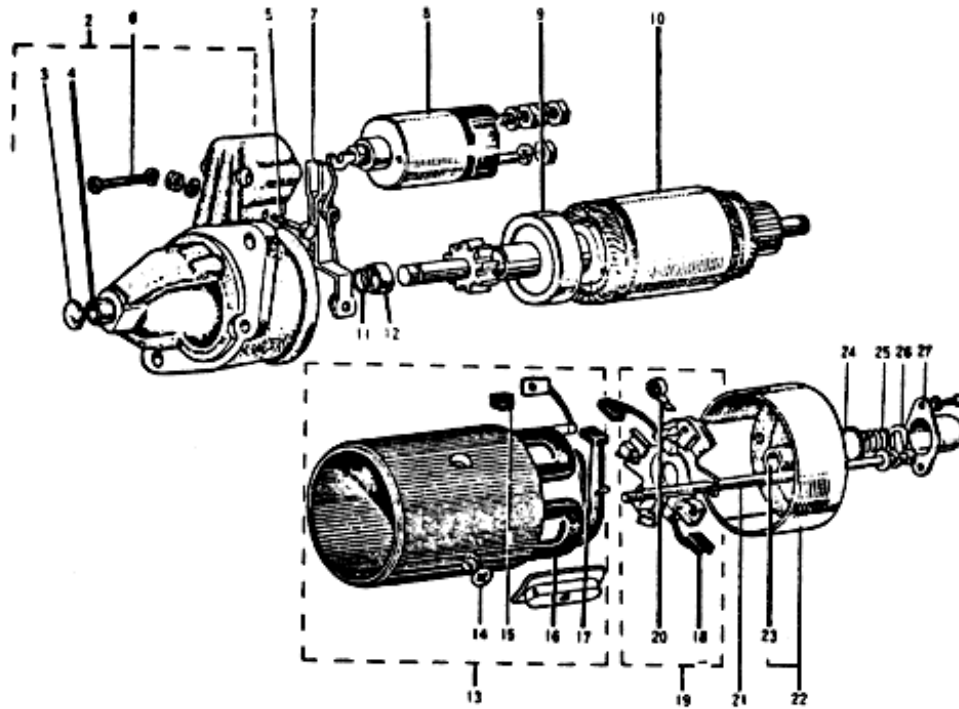
ITEM	PART NO.	DESCRIPTION	UNIT
1	298787	Nozzle Holder Assembly	1
2	298788	Nozzle Holder Assembly	1
3		Nut	1
4		Joint, Eye	1
5		Joint, Eye	1
6		Washer, Plain	1
7		Nozzle Holder Body	1
8		Washer, Adjusting	1
9		Spring, Nozzle	1
10		Piece, Distance	1
11		Rod, Push	1
12		Nut, Nozzle	1
13		Piece, Nozzle	1

INJECTION PUMP GROUP



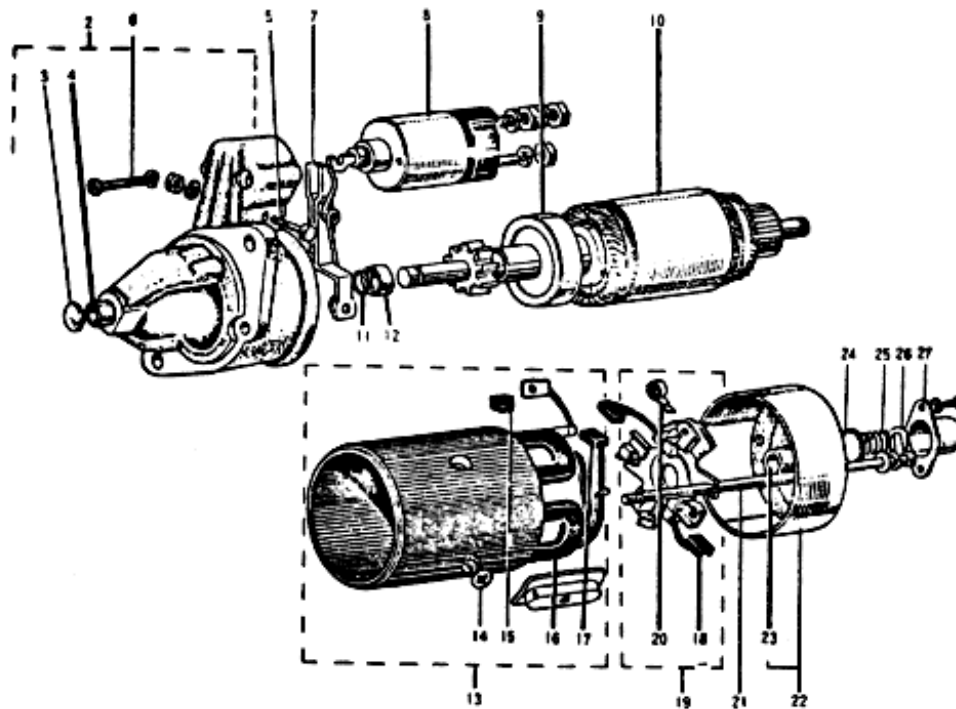
ITEM	PART NO.	DESCRIPTION	UNIT
1		Injection Pump Assembly	1
2		Housing, Pump	1
3		Element, Pump	2
4		Valve, Delivery	2
5		Spring, Delivery Valve	2
6		Gasket, Delivery Valve	2
7		Holder, Delivery Valve	2
8		O Ring	2
9		Tappet Assembly	2
10		Pin, Tappet Guide	2
11		Pin, Clamp	2
12		Spring, Plunger	2
13		Seat, Spring Upper	2
14		Seat, Spring Under	2
15		Shim	1
16		Rack, Control	1
17		Sleeve, Control	2
18		Screw	1
19		Gasket	2
20		Screw, Air Bleeder	1
21		Gasket	1
22		Collar	1
23		Washer, Spring	1
24		Plate, Adjust	1
25		Bolt, Plate Adjust	1

STARTER GROUP

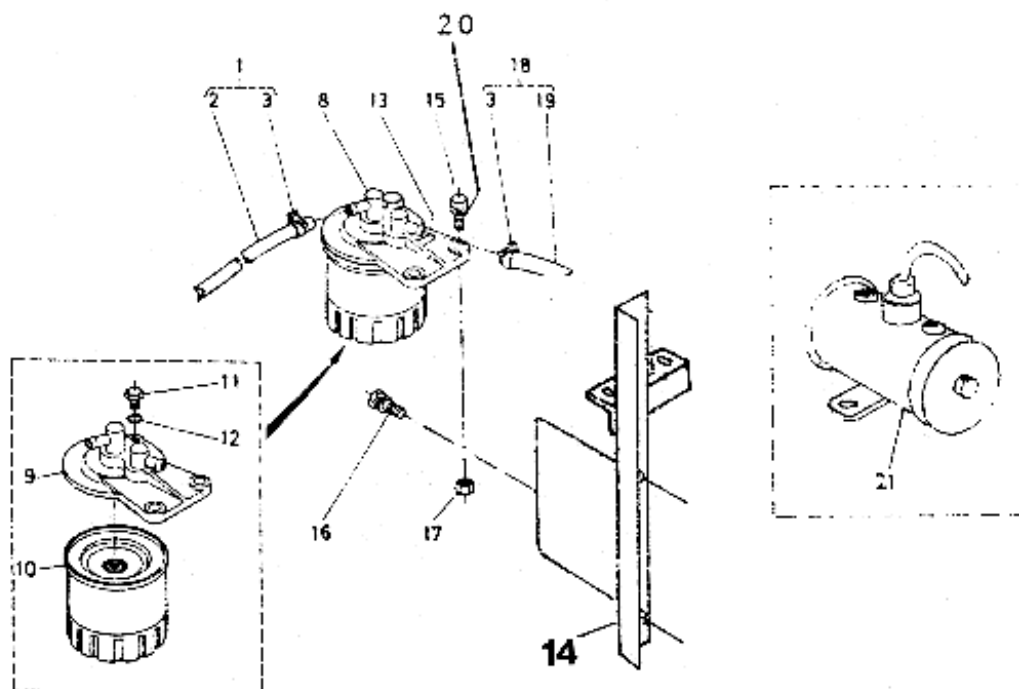


ITEM	PART NO.	DESCRIPTION	UNIT
1	298783	Starter Assembly	1
2		Frame, Drive End	1
3		Plug, Expansion	1
4	299770	Bushing	1
5		Bolt, Set	1
6		Bolt	2
7		Lever, Drive	1
8	299771	Solenoid	1
9	299772	Clutch, Over Running	1
10	299773	Armature	1
11		Pin, Snap	1
12		Collar	1
13		Yoke	1
14		Bolt, Set	4
15		Gasket	1
16		Coil, Field	1
17	299774	Brush	2
18	299775	Brush	2
19		Holder, Brush	1
20	299776	Spring, Brush	1
21		Bolt, Through	2
22		Frame, End	1

STARTER GROUP

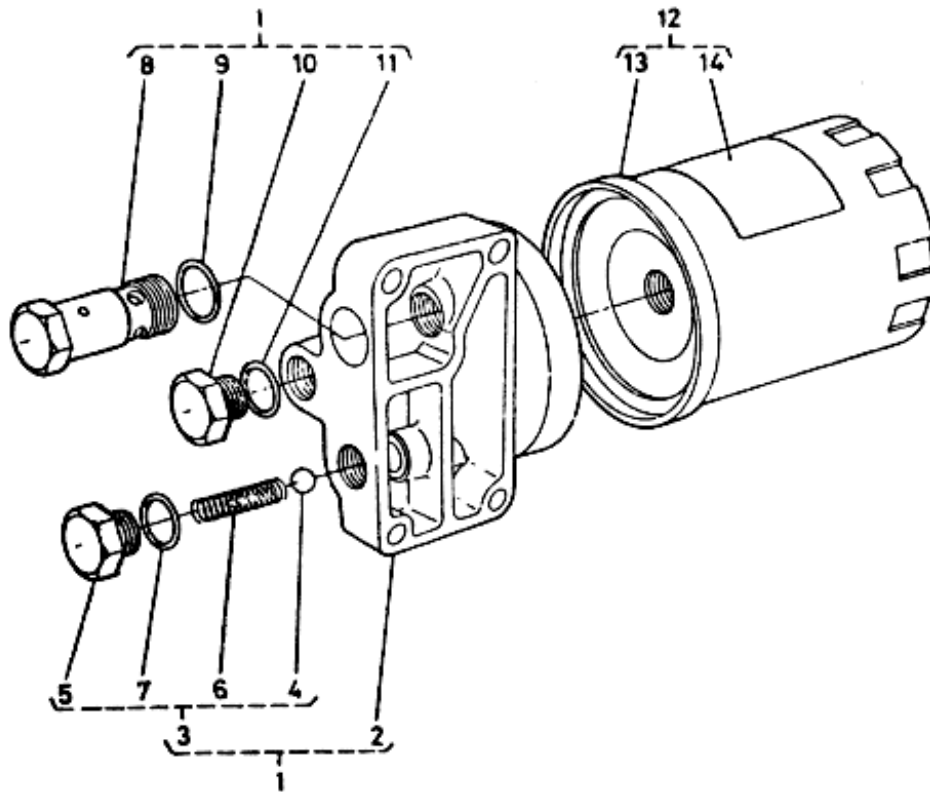
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FUEL FILTER GROUP



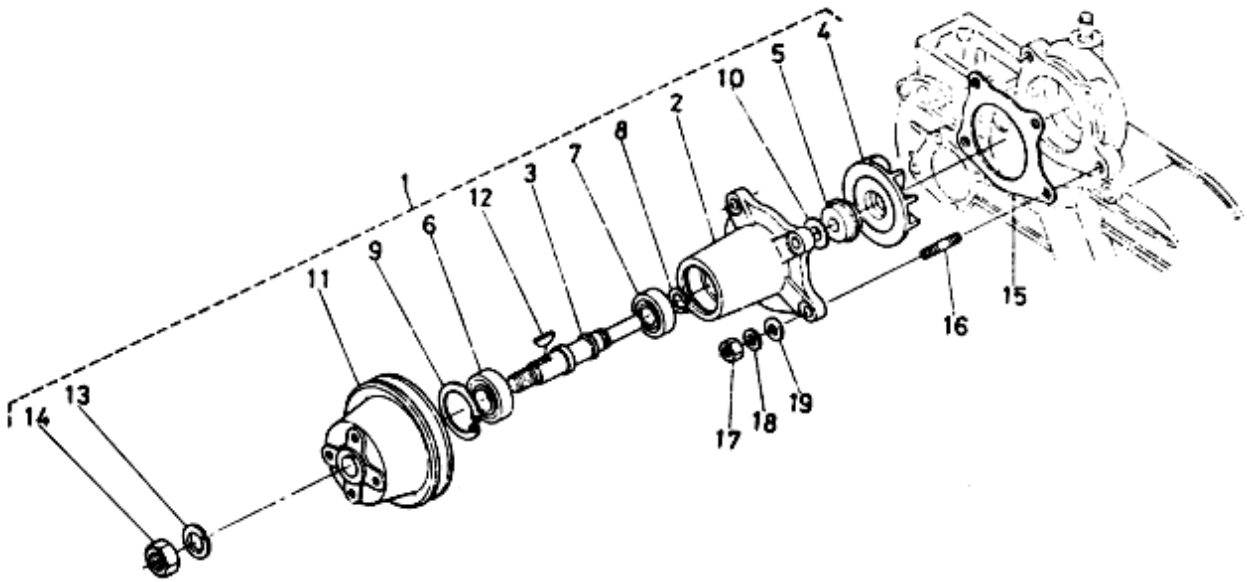
ITEM	PART NO.	DESCRIPTION	UNIT
1		Fuel Pipe Assembly	1
2		Pipe, Fuel	1
3	298605-A	Clip, Pipe	2
4		Gasket	2
5		Joint, Fuel Pipe	1
6		Pipe, Fuel	1
7		Clip, Pipe	2
8	298853	Fuel Filter Assembly	1
9		Cover, Filter	1
10	298854	Element, Filter	1
11		Plug, Filter Breather	1
12		O Ring	1
13		Mark, Form	1
14	298636	Bracket, Filter	1
15	231059	Bolt	2
16	298973	Bolt	2
17	230142	Nut	2
18		Fuel Pipe Assembly	1
19	298567	Pipe, Fuel Filter to Engine	1
20	298461	Lockwasher	1
21	299736	Electric Fuel Pump	1

OIL FILTER 2 GROUP



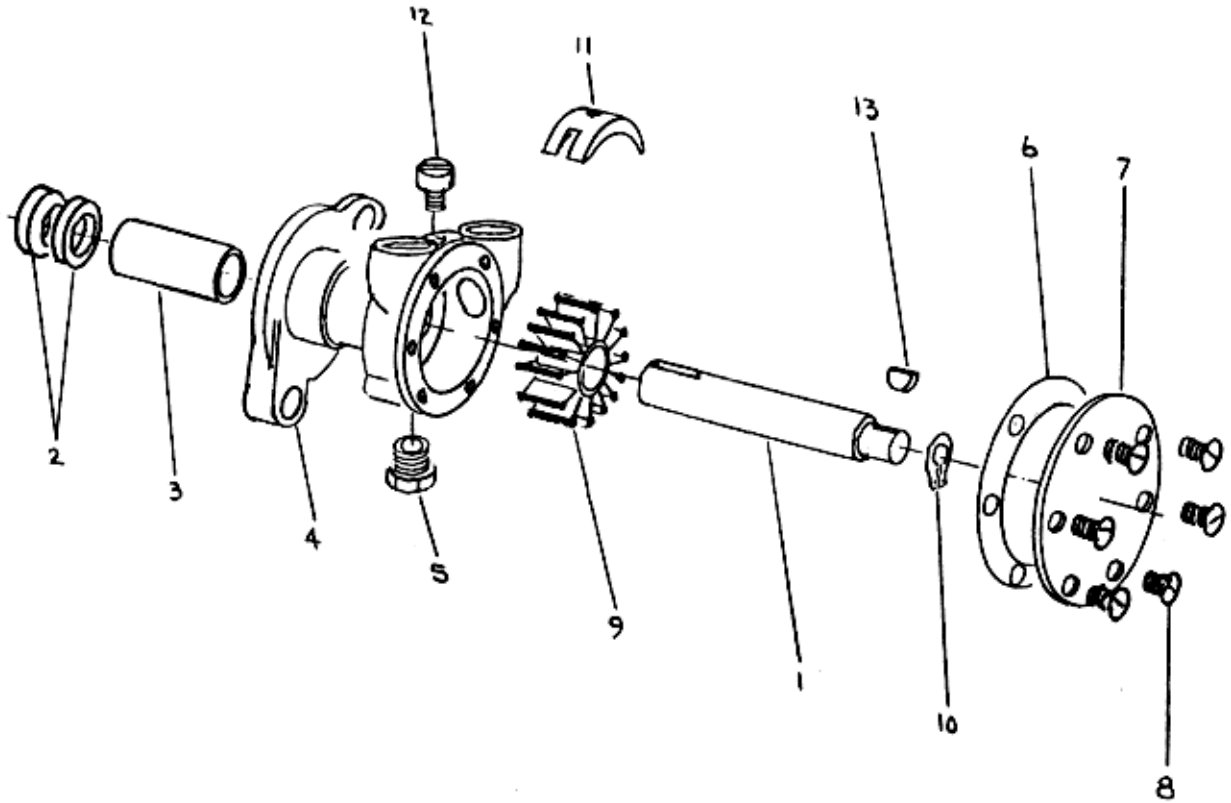
ITEM	PART NO.	DESCRIPTION	UNIT
1		Assembly Cover, Filter	1
2		Cover	1
3		Assembly Valve, Safety	1
4		Valve, Safety	1
5		Plug	1
6		Spring	1
7		O Ring	1
8		Assembly Valve, Relief	1
9		O Ring	1
10		Plug	1
11		O Ring	1
12	298852	Assembly, Cartridge (FRAM PH2870A or equivalent)	1
13		Filter, Cartridge	1
14		Label, Oil Filter	1

WATER PUMP GROUP



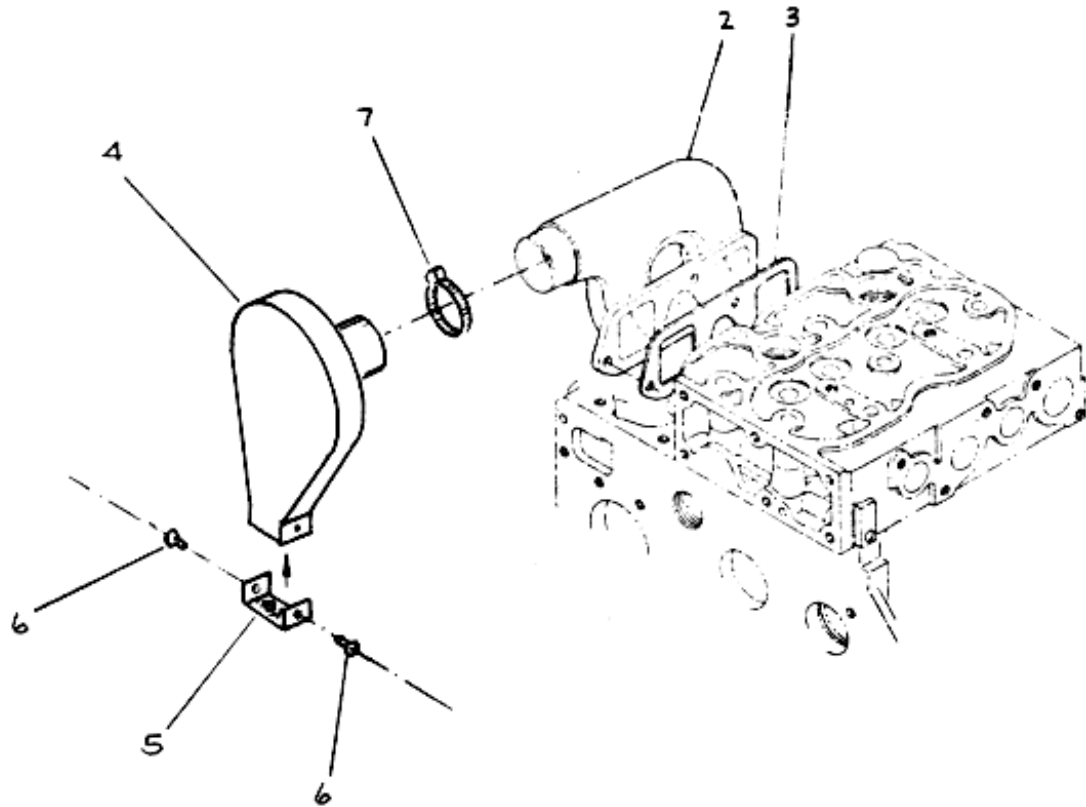
ITEM	PART NO.	DESCRIPTION	UNIT
1	298845	Water Pump Assembly	1
2		Body, Water Pump	1
3		Shaft, Water Pump	1
4		Impeller, Water Pump	1
5		Set Seal	1
6		Bearing, Ball	1
7		Bearing, Ball	1
8		Circlip, External	1
9		Circlip, Internal	1
10		Slinger	1
11		Pulley	1
12		Key, Woodruff	1
13		Washer, Spring	1
14		Nut	1
15	298846	Gasket, Water Pump	1
16		Stud	4
17		Nut	4
18		Washer, Spring	4
19		Washer, Plain	4

WATER PUMP GROUP (SHERWOOD)

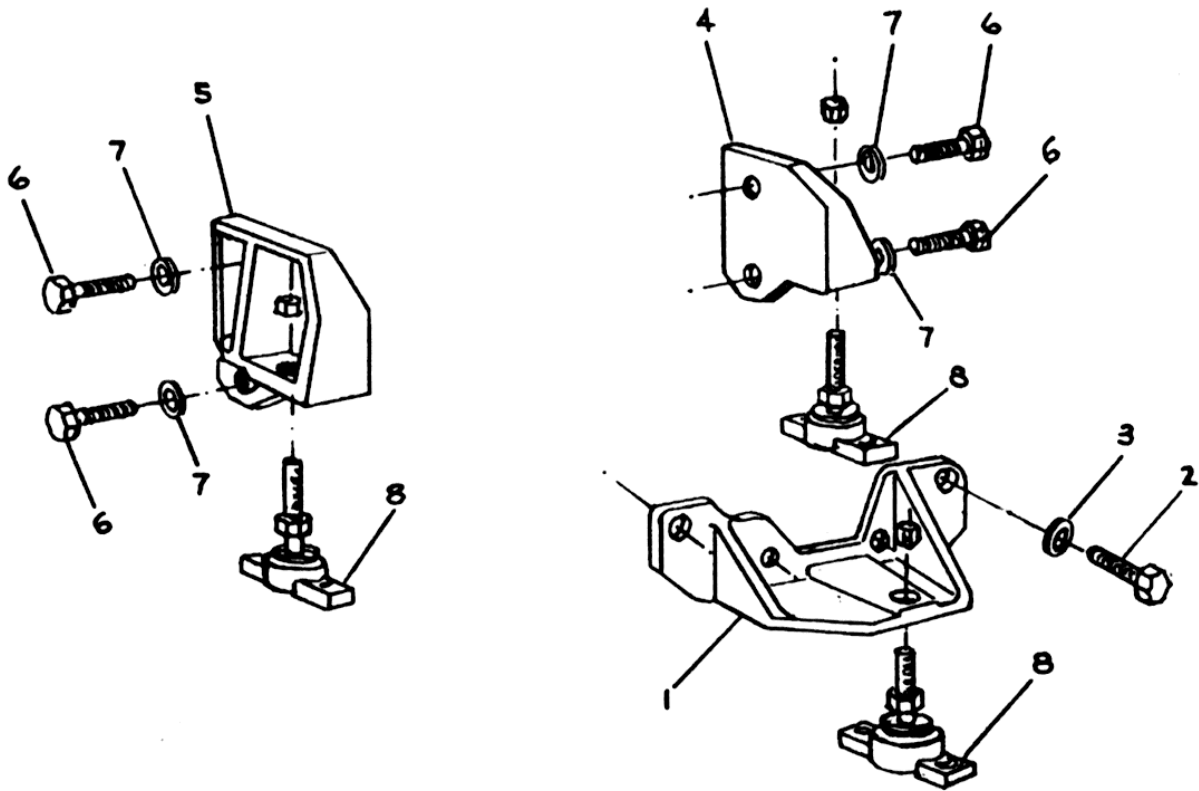


ITEM	PART NO.	DESCRIPTION	UNIT
	299805	Pump Assembly, Complete (Sherwood)	1
1	299888	Shaft	1
2	262286	Seal, Lip	2
3	299889	Bushing, Carbon	1
4	299890	Body	1
5	239136	Plug, Drain	1
6	297745	Gasket	1
7	299891	Cover	1
8	299895	Screw – 10-24 x 3/8 Long	6
9	287439	Impeller	1
10	299893	Retaining Ring – External	1
11	299894	Cam (.187)	1
12	299895	Screw – 1/4-20 x 5/16 Long	1
13	299896	Key No 2	1
14	298477	Adaptor Plate (not shown)	1

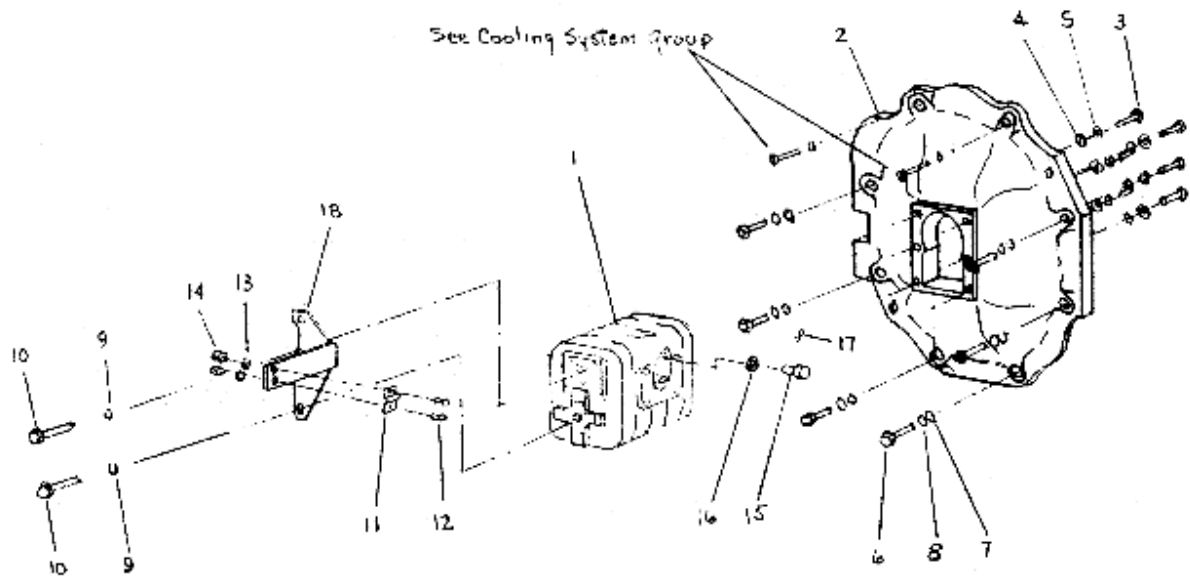
AIR CLEANER GROUP

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ENGINE MOUNT GROUP

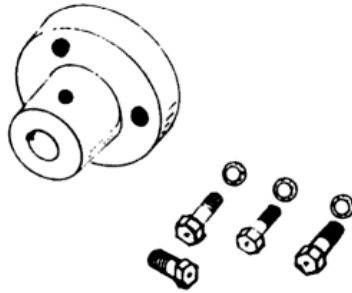
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TRANSMISSION GROUP



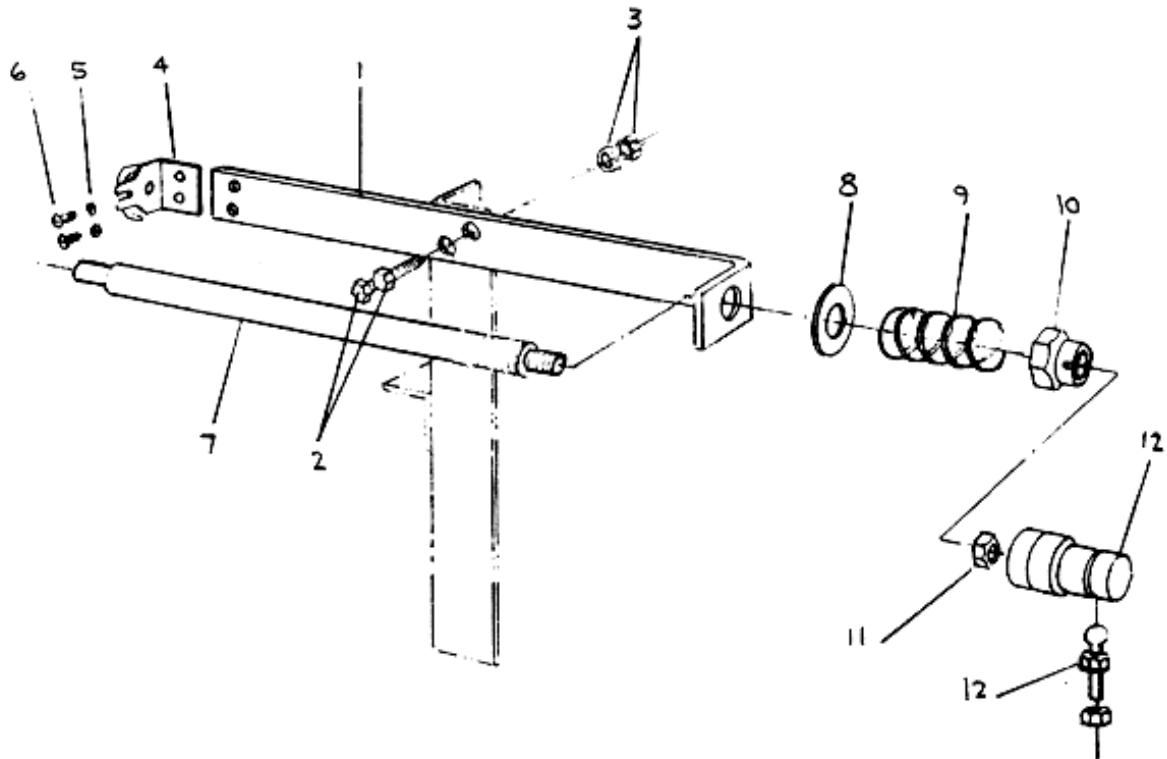
ITEM	PART NO.	DESCRIPTION	UNIT
1	299155	Reverse Gearbox, Complete	1
2	298523-D	Bell Housing, Reverse Gear	1
3	298468	Hex HD. Cap Screw (8mm x 1.25P x 25mm Long)	6
4	231875	Flat Washer, SAE 5/16	6
5	298461	Washer, Lock (8mm Screw)	6
6	298616	Hex HD. Cap Screw (10mm x 50mm Long)	6
7	298456	Flat Washer (.413 I.D.)	6
8	298463	Lock Washer, Split (10mm Screw)	6
9	298461	Lock Washer, Split (8mm Screw)	2
10	298895	Hex HD. Cap Screw (8mm x 1.25P x 16mm Long)	2
11	298897	Clamp, Shift Cable to Shift Control Bracket	1
12	231224	Round HD. Mach. Screw (#10-32 x 1/2 Long)	2
13	231890	Lock Washer, Split (#10 Screw)	2
14	230138	Hex Nut (#10-32)	2
15	298898	Pivot, Shift cable to Reverse Gear Lever	1
16	231874	Flat Washer SAE 1/4"	1
17	230281	Cotter Pin 3/32 x 1/2"	1
18	299160	Bracket, Shift Control Mt'g Cable	1
19	299156	Damper Plate	1
20	299243	Damper Mounting Plate	1
		See Page 30A for Shaft Coupling	

TRANSMISSION GROUP



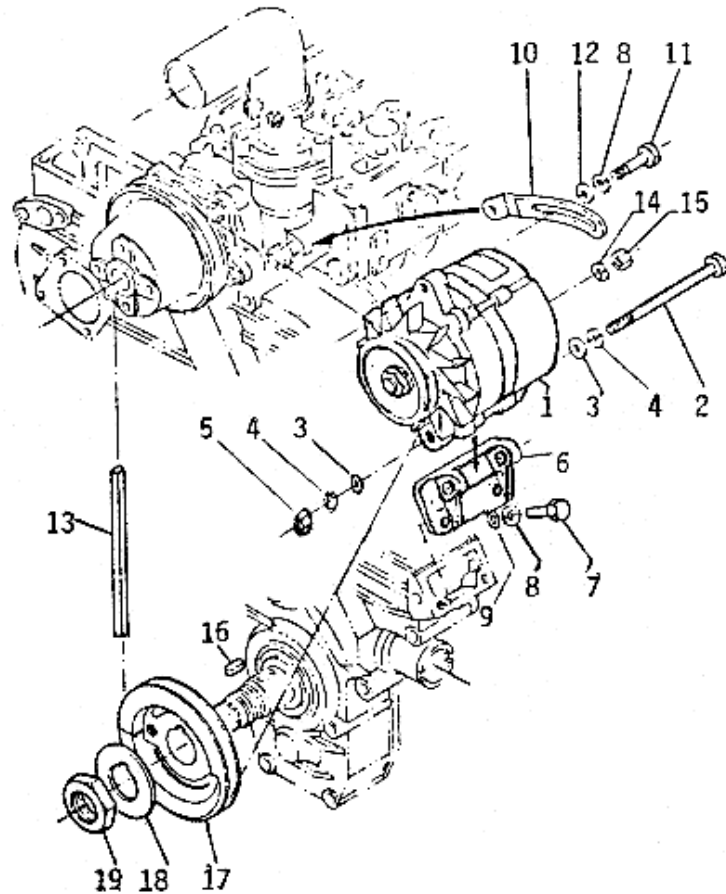
ITEM	PART NO.	DESCRIPTION	UNIT
	299640	Rigid Coupling 3/4"	
	299641	Rigid Coupling 7/8"	
	299642	Rigid Coupling 1"	
	299643	Rigid Coupling 1-1/8"	
	299644	Rigid Coupling 1-1/4"	
	238162	Screw – Sq. Hd. 3/8 – 16 x 1"	2
	239548	Screw – Hex Hd. 3/8 – 24 x 1-1/4"	4
	231910	Washer – Shake Proof	4
	230189	Nut – Jam 3/8-24	4
	298568	Flexible Coupling 3/4" – 1/4" Key	
	298569	Flexible Coupling 7/8" – 1/4" Key	
	298484	Flexible Coupling 1" – 1/4" Key	
	298570	Flexible Coupling 1-1/8" – 1/4" Key	
	299300	Flexible Coupling 1-1/4" – 5/16" Key	

THROTTLE LINKAGE CONTROL GROUP



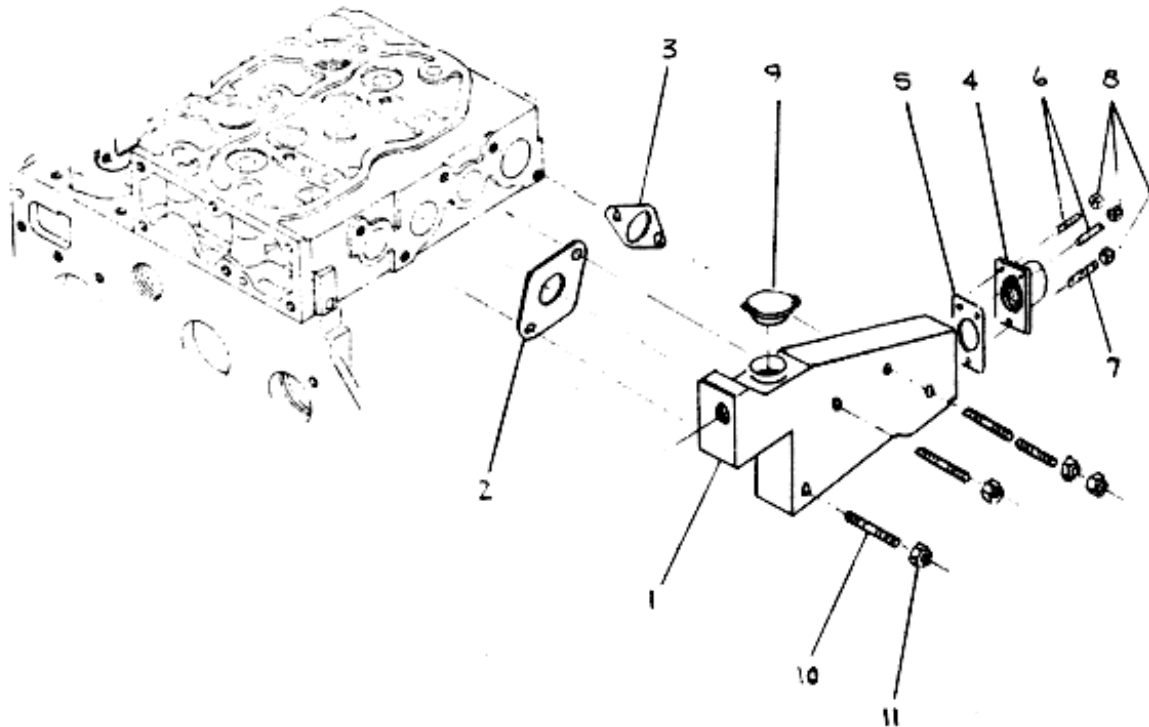
ITEM	PART NO.	DESCRIPTION	UNIT
1	298637-B	Bracket, Throttle Cable Mtg.	1
2	231035	Hex Hd Cap Screw (1/4-20 x 3/4 Lg.)	2
3	230257	Lock Nut, Flexlock (1/4-20)	2
4	298630	Cable Hook Clip	1
5	231890	Lock Washer, Split (#10)	2
6	231224	Rd Hd Machine Screw (#10-32 x 1/2" Lg.)	2
7	298638	Stud, Throttle Control Linkage	1
8	231875	Flat Washer SAE 5/16	1
9	298886	Spring, Throttle Stop	1
10	298610	Lock Nut, Flexlock (5/16 x 24)	1
11	230138	Hex Nut (#10-32)	1
12	298629	Ball Joint, Throttle Linkage	1

DYNAMO GROUP



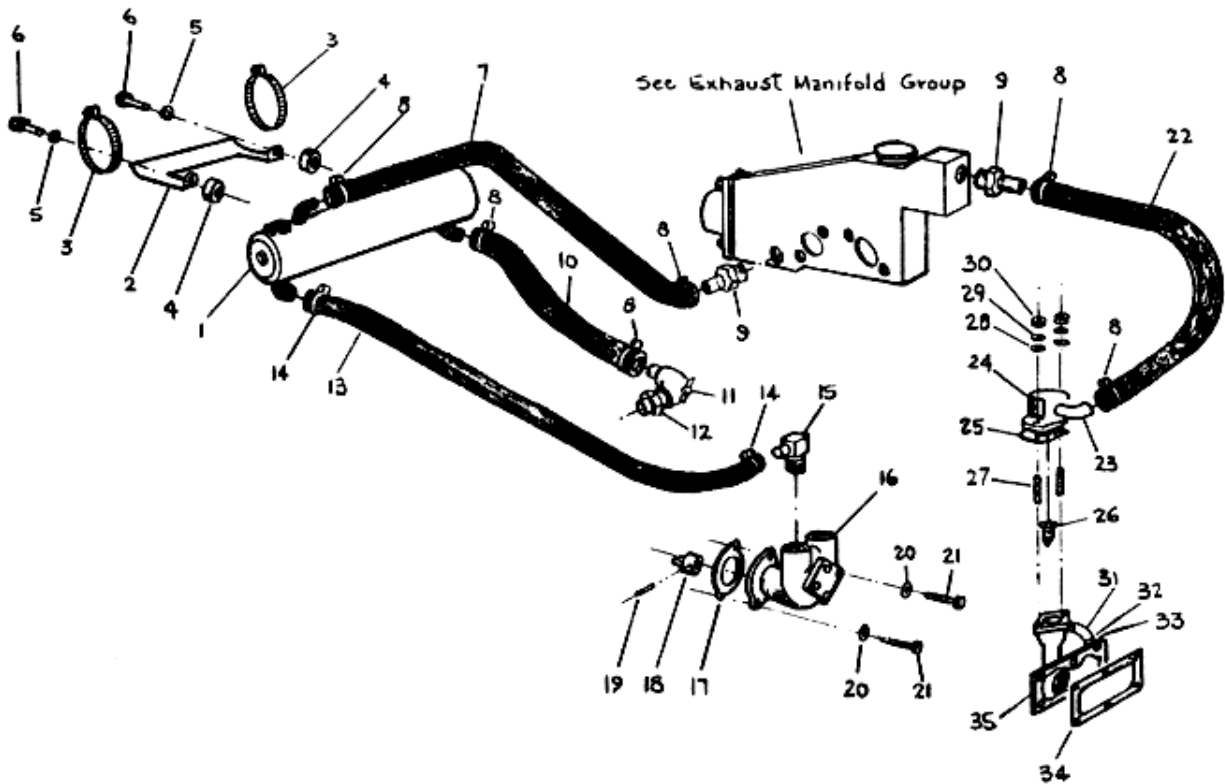
ITEM	PART NO.	DESCRIPTION	UNIT
1	298972-A	55AMP Alternator & Tach A.C. Tap Kit	1
2	231093	Hex Hd Cap Screw (3/8-16 x 3-3/4" Long)	1
3	231878	Washer, SAE 3/8"	2
4	285305	Washer, Split Lock 3/8"	2
5	230144	Hex Nut, 3/8-16	1
6	298521	Alternator Mounting Bracket	1
7	298468	Hex Hd Cap Screw (8mm x 1.25 x 25mm Long)	2
8	298461	Washer, Lock (8mm Screw)	3
9	231875	Washer, Flat SAE 5/16	2
10	298471	Alternator Adjusting Arm	1
11	231057	Hex Hd Cap Screw (3/8-18 x 3-3/4" Long)	1
12	231856	Washer, Flat Plain 5/16"	1
13	204002	"V" Belt	1
14	Supplied with	Washer, Spring	1
15	Alternator	Nut	1
16		Key, Feather	1
17		Pulley	1
18	298837	Washer, Crankshaft	1
19	298836	Nut, Crankshaft	1

EXHAUST MANIFOLD GROUP



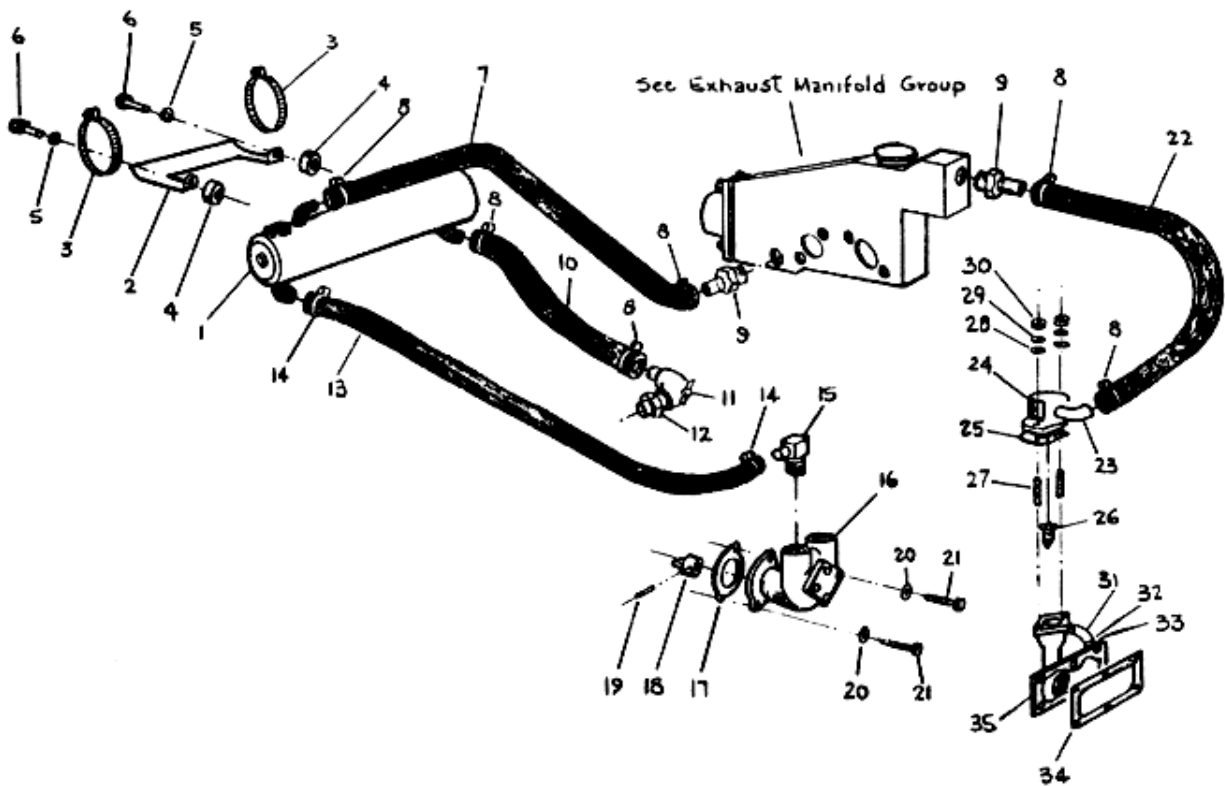
ITEM	PART NO.	DESCRIPTION	UNIT
1	298595	Manifold	1
2	298707	Gasket, Exhaust Manifold	1
3	298708	Gasket, Exhaust Manifold	1
4	298599	Exhaust Flange, Manifold	1
5	298600	Gasket, Exhaust Flange	1
6	276440	Stud – Exh. Flange Mtg. (3/8-16 x 1-7/16 Lg)	2
7	298974	Stud – Exh. Flange Mtg. (3/8-16 x 2-5/8 Lg)	1
8	230147	Hex Nut, Exh. Flange Mtg. (3/8-24)	3
9	298576	Radiator Cap, Pressurized 7# PSI	1
10	298635	Stud – Exh. Manifold (8 mm x 1.25P x 102mm)	4
11	298466	Hex Nut, Exh. Manifold (8 mm x 1.25P)	4

COOLING SYSTEM GROUP



ITEM	PART NO.	DESCRIPTION	UNIT
1	298633	Heat Exchanger	1
2	298632	Support Bracket	1
3	294386	Clamp, Heat Exchanger	2
4	298634	Spacer	2
5	298463-A	Washer, lock Split (10mm)	2
6	298617-A	Hex HD Cap Screw (10mm x 1.25P x 55mm Long)	2
7	298646	Hose 7/8 10 x 8-1/2 Long	1
8	298648	Hose Clamp	6
9	286075	Hose Connector	2
10	298647-A	Hose 7/8 10 x 16 Long	1
11	239138	Drain Cock 1/8"	1
12	298641	Hose and Drain Adaptor	1
13	298642-A	Hose 1/2 10 x 21-1/2 Long	1
14	374747-A	Hose Clamp	2
15	241019	Hose Fitting 90" x 3/8	1
16	299805	Raw Water Pump	1
17	261044-A	Gasket, Raw Water Pump	1
18	298478	Coupling, Water Pump	1
19	230371	Roll Pin, 3/16 x 7/8 Long	1
20	285305	Washer, Lock Split 3/8	2
21	231080	Hex HD Cap Screw (3/8-16 x 1" Long)	2
22	298645	Hose 7/8 10 x 4-3/4 Long	1
23	298644	Hose Connector	1
24	298583	Thermostat Housing	1

COOLING SYSTEM GROUP



ITEM	PART NO.	DESCRIPTION	UNIT
25	298843	Gasket, Thermostat Housing	1
26	299798	Thermostat Assembly	1
27		Stud	2
28		Washer, Plain	2
29		Washer, Lock Split	2
30		Hex Nut	2
31	298841	Hose, Water Return	1
32	298842	Clamp, Hose	2
33	298840	Pipe, Water Return	1
34	298839	Gasket, Water Flange	1
35	298838	Flange, Water	1
36	299066	Temperature Sender (Not Shown)	
37			
38			
39			
40	298904	Spare Parts Kit (Not Shown)	1
41	262249	Hand Sump Pump (Not Shown)	1

INSTRUMENT PANEL

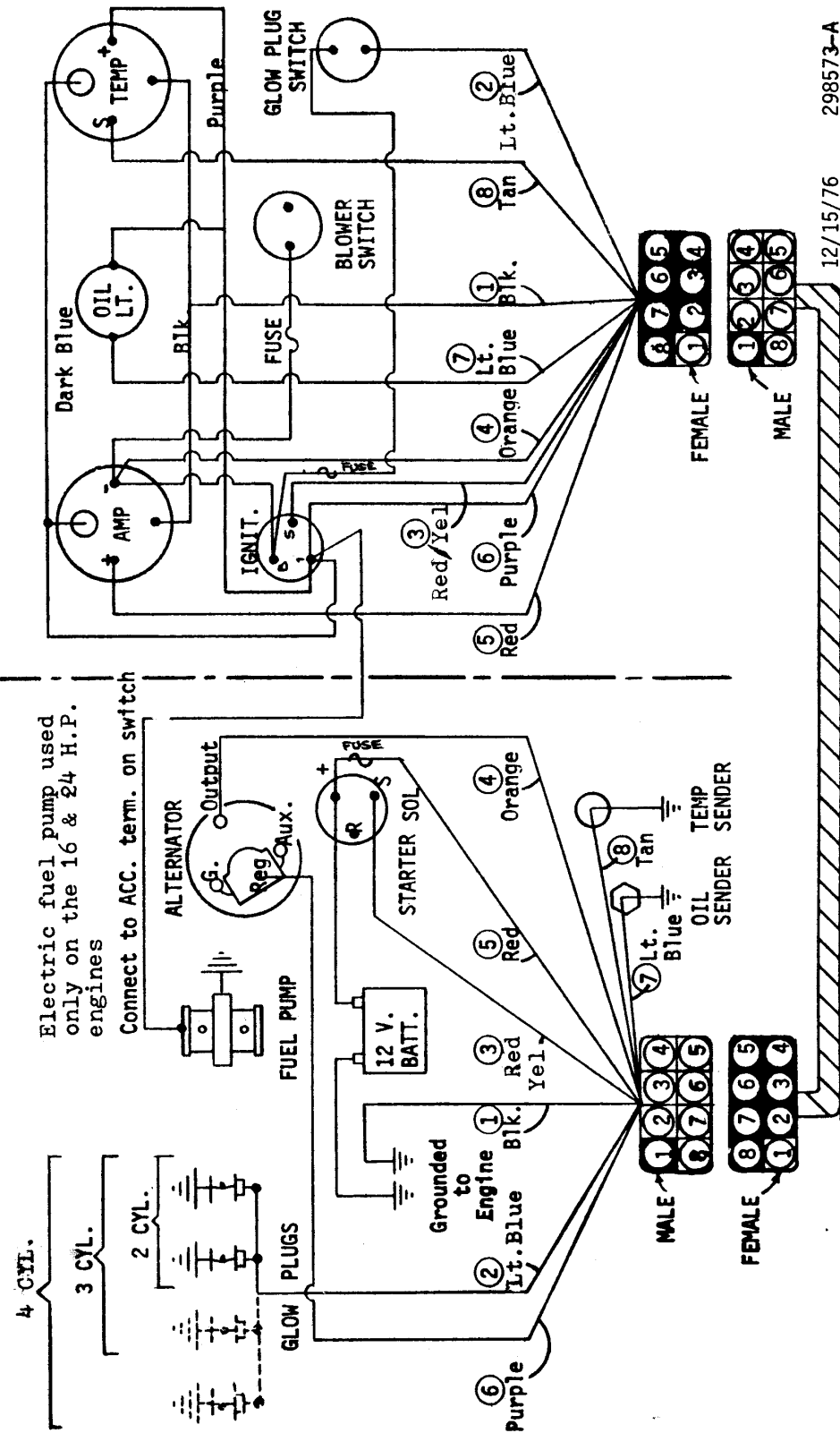
PART NO.	DESCRIPTION	UNIT
298559	Instrument Panel Complete	Optional
298572	Panel	1
298385	Ammeter	1
299240	Oil Indicator Light	1
298383	Temperature Gauge	1
299190	Ignition Switch	1
299650	Blower Switch	1
299754	Blower Switch Plate	1
299839	Glo Plug Switch	1
299755	Glo Plug Switch Plate	1
299756	Caution Plate	1
299651	Fuse – 10A	1
299066	Temperature Sender – 1/4”	1
298584	Panel Harness	1
298585	10 Ft. Extension Harness	1
298586	Engine Wire Harness	1
	OR	
299732	Instrument Panel Complete with 299263 Tachometer and All Other Components Listed Above.	
256748	Spare parts Kit	Optional
256735	Gasket Set	Optional

(Used on instrument panel Spec. dwg. #298559-A)

Universal Diesel

ENGINE CONNECTIONS

PANEL CONNECTIONS



UNIVERSAL DIESEL

Model 20 & 30
(5416, 5424)

SERVICE MANUAL



Universal Motors

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Specifications

MODELS	15 (5411)	20 (5416)	30 (5424)	40 (5432)	50 (5444)
Horsepower	11	16	24	32	44
No of Cylinders	2	2	3	4	4
Bore & Stroke	2.67 x 2.75	2.99 x 3.23	2.99 x 3.23	2.99 x 3.23	3.3 x 3.25
Displacement (Cu. In.)	31	45	68	91	115
Maximum RPM	3000	2800	2800	2800	3000
Compression Ratio	22:1	21:1	21:1	21:1	21:1
Type	Vertical, water cooled, 4-cycle diesel engine				
Electrical Equipment	12 volt, 55 AMP Alternator, Electric Starter & Glowplugs				
Fuel Pump	Mechanical	Electric	Electric	Mechanical	Electric
Lubrication (Engine)	2.2 Qts	3.7 Qts	5.6 Qts	11.5 Qts	8.5 Qts
	Use SAE 30 HD (CD) or 10W40 heavy duty diesel lubricating oil				
Lubrication (Transm'n)	Fill to mark on dipstick with automatic transmission fluid Type A				
Transmission Reduction	2:1				
Cooling System (7 psi cap)	Sea water cooled	Fresh water cooling system			
		4.8 Qts	6 Qts	8 Qts	8 Qts
		14psi	14psi	14 psi	14 psi
Sea Water Inlet & Outlet	3/8" NPT				
Exhaust Flange	1 1/4" NPT			1 1/2" NPT	
Fuel	Diesel fuel number 2-D				
Fuel Inlet Hose	5/16" I.D.				
Filter, Fuel Oil	298854	298854	298854	298854	298854
Filters, Lubrication Oil	299381	298852	298852	299584	299927
Governor	Centrifugal type - all speeds				

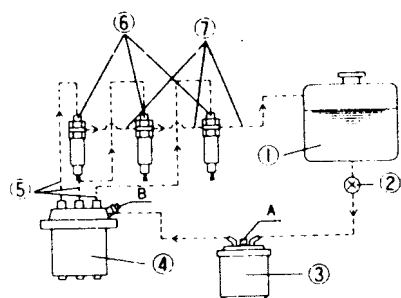
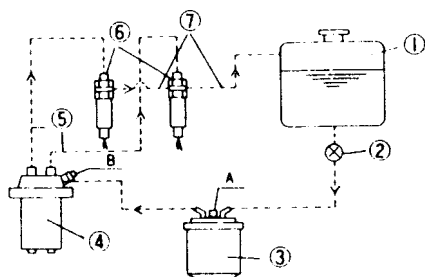
MODELS	15 (5411)	20 (5416)	30 (5424)	40 (5432)	50 (5444)
Operating Temperature	135° to 150°	175° to 190° F			
Maximum Operating Angle	15°				
Engine Rotation	Clockwise when viewed from V-belt end				
Propeller Rotation	Right Hand (Both Standard & V-Drive)				
Engine Weight (Pounds)	245	365	425	490	545
Length (Overall)	25.6"	28.0"	32.5"	36.2"	36.0"
Height (Overall)	21.2"	24.1"	24.6"	26.0"	26.0"
Width (Overall)	20.7"	20.7"	20.7"	20.7"	21.4"
Injection Nozzle					
Injection Timing	25° before top dead center – all models				

Construction and Handling

2.1 Fuel System

♦ Fuel system

The fuel system schematic is shown in Fig. 1 with the fuel flowing in the direction indicated by the arrows. To bleed air from the system, loosen the vent plug "A" on the fuel filter and crank the engine until there are no more air bubbles from the vent. Tighten vent A' and purge the air from the injection pump at vent "B" using the same procedures.



- a) Fuel tank
- b) Fuel cock
- c) Fuel filter
- d) Fuel injection pump
- e) Injection pipe
- f) Nozzle holder
- g) Overflow pipe
- A. Vent plug, filter
- B. Vent plug, pump

Fig. 1. Fuel System

♦ Fuel-filter

The fuel filter is of the cartridge type shown schematically in Fig. 2. Under normal conditions it should only have to be replaced every 400 hours. To install, apply a small amount of fuel to the packing and tighten securely by hand. For removal, the use of a filter wrench 15221—86611 is recommended.

- 1. Fuel Filter
- 2. Cover
- 3. Pipe coupling
- 4. Vent plug
- 5. "O" ring
- 6. "O" ring
- 7. Element

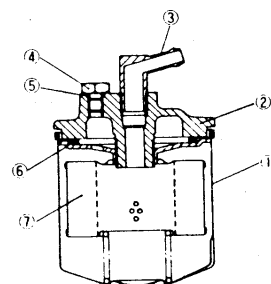


Fig. 2. Fuel Filter

♦ Fuel injection timing

Fuel injection timing is adjusted by changing the number of shims used between the pump and the gear case it fits into. See Fig. 3. One shim corresponds to approximately 1.5 degrees in crank angle. Therefore, injection will take place 1.5 degrees later when a shim is added and 1.5 degrees earlier when a shim is removed. The timing is correct when the pointer in the peephole on the side of the flywheel housing lines up with the "F 1" marked on the flywheel. See Fig. 4.

Fuel injection pump Speed control lever

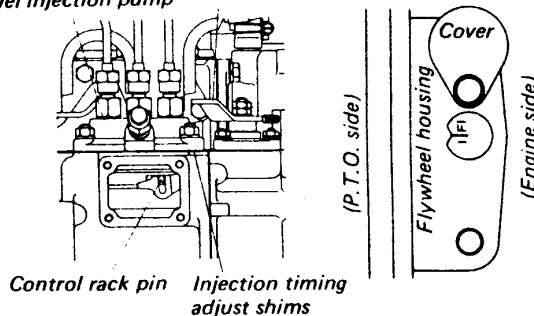
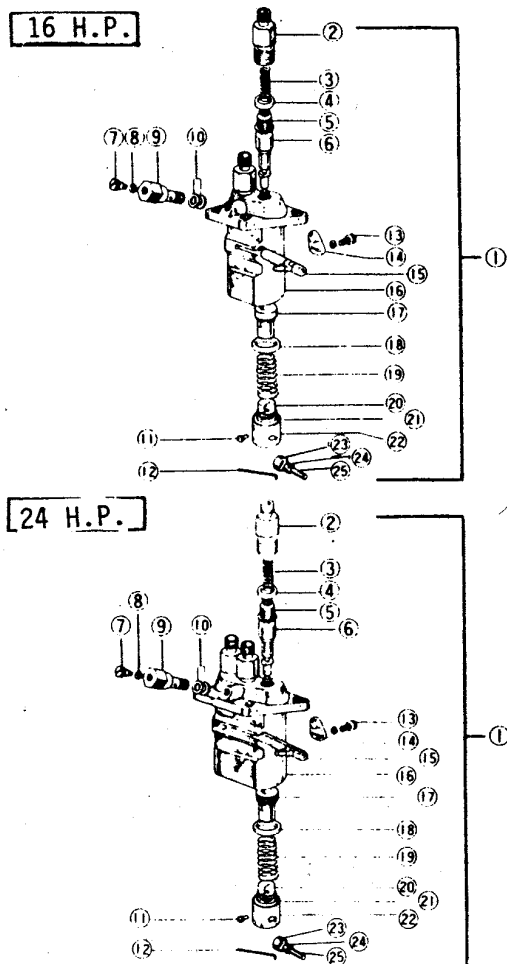


Fig. 3. Adjustment of Injection Timing

Fig. 4. Inspection of Injection Timing

◆ Fuel injection pump

The fuel injection pump is the Bosch "Mine K-type". It is a precision piece of equipment machined to close tolerances and its performance directly affects the performance of the engine. Therefore, handle it with care.



- | | |
|--------------------------|------------------------|
| 1. Injection pump ass'y | 14. Adjusting plate |
| 2. Delivery valve holder | 15. Control rack |
| 3. Delivery valve spring | 16. Pump housing |
| 4. Delivery valve gasket | 17. Control sleeve |
| 5. Delivery valve | 18. Upper spring sheet |
| 6. Cylinder pump element | 19. Plunger spring |
| 7. Air bleeder screw | 20. Lower spring sheet |
| 8. Packing | 21. Shim |
| 9. Hollow screw | 22. Tappet ass'y |
| 10. Packing | 23. Roller |
| 11. Tappet guide pin | 24. Roller bushing |
| 12. Clamp pin | 25. Roller pin |
| 13. Bolt | |

Fig. 5. Fuel Injection Pump

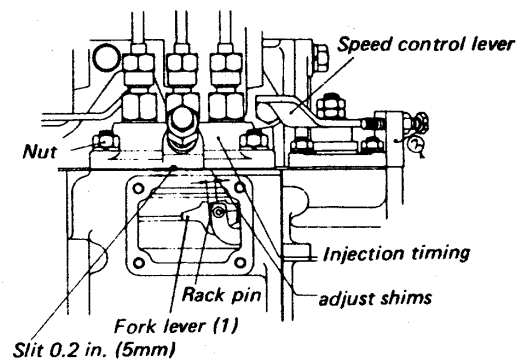
◆ Handling the injection pump

Use care in handling and using the injection pump. As mentioned before, the injection pump is a precision piece of equipment and care should be taken not to drop it or clamp it tightly when working on it. Also, be sure to use only clean fuel that has been filtered. Oil drums left outdoors are always considered to contain water, so always filter this fuel before using.

Clean fuel is a must as the fuel is forced through parts of the pump and nozzle with clearances of 0.0004 in. (1/1000mm) which may easily be stuck or rusted by even the slightest amount of water in the fuel.

◆ Installing the injection pump

When installing the injection pump, make certain that the control rack pin is correctly placed in the 0.2 in. (5mm) wide groove of the fork lever (1) before tightening the attaching bolts. Refer to the diagram. If the bolts are drawn down with the rack pin off the groove, the rack may over travel and stick in this position. This would cause excess fuel flow, allowing the engine to overspeed which would result in engine failure.

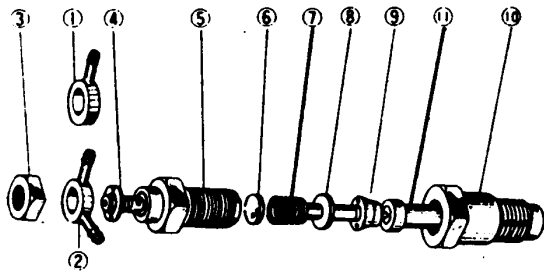


◆ Fuel injection nozzle

The fuel injection nozzle, like the fuel injection pump, is also a precision piece of equipment and should be treated with the same amount of care.

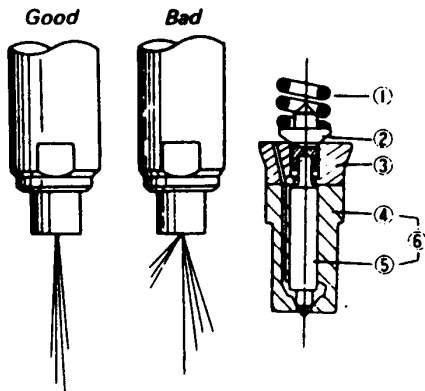
◆ The nozzle cracking pressure

The nozzle cracking pressure is adjusted by adding or subtracting shims from the top of the nozzle spring. Adding a 0.004in. (0.1mm) shim will increase the cracking pressure by about 142 psi. (10 kg/cm²). The nozzle cracking pressure is 1990 to 2133 psi. (140 to 150 kgf/cm²)



- | | |
|-----------------------|------------------------|
| 1. Delivery nipple 1 | 7. Nozzle spring |
| 2. Delivery nipple 2 | 8. Push rod |
| 3. Nut | 9. Pressure pin holder |
| 4. Washer | 10. Nozzle nut |
| 5. Nozzle holder body | 11. Nozzle piece |
| 6. Adjusting washer | |

Fig. 6. Fuel Injection Nozzle



- | | |
|------------------------|-----------------|
| 1. Pressure spring | 4. Nozzle body |
| 2. Pressure pin | 5. Needle valve |
| 3. Pressure pin holder | 6. Nozzle piece |

Fig. 7. Nozzle

◆ Spray pattern

The nozzle cracking pressure and fuel spray pattern are most accurately checked by using a nozzle "pop test" stand. If a "pop test" stand is not available, remove the nozzles from the engine, leaving the pressure lines connected.

[[CAUTION]]

Hold nozzles so that the high pressure spray from them will not in any way impinge upon unprotected skin. The atomized fuel will easily penetrate the skin and cause blood poisoning.

Set the speed control lever at W. O. T. and operate the starter. The needle valve, if it is working properly, will produce a high pitched pulsating sound like that of a flute as fuel is sprayed out. If this sound is not heard or other problems are noted, refer to the "Fuel Injection Pump & Nozzle Maintenance Std." in 4.1 in "Engine".

[[Precaution]]

- (1) Assembly and disassembly of the nozzle should be done in fresh clean fuel
- (2) The nozzle should always be installed as an assembly, never by component parts
- (3) Remember never to let the nozzle spray contact unprotected flesh
- (4) Tighten the retaining nut to 43.5 to 58 ft-lb (6 to 8 kgf.m) Any torque higher than this will cause slow action of the needle valve and poor injection.

2.2 Lubrication System

◆ Oil pump pick-up screen

The oil pump pick-up is located in the crankcase as shown in Fig. 9 and is fitted with a metal screen. If the screen becomes plugged, wash it off with diesel fuel or kerosene.

◆ Lubrication system

The entire lubrication system is illustrated in Fig. 8. Oil from the pump is forced through the replaceable paper element filter. The filter is equipped with a pressure regulated valve to keep the pressure through the filter at 64—71 psi. (4.5—5 kgf/cm²). From the filter part of the oil goes to the crankshaft to lubricate the crankpins and the remainder goes to lubricate the rocker arms.

An oil pressure switch is located in the passage from the filter and controls the oil pressure. If the oil pressure falls below 14 psi. (1.0 kgf/cm²) the oil warning lamp will light on the dash panel. If the oil pressure lamp stays on after the engine is running at normal speed, shut the engine off immediately. Find and correct the cause of the low oil pressure before operating again.

If the pressure regulating valve in the filter fails and the pressure rises, a safety valve will limit the pressure to 140 psi. (10 kgf/cm²)

[[Probable cause of low oil pressure]]

- (1) Clearance on one of the bearings is too great
- (2) One of the rocker arms is too loose
- (3) Faulty pressure regulating valve; pressure lower than normal (replace the oil filter or clean the valve on the old one with kerosene or diesel fuel.)

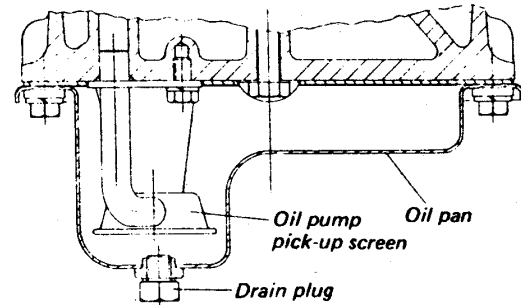
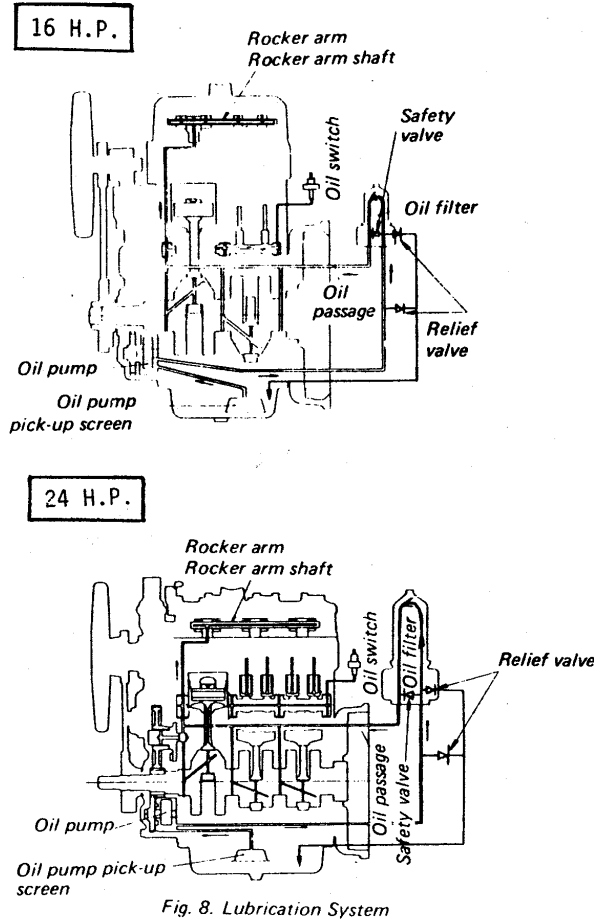


Fig. 9. Detail of Oil Pump Pick-up

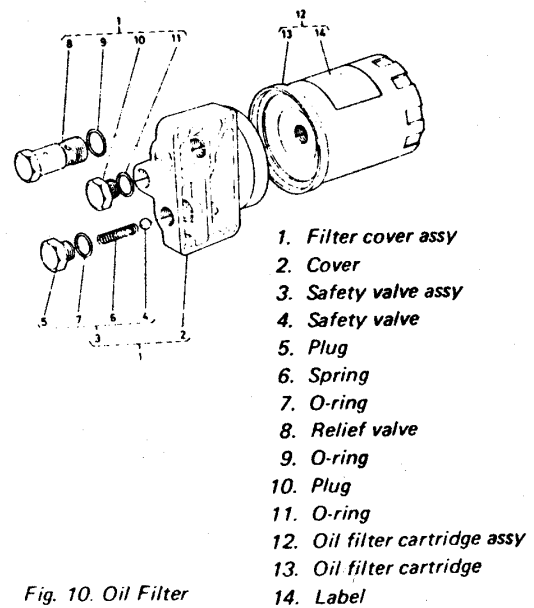


Fig. 10. Oil Filter

◆ Oil Filter

- (1) Replace the oil filter at every other oil change (every 150 hours)
- (2) Under normal conditions it is only necessary to change the oil filter at specified intervals. If, however, the engine is used in EXTREMELY dirty conditions, the pressure regulating valve and safety valve should also be removed and cleaned.
- (3) Whenever the oil filter is replaced, run the engine under no load for a few minutes until the filter has been filled and then add oil to make up for what is contained in the filter.

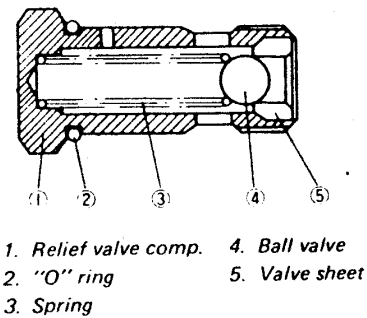
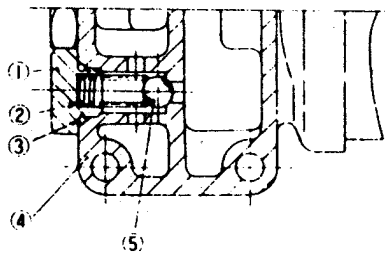


Fig. 11. Pressure Regulating Valve



1. Safety valve body
2. Safety valve spring
3. "O" ring
4. Oil filter base
5. Safety valve

Fig. 12. Safety Valve, Complete

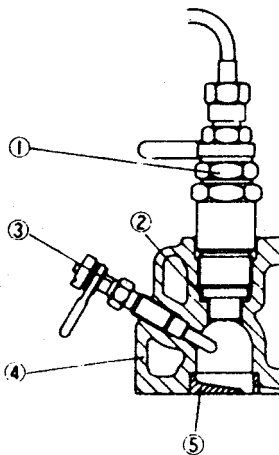
◆ Replacing engine oil

- (1) Drain and replace the engine oil after the first 35 hrs of operation and every 75 hrs thereafter.
- (2) The oil is easier to change if the engine is warm.
- (3) Do not mix different brands of oil. If a different brand of oil must be used, drain the oil and replace with all one brand. Also, do not mix oils of different viscosities.

2.3 Combustion System

◆ Combustion chamber

The engine utilizes a swirl type pre-combustion chamber. See (Fig. 13). Fuel and air are mixed in this chamber resulting in more efficient combustion. A glow-plug is employed to preheat the fuel for easy starts down to 5°F (-15°C).



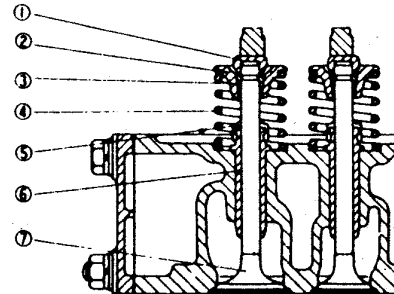
1. Nozzle holder
2. Nozzle piece packing
3. Glow plug
4. Cylinder head
5. Combustion chamber

Fig. 13. Combustion Chamber

◆ Valve

Combustion air, of course is brought in through the intake valve when the descending piston creates a partial vacuum in the cylinder.

Valve stem seals should be replaced whenever they are removed. If the stem seal are replaced, coat the stem liberally with oil before inserting in the valve guide to prevent burning the valve stem seal.



1. Valve cap
2. Valve spring retainer
3. Valve spring collet
4. Valve spring
5. Valve stem seal
6. Valve guide
7. Valve

Fig. 14. Structure of Valves

The dimensions of the replacement valves and valve guides are shown in Fig 16. When new valve guides are installed, the bores should be reamed to 0.316 to 0.315 in. (8.030 to 8.015mm) after installation. The valve head must be recessed 0.043 to 0.055 in. (1.1 to 1.4mm) from the face of the cylinder head to prevent it from hitting the top of the piston.

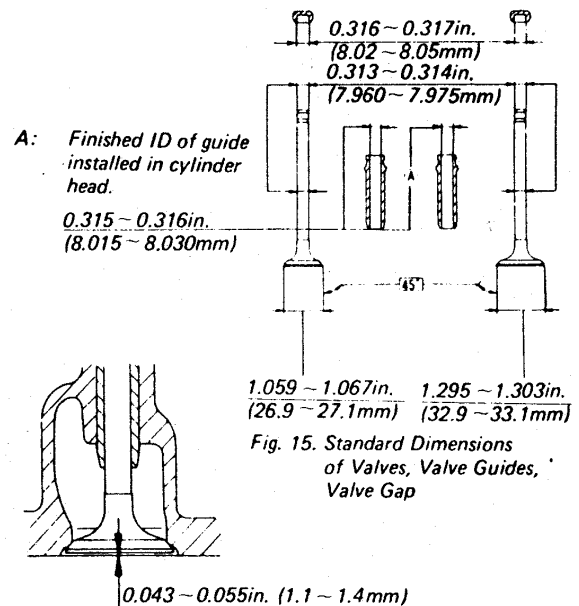


Fig. 15. Standard Dimensions of Valves, Valve Guides, Valve Gap

Fig. 16. Sinking of Valve

◆ Valve timing

When the valve clearance has been adjusted as shown in Fig. 17, the standard valve timing shown in the chart can be attained.

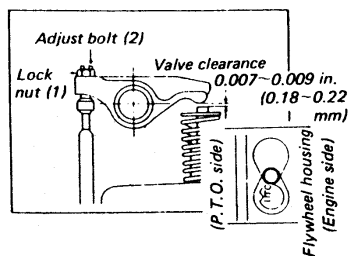


Fig. 17. Adjustment of Valve Clearance

Intake valve opens	20° B TDC
Intake valve closes	45° A TDC
Exhaust valve opens	50° B TDC
Exhaust valve closes	15° A TDC
Valve clearance 0.007 to 0.009 in. (0.18 to 0.22 mm.) with engine cold	

◆ Rocker Arms

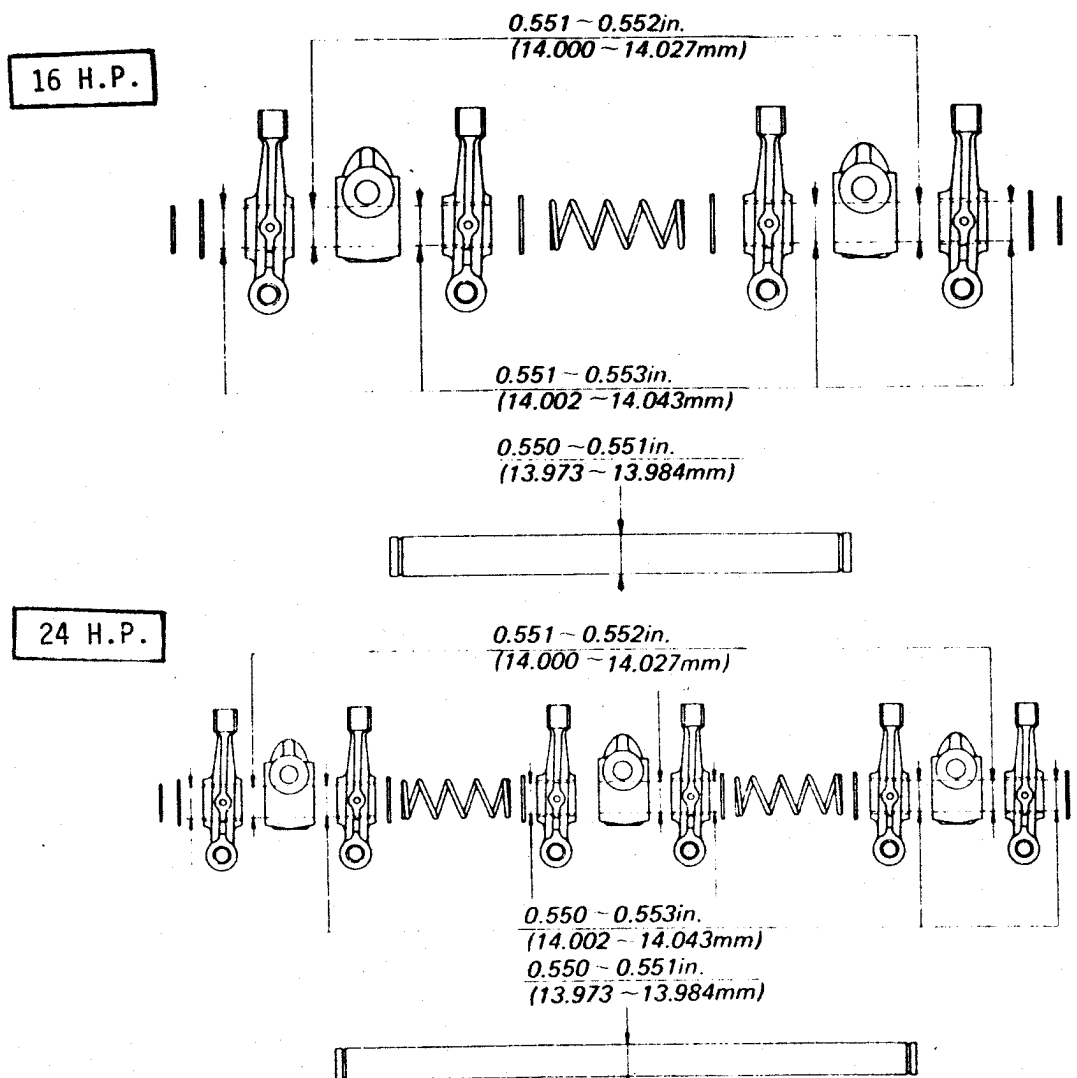


Fig. 18. Standard Relative Position of Rocker Arms

◆ **Compression release (Release wire is optional parts)**

Assemble the parts as shown in Fig. 19. Pull the lever out as far as it will go. Check to see that the 60° angle is attained and that compression is released. The compression release is to be used when the battery is low or when starting in cold weather. To use the compression release, preheat the glow plug as usual, pull the compression release knob out as far as possible and hold it there while cranking the engine. This partially releases the engine compression enabling it to turn faster in cold weather or when the battery is low. Once the engine is turning fast enough to start, release the lever and engine will start.

[[NOTE]]

Make sure the compression release has returned to the operating position by pushing the knob all the way in.

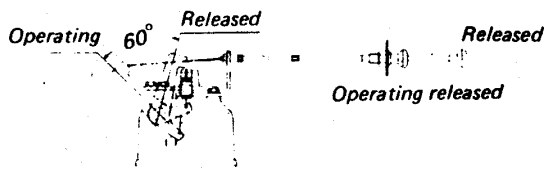


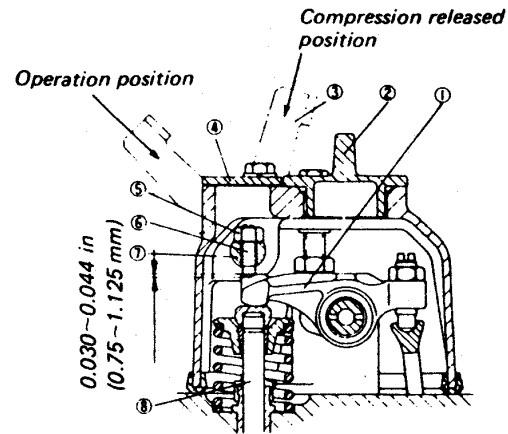
Fig. 19. Compression Released

[[CAUTION]]

Do not pull the compression release lever when the engine is running at high speed or under load. If it is necessary to use the compression release while the engine is running reduce the speed to idle before doing so.

◆ **Adjustment of compression release**

- 1) Set exhaust valve in totally closed position.
- 2) Remove decompression adjustment window cover from cylinder head cover.
- 3) Make valve clearance as "0" with use of decompression adjust bolt. From this position, turn the bolt further by 1 to 1.5 turns. Decompression clearance will then be set at 0.030 to 0.044 in. (0.75 to 1.125mm), which is the designed clearance.
- 4) After adjusting, be sure to lock adjust bolt securely so that it will not unturn while engine is in service.
- 5) Make certain that the clearance is not too wide. To check this, turn crankshaft by hand and make certain valve disk does not contact with piston top.



- | | |
|------------------------------|-----------------------------|
| 1. Rocker arm | 5. Compression release nut |
| 2. Oil filler cap | 6. Compression release bolt |
| 3. Compression release lever | 7. Shaft |
| 4. Adjustment access cover | 8. Valve |

Fig. 20. Adjustment of Compression Release

◆ **Top clearance**

Top clearance should be 0.028 to 0.035 in. (0.7 to 0.9 mm). To adjust, use cylinder gasket shims, 0.006 in. (0.15mm) thick each, onto the head side.

For checking the measurement, place a piece of fuse on the piston top and fix the cylinder head securely on the cylinder-head flange. The measurement is taken by the fuse. The liner is level with the cylinder frame at top surface.

The gasket shims can be reused, so do not lose them.

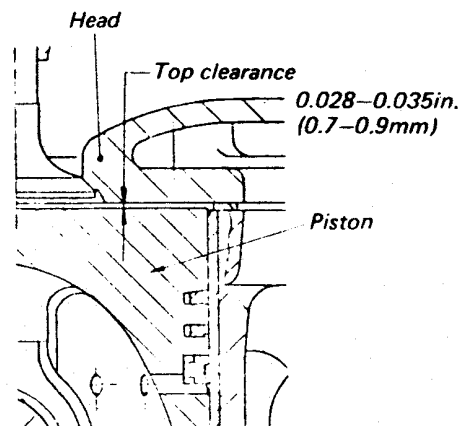


Fig. 21. Top Clearance

◆ Boring and replacing the cylinder liner

Referring to Fig. 22, the inside diameter of the liner should be checked at points 1, 2, and 3 and in the directions (a) and (b). The liner on which the wear has exceeded the service limit can be bored and honed to 0.020 in (0.50mm) oversize. The finished dimensions are 3.012 to 3.013 in: (76.500 to 76.519mm) Models 5416 and 5424.

An oversized piston and rings must then be used with this liner. Once this oversized liner has exceeded its wear limit, it should be replaced with a new one. To install a new liner, coat the outside liberally with oil, push into the block with a press and finish to the standard size. When this is done, a standard size piston must again be used.

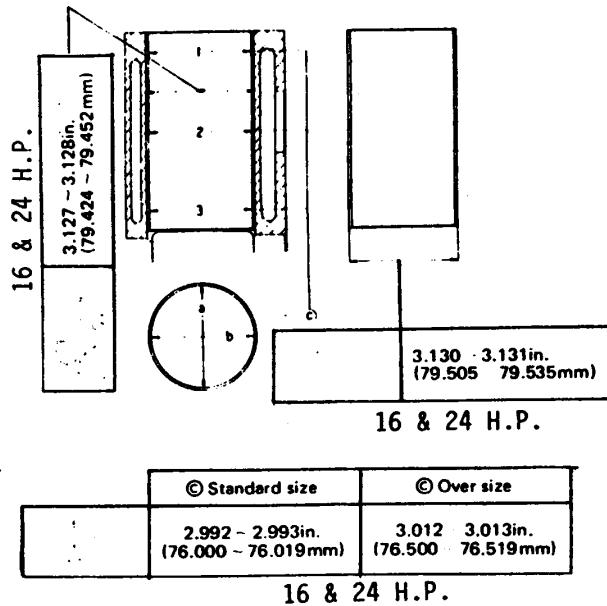


Fig. 22. Standard Dimensions of Cylinder Liner and Liner Bore in Block

◆ Tightening Cylinder Head Capscrews (Fig. 23)

- (1) The tightening torque of the cylinder head capscrews is 54 to 58 ft.lbs. (7.5 to 8.0 kg.m). Numbers 7, 8, 11 and 13 (◆) are studs. The nuts on these studs should also be tightened to this torque.
- (2) All the capscrews must be tightened uniformly. To do this, tighten all the capscrews in the order indicated on the diagram until they are just snug. Then tighten each one (1) turn at a time in this same sequence until all have been tightened to the required torque.
- (3) The cylinder head capscrews should be re-tightened if the engine has not been used for a long time. The valve lash should also be adjusted each time the cylinder head capscrews are retorqued. If the cylinder head gasket has been replaced, run the engine for about 30 minutes and re-tighten the cylinder head capscrews as described above.

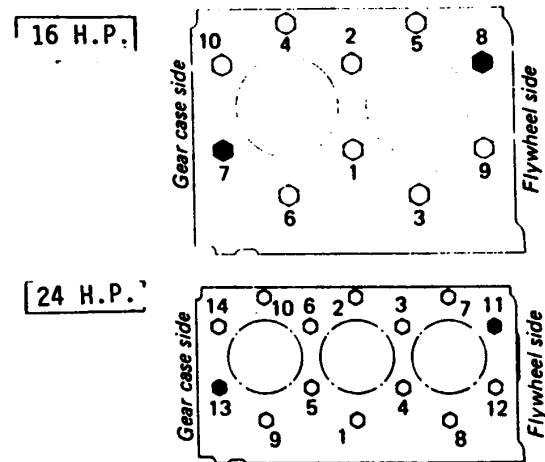


Fig. 23. Tightening of Cylinder Head Bolts

Main Moving Parts

◆ Pistons and piston rings

The pistons and piston rings are shown in Fig. 26. If the cylinder liners have been bored oversize, oversize pistons and rings must be used. The piston is made of high silicon J-Alloy and is cam ground. The top compression ring is a chrome plated keystone type, the second compression ring is discontinuous and undercut and the oil control ring is of the standard expansion type.

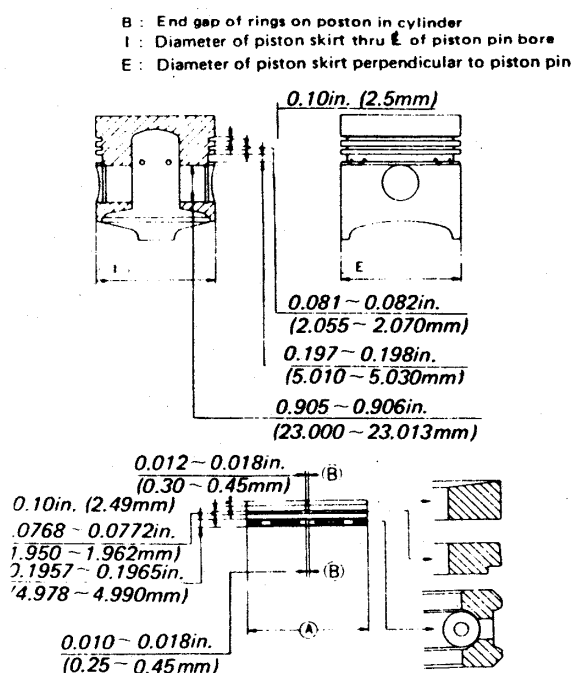


Fig. 26. Standard Dimensions of Piston and Piston Rings

	Standard size	Over size
A	2.992 in. (76 mm)	3.012 in. (76.5 mm)
I	2.986 ~ 2.987 in. (75.839 ~ 75.859 mm)	3.005 ~ 3.006 in. (76.339 ~ 76.359 mm)
E	2.989 ~ 2.990 in. (75.915 ~ 75.935 mm)	3.008 ~ 3.009 in. (76.415 ~ 76.435 mm)

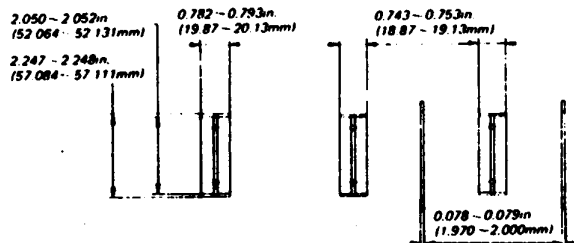
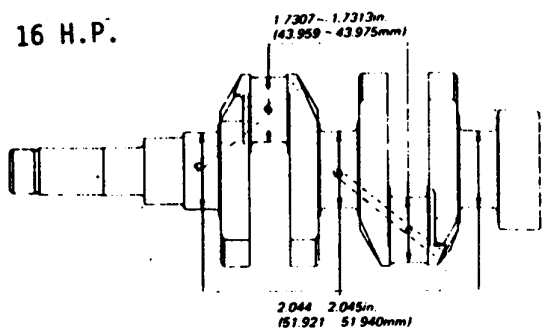
Over size	Name of part	Mark
0.02 in. (0.5 mm)	Piston 05 Piston ring 05	05 OS 05 OS
	Cylinder liner	3.012 to 3.013 in. (76.500 to 76.519 mm) (1.2 μ R max. to 2 μ R max.) by honing.

◆ Crankshaft and connecting rod

- The crankshaft is a heat treated steel alloy forging. The crank pins are induction hardened for additional wear resistance. Crankshaft endplay is 0.006 to 0.012 in. (0.15 to 0.31 mm).
- The crankpin bearings are aluminum. When installing the connecting rods:
 - Clean both surfaces thoroughly.
 - Apply engine oil to the threads of the connecting rod capscrews before installing and tighten each to 27 to 30.4 ft-lbs. (.3.7 to 4.2 kg-m).

The bearing caps are matched to each connecting rod and should not be interchanged. Also, since there are variations in machining from side to side, each bearing cap and connecting rod are marked and should be assembled so that marks line up.
- In the event that the crankpins become worn and are no longer serviceable, undersized hearings may be used. When installing the undersize bearings observe the following precautions:
 - Machine the crankpin diameter and radii to within a few thousandths of the correct dimensions and finish grind to the exact dimensions.
 - After finish grinding the bearing diameter and the radii, chamfer the diameter of the oil hole with an oilstone. If this is not done an oil film will not form and the bearing will seize.
 - The crankpin should always be super-finished to 0.000016 in. (0.0004 mm) or less.
 - Select the bearing from the chart that necessitates the removal of the least amount of metal from the crank-pin. Do not deviate from the chart dimensions as the bearing life will be reduced if they are machined.
 - To determine the running clearance, assemble the connecting rod, bearing cap and bearing as described in section 2 and measure the diameter anywhere within the 120° angle indicated in Fig. 28 and subtract the crankpin diameter from this figure.
 - The piston pin bushings are of lead bronze. The inside diameter of the bushing should be finished to 0.906 to 0.907 in. (23.025 to 23.040 mm).

16 H.P.



24 H.P.

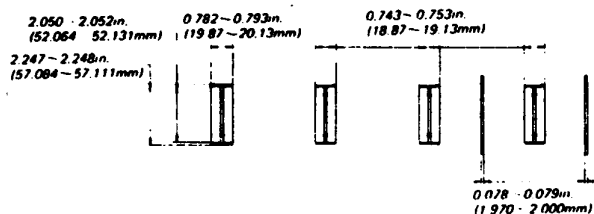
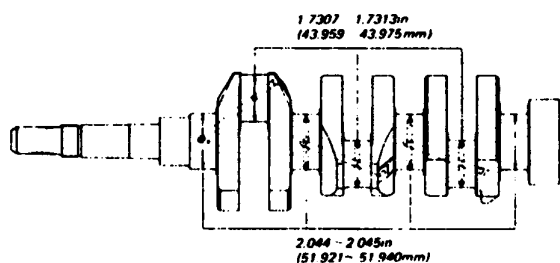


Fig. 27. Standard Dimensions of Crankshaft and Bearings

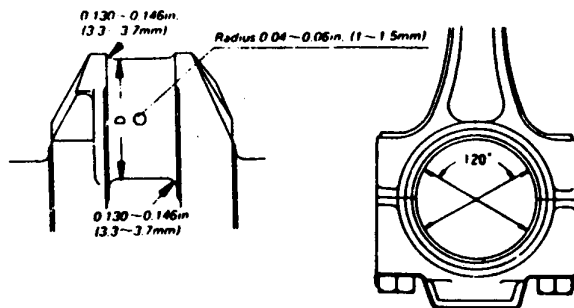
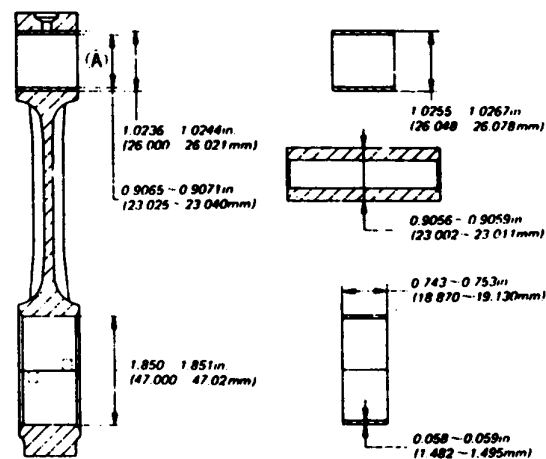


Fig. 28. Crankpin for Undersize Bearing



(A) : Diameter of piston pin bushing after installation

Fig. 29. Standard Dimensions of Connecting Rod Bearing and Bushing

Size	Part No	Bearing	Crankpin Diameter	Metal Mark	Running Clearance in. (mm)
020		0.20 mm undersize	1.7228 to 1.7234 in. (43.759 to 43.775 mm)	020 US	0.001379 to 0.003819 in. (0.035 to 0.097 mm)
040		0.40 mm undersize	1.7149 to 1.7156 in. (43.559 to 43.575 mm)	040 US	

Main Components

◆ Gear train

Be sure to assemble the gears by matching the mating marks as shown in Fig 30. The backlash of each gear is 0.002 to 0.005in. (0.0415 to 0.1154mm).

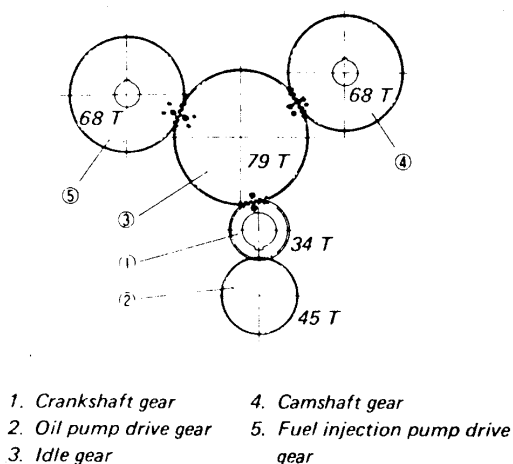


Fig. 30. Mating Marks of Gear Train

◆ Crankshaft gear

Heat to about 176° F (80° C) and slide on crankshaft. If the shaft and bore dimensions are such that the gear will not slide easily, it may be heated to a slightly higher temperature for installation.

◆ Camshaft gear

Refer to Fig. 31. Place the camshaft retainer plate on the camshaft first. Shim the camshaft retainer plate out from the camshaft 0.003 to 0.009 in. (0.07 to 0.22 mm) with shims that can be pulled out after the gear is installed. Heat the gear to approximately 176° F (80°C) and slide on the shaft until it butts against the retainer plate. Remove spacer shims. If gear will not slide on the shaft easily it too may be heated to a slightly higher temperature as described above.

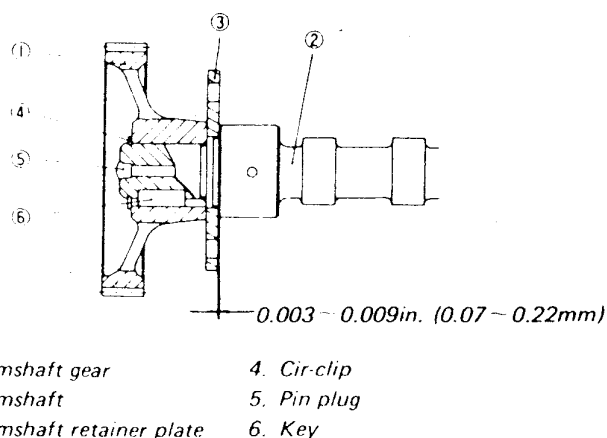


Fig. 31. Assembly of Camshaft Gear with Camshaft

◆ Camshaft and camshaft bearings

Standard dimensions are shown in Fig. 32. Camshaft running clearance is: 0.002 to 0.004 in. (0.05 to 0.091 mm)

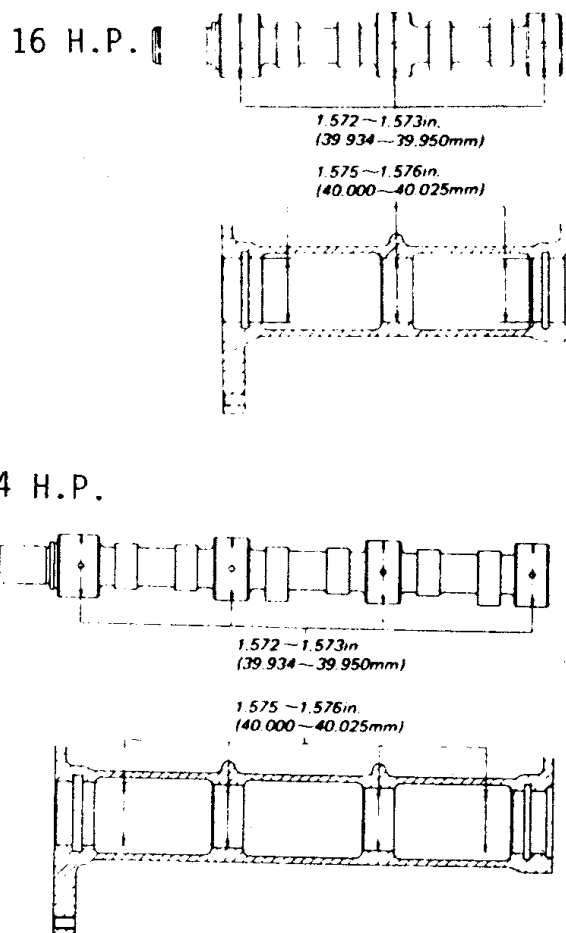
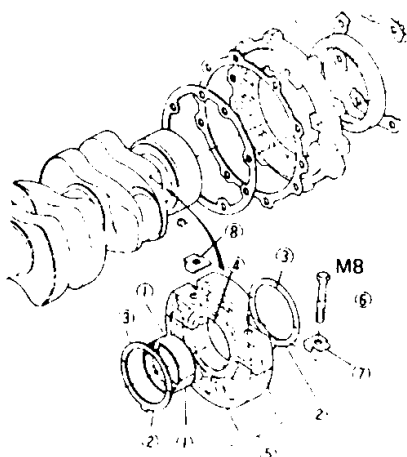


Fig. 32. Standard Dimensions of Camshaft and Bearings

◆ Main bearing ass'y

Insert the bearings in the main bearing housing halves as indicated in Figs. 33 & 34, using the thrust washers only on the journal nearest the flywheel. Coat the crankshaft journals and the bearing surfaces with engine oil, place the housing halves with bearings on the crankshaft, coat the capscrew threads with engine oil and tighten to 21 to 25 ft-lbs (3 to 3.5 kg-m) – M8

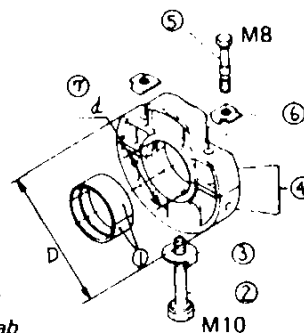


1. Bearing
2. Thrust washer
3. Thrust washer
4. Crankshaft journal
5. Main bearing
6. Cap screw
7. Locking tab
8. Locking tab

Fig. 33. Main Bearing Housing 3 with Thrust Washers

◆ Main bearing housing

Installation of crankshaft with main bearings in engine block. Slide the crankshaft assembly into the engine block, being careful not to nick or scrape the crankpins. After the assembly is in position make sure the oil passages are correctly lined up. Install the main bearing housing to engine block locking capscrew and washer from the side to position the housing and then install capscrew (2) from the bottom and torque to 47 to 50 ft-lbs (5.5 to 7 kg-m) – M10



1. Bearing
2. Cap screw
3. Locking tab
4. Main bearing housing
5. Cap screw
6. Locking tab
7. Locking tab

Fig. 34. Main Bearing Housing 1
Main Bearing Housing 2

	D	d	
Main bearing housing 1	5.156 ~ 5.157 in. (130.968 ~ 130.986 mm)	2.2047 ~ 2.2055 in. (56.000 ~ 56.019 mm)	16 & 24 H.P.
Main bearing housing 2	5.1956 ~ 5.1963 in. (131.968 ~ 131.986 mm)		24 H.P.
Main bearing housing 3	5.3137 ~ 5.3144 in. (134.968 ~ 134.986 mm)		16 & 24 H.P.

◆ Idler gear

Secure the idler gear shaft to the engine block with 3 capscrews, torque to 17 to 20 ft-lbs (2.4 to 2.8 kg-m) and bend tabs of tab washer. Install gear as shown, make sure it runs freely, has a running clearance of 0.001 to 0.002 in. (0.020 to 0.054 mm) and 0.008 to 0.020 in. (0.20 to 0.51 mm) end play.

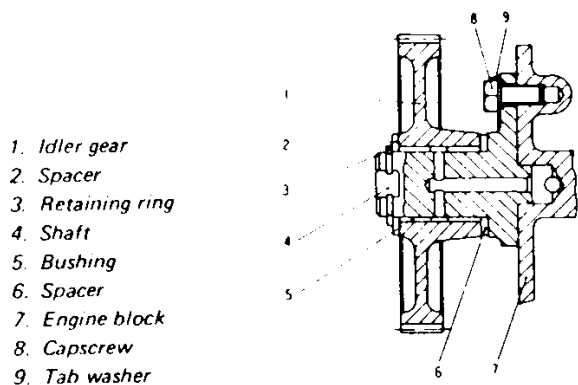
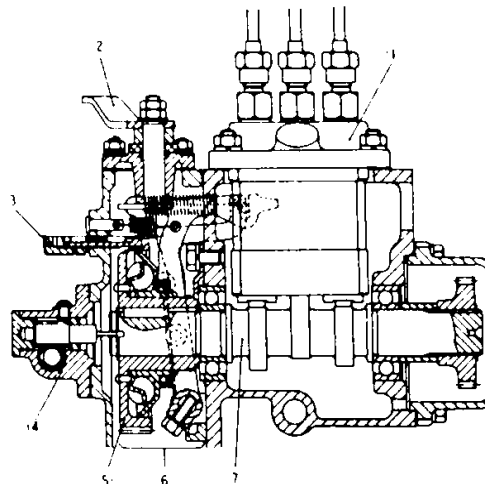


Fig. 36. Idler Gear

◆ Injection pump camshaft

Injection pump camshaft, Fig. 37. Install the bearings and governor unit on the camshaft and install in the engine block Hour Meter Unit, Fig. 37. Insert the "tang" on the end the hour meter drive shaft into the slot on the end of the injection pump camshaft and install as per the illustration.



- | | |
|------------------------|----------------------------|
| 1. Fuel injection pump | 5. Injection pump gear |
| 2. Speed control lever | 6. Governor system |
| 3. Fuel control system | 7. Injection pump camshaft |
| 4. Hour meter unit * | |

Fig. 37. Injection Pump Camshaft Assy

NOTE

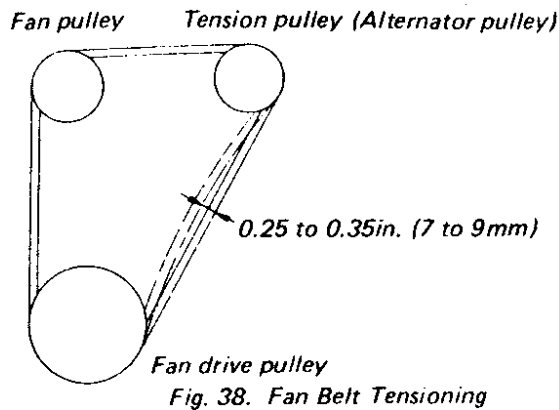
* Hour meter unit is optional parts.

◆ Attaching flywheel to crankshaft

Clean the entire contact surface carefully coat the contact surface with engine oil, wash all the oil off with gasoline and dry it thoroughly. Put the flywheel on and torque the capscrews to 70 to 77 ft-lbs (10 to 11 kg-m). Bend the locking tabs back on the washers.

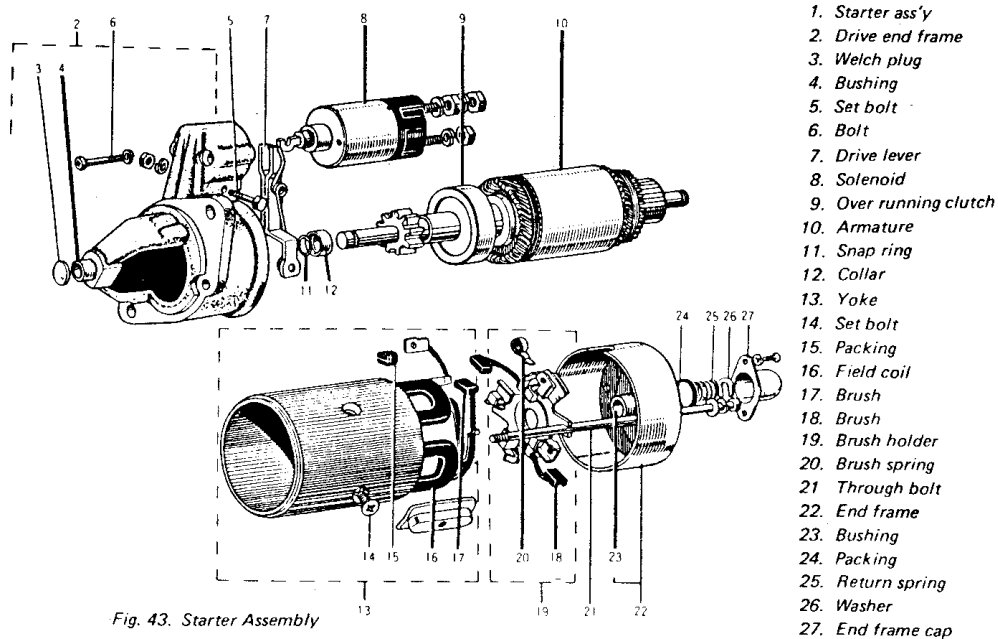
◆ Tensioning of fan belt

The fan belt tension is adjusted by moving the alternator bracket in or out. The belt is properly tensioned when the belt deflection midway between the alternator pulley and the crankshaft pulley is 0.26 to 0.35in. (7 to 9 mm) with a force of 20 lbs applied. Proper belt tension is essential for good engine cooling and belt life. See Fig. 38.



◆ Starting Motor

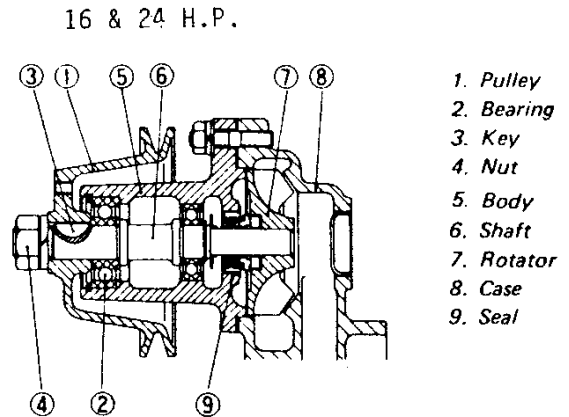
The starting motor is of the standard Bendix type drive with actuating solenoid. The assembly is shown in Fig. 43.



◆ Cooling water pump

To install the cooling fan pulley on the pump securely tighten the nut (4) to 50.6 to 57.9 ft-lbs. (7 to 8 kgf-m) torque.

- (1) Rust inhibitor and antifreeze should be used in accordance with the recommendations in the related manuals.
- (2) Be sure to remove all debris that may be plugging the fins.
- (3) Check the rubber shock mount nuts periodically to be sure they are tight.



◆ Starter Specifications

	16 H.P.	24 H.P.
Code No	298783	298876
Type	Solenoid actuated with overrunning clutch	
Nominal voltage	12V	
Nominal output	0.8 kW	1.0 kW
Direction of rotation	Clockwise viewed from pinion end	

◆ Trouble shooting

If the battery turns extremely slow or not at all, the cause may lie in the battery, wiring or the starter. The lights are a very convenient tool for tracing the cause of the trouble.

Light method

The use of this method, of course, assumes that the lights are functioning normally.

(1) Lights are dim

Probable cause: Low battery. faulty contact at one of the connections, faulty wiring. If the battery remains discharged because of a malfunction in the charging system, it should be corrected before charging the battery to prevent the problem from reoccurring.

(2) With battery fully charged:

a) Symptom. Lights do not light

Probable cause: Battery terminal not properly connected.

b) Symptom: Lights become extremely dim when cranking the engine and starter slows down or stops.

Probable causes.

Bad engine (rotational resistance too great)

Starter does not turn satisfactorily

Armature shaft bent

Worn bushing

Pole core screw loose

Field coil grounded or insulator short circuited

Armature coil grounded or insulator short-circuited

c) Lights are bright Out starter does not turn or hums very slowly.

Probable causes.

Starter terminal not connected properly

Solenoid switch not making contact

Solenoid not working (coil grounded or insulator short-circuited)

Faulty starter switch contact

Insufficient brush contact

Dirty or worn commutator

◆ Precautions in care and handling of starter motor

- (1) The starting motor must be installed properly for the starter pinion to mesh with the engine ring gear as should. If the ring gear and pinion do not mesh properly, the pinion and starter housing may be damaged and in extreme cases, the starter may not even turn.
- (2) If the starter switch is turned on and the engine turns, but will not start, the cause is probably in the fuel system. Check the fuel lines and correct as necessary.
- (3) In attempting to start an engine, never use the starting motor for more than 30 seconds at a time without a pause to let it cool down. The starting motor heats up very rapidly when used and if it is used continuously for more than 30 seconds the solder may melt from the armature or the coil or lead wires may melt. Also, the battery will be discharged to such a degree and won't have sufficient power for another attempt at starting. A good rule to follow is to crank for 10 seconds and pause for 10 seconds. Repeat until the engine starts.
- (4) If the starting motor is too far forward, the pinion will not mesh properly with the ring gear and cause rapid pinion wear. Adjust for proper mesh.
- (5) Do not turn the starter switch while the engine is running. If this is done, the pinion gear will contact the ring gear, which is turning with the full force of the engine which may cause a broken pinion, bent shaft, broken housing, etc.

◆ Glow Plugs

The glow plugs are shown in Fig. 44.

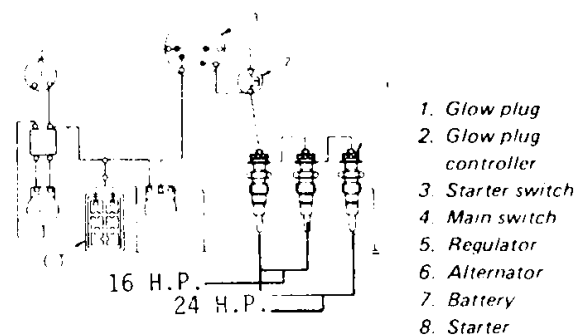


Fig. 44. Circuit Diagram for Glow Plugs

◆ **Glow Plug Specification**

	16 H.P.	24 H.P.
Code No	298795	
Number	2	3
Voltage & current	Approx 6.5 amp @ 10.5 V	

◆ **Glow Plug Controller Specification**

	16 H.P.	24 H.P.
Code No	299839	
Current	13A	20A

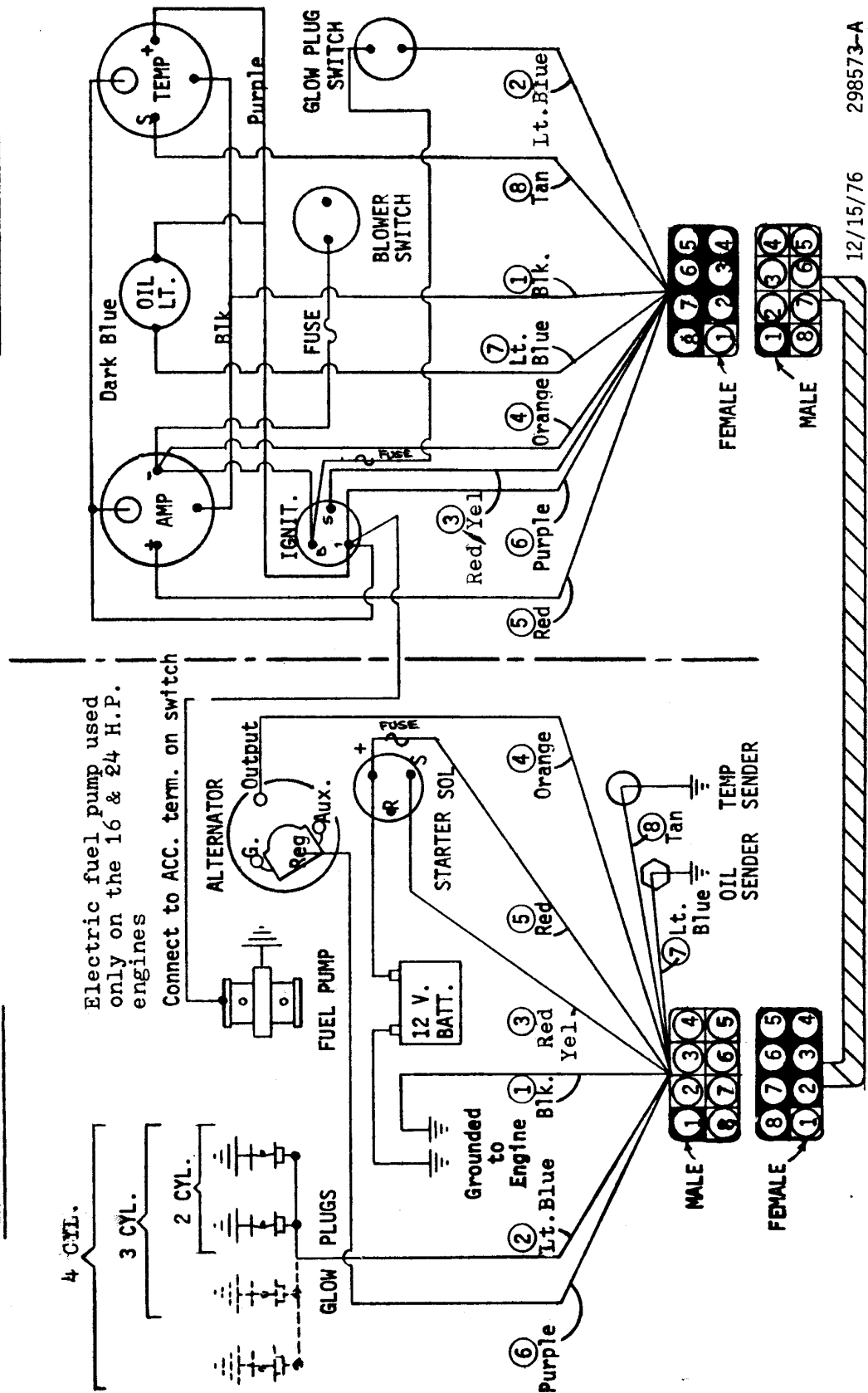
◆ **Precautions in handling the glow plug(s)**

1. Use the glow plugs only with Universal glow plug controller. If any other type is used, the heating time will not match that of the glow plugs and cause hard starting and various other problems.
2. As the glow plugs are in parallel, the controller heating element will turn red even if one of the plugs is bad. However, the time it takes for the controller heating element to get hot is less, which will cause the element to burn out.
3. Replacing a faulty glow plug may not solve all the system problems. Should the failed plug indicate problems to other areas beside the plug they should be checked out also. The most probable areas are improper fuel injection timing, bad nozzle, wrong fuel, incorrect circuit connection, gas leak, etc.

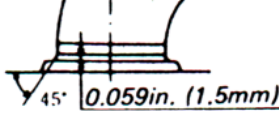
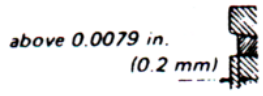
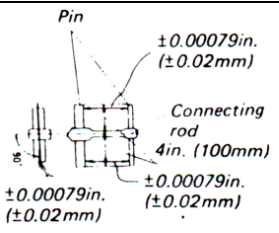
Universal Diesel

ENGINE CONNECTIONS

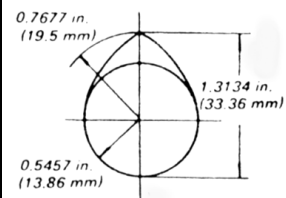
PANEL CONNECTIONS



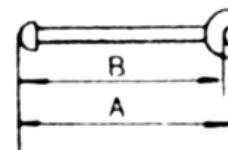
Reference Chart

Parts	Items	Specifications	Standard Value	Maximum Limit	Remarks
Cylinder Head	Cylinder head tightness	M10 x 1.25	54.2 ~ 57.9 ft. lbs (7.5 ~ 8 kg.m)		When installing apply a generous coat of engine oil onto the entire surface of each bolt. 
	Cylinder head surface distortion		0.002 in below (0.05mm below)		
	Intake/exhaust valve seat thickness	45° 0.059 in. (1.5 mm)			
	Top clearance		0.0276 ~ 0.0354 in. (0.7 ~ 0.9 mm)		
Cylinder Liner	Standard ID – 5416 & 5424	2.9921 ~ 2.9929 in (76.000 ~ 76.019 mm)		2.9980 in. (76.15 mm)	Height above block surface ± 0.00098 in (± 0.025 mm)
	050 Oversize Liner ID	3.0118 ~ 3.0126 in (76.500 ~ 76.519 mm)			
	Piston clearance (at skirt)	0.0026 ~ 0.0041 in (0.065 ~ 0.104 mm)	E side		
		0.0056 ~ 0.0071 in (0.141 ~ 0.180 mm)	I side		
Piston	Type	Dry			
	Standard OD – 5416 & 5424	2.9921 in (76 mm)			Oversize 0.020 in (0.5 mm)
	Piston-pin boss ID	0.9055 ~ 0.9060 in. (23.000 ~ 23.013 mm)		0.9071 in. (23.04 mm)	
Piston Ring	Piston-pin clearance		Interference Clearance 0.0004 in 0.0004 in (0.011mm) (0.011mm)		
	Ring gap	(top.2nd)	0.0118 ~ 0.0178 in (0.3 ~ 0.45 mm)	0.0492 in (1.25 mm)	0.5 oversize top ring surface should be 0.0079 in (0.2 mm) below piston side surface. 
		(oil ring)	0.0098 ~ 0.0158 in (0.25 ~ 0.45 mm)		
	Top ring width	Keystone type	Ring groove clearance		
Piston Pin	2nd ring width	0.0768 ~ 0.0772 in (1.95 ~ 1.962 mm)	0.0037 ~ 0.0047 in (0.093 ~ 0.120 mm)		
	Oil ring width	0.1960 ~ 0.1965 in (4.978 ~ 4.99 mm)	0.0008 ~ 0.0020 in (0.02 ~ 0.052 mm)		
	OD	0.9056 ~ 0.9059 in (23.002 ~ 23.011 mm)			
Connecting Rod	Pin to bush clearance		0.0006 ~ 0.0015 in (0.014 ~ 0.038 mm)	0.0059 in (0.15 mm)	
	Small end ID (without bush)	1.0236 ~ 1.0244 in (26.000 ~ 26.021 mm)			
Connecting Rod	Small end width	1.0236 in (26 mm)			
	Large end ID (without bush)	1.8504 ~ 1.8512 in (47.000 ~ 47.020 mm)			
	Large end width	1.0079 ~ 1.0118 in (25.6 ~ 25.7 mm)			
	Rod torsion (see diagram)		0.0008 in (0.02 mm)	0.002 in (0.05 mm)	
	Rod bolt torque M8 x 1	26.76 ~ 30.38 ft lbs (3.7 ~ 4.2 kg-m)			

Parts	Items	Specifications	Standard Value	Maximum Limit	Remarks
Crank-pin metal	ID (with metal)	1.7327 ~ 1.7345 in (44.01 ~ 44.056 mm)			
	Width	0.7429 ~ 0.7531 in (18.87 ~ 19.13 mm)			
	OD	1.85 in (47 mm)			
	Running Clearance		0.0014 ~ 0.0038 in (0.035 ~ 0.097 mm)	0.0079 in (0.2 mm)	Center thickness 0.0583 ~ 0.0589 in (1.482 ~ 1.495 mm)
	Axial Clearance		0.0157 ~ 0.0236 in (0.4 ~ 0.6 mm)		Crank arm to large end clearance
Crankshaft Main Bearing	Crankshaft journal dia	2.0441 ~ 2.0449 in (51.921 ~ 51.94 mm)	) Running clearance) 0.0016 ~ 0.0041 in) (0.04 ~ 0.104 mm)	0.0079 in (0.2 mm)	
	Main bearing ID (with metal)	2.0465 ~ 2.0483 in (51.98 ~ 52.025 mm)	)		
	Crankshaft metal (2) width	0.7429 ~ 0.7531 in (18.87 ~ 19.13 mm)			
	Crankshaft journal dia	2.0441 ~ 2.0449 in (51.921 ~ 51.94 mm)	) Running clearance) 0.0016 ~ 0.0046 in) (0.04 ~ 0.118 mm)	0.0079 in (0.2 mm)	
	Gear-side main bearing ID (with metal)	2.0465 ~ 2.0488 in (51.98 ~ 52.039 mm)	)		
	Crankshaft metal (1) width	0.7823 ~ 0.7925 in (19.87 ~ 20.13 mm)			
	Crankshaft metal (1) OD	2.2485 ~ 2.2474 in (57.111 ~ 57.084 mm)			
	Crank-pin journal dia	1.7307 ~ 1.7313 in (43.959 ~ 43.975 mm)		0.0047 in (0.12 mm)	When installing apply a generous coat of engine oil onto the entire surface of each bolt.
	Crankshaft side clearance		0.0059 ~ 0.0122 in (0.15 ~ 0.31 mm)		
	Crank bearing cap bolt (1) torque	M8 x 1.25	21.7 ~ 23.3 ft lbs (3 ~ 3.5 kg-m)		
Cam Shaft	Cam bearing ID	1.5748 ~ 1.5758 in (40.000 ~ 40.025 mm)	) Running clearance) 0.0020 ~ 0.0036 in) (0.05 ~ 0.091 mm)		
	Camshaft dia	1.5722 ~ 1.5728 in (39.934 ~ 39.950 mm)	)		
	Axial clearance		0.0028 ~ 0.0087 in (0.07 ~ 0.22 mm)		
	Cam lift	0.2165 in (5.5 mm)			
	Cam height	1.3134 in (33.36 mm)			



Parts	Items	Specifications	Standard Value	Maximum Limit	Remarks
Timing Gear	Number of teeth, crank gear	34			
	Number of teeth, idle gear	79			
	Number of teeth, cam gear	68			
	Number of teeth, injection pump gear	68			
	Number of teeth, oil pump drive gear	45			
	Backlash		0.00163 ~ 0.00454in (0.0415 ~ 0.1154 mm)	0.0118 in (0.3 mm)	
Valve	Shinkage	0.0433 ~ 0.0551in (1.1 ~ 1.4 mm)			
	Face angle	45°			
	Intake bore	1.2953 ~ 1.3031in (32.9 ~ 33.1 mm)			
	Exhaust bore	1.0591 ~ 1.0669in (26.9 ~ 27.1 mm)			
	Stem dia	0.3134 ~ 0.3140in (7.960 ~ 7.975 mm)			
	Valve guide ID	0.3156 ~ 0.3161in (8.015 ~ 8.030 mm)			
	Stem guide clearance		0.0016 ~ 0.0028in (0.04 ~ 0.07 mm)		
	Valve clearance		0.0071 ~ 0.0087 in (0.18 ~ 0.22 mm)		When cold
Valve Spring	Free length	1.6417 ~ 1.6614in (41.7 ~ 42.2 mm)			
	Spring pressure		26.46 lbs / 1.3839in (12kg/35.15mm)		
	Perpendicularity			3%	
	Spring pressure loss when installed			15%	
Push Rod	Overall length				
	A	5.984 in (152 mm)			
	B	5.8189 ~ 5.8346 in (147.8 ~ 148.2 mm)			
	Dia	0.2323 ~ 0.2402 in (5.9 ~ 6.1 mm)			



Parts	Items	Specifications	Standard Value	Maximum Limit	Remarks
Valve Timing	Intake valve opened		At 20° BTDC		
	Intake valve closed		At 45° ABDC		
	Exhaust valve opened		At 50° BBDC		
	Exhaust valve closed		At 55° ATDC		
	Ignition process				
	5416		1-2		
	5424		1-2-3		
Oil Pump	Injection timing		25° ~ 26° BTDC		
	Trochoid tooth width				Use engine oil CD(DS)
	5416	0.5866 ~ 0.5874 in (14.90 ~ 14.92 mm)			Above 77° F (25°C) , SAE 30
	5424	0.8622 ~ 0.8630 in (21.90 ~ 21.92 mm)			Between 32° ~ 77° F (0° ~ 25°C) , SAE 20
	Outer Rotor OD	1.9669 ~ 1.9685 in (49.96 ~ 50.00 mm)			Below 32° F (0°C) , SAE 10W, 10W-30
	Trochoid to body clearance		0.0035 ~ 0.0063 in (0.09 ~ 0.16 mm)		
	Trochoid to body side clearance		0.0039 ~ 0.0059 in (0.10 ~ 0.15 mm)		
	Oil pressure		64 ~ 71 psi (4.5 ~ 5 kgf/cm ²)		
	Pump capacity				
Fuel Injection Pump	5416		4.2 gal/min (16 ℓ/min)		At pump 2,116 rpm
	5424		5.8 gal/min (22 ℓ/min)		At pump 2,000 rpm
	Model		NP-PFR3K55/2NP2		
	Injection pressure		1990 psi (140 kgf/cm ²)		
	Pump plunger dia		0.2165 in (5.5 mm)		
Injection Nozzle	Pump Stroke		0.2756 in (7 mm)		
	Pump discharge		0.0013 ~ 0.0015 in ³ /rev (23 ± 1 mm ³ /rev)		
	Model		ND-DN12SD12		
	Injection pressure		1990 ~ 2133 psi (140 ~ 150 kgf/cm ²)		

Parts	Items	Specifications	Standard Value	Maximum Limit	Remarks
Cooling Water System	Cooling system 5416 5424	Natural Circulation Forced Circulation			With pressurized radiator (corrugated)
	Water Pump (Z751-BW and DH1101-B)	Centrifugal pump with thermostat (impeller)			
	Gear case to impeller clearance		0.0232 ~ 0.437 in (0.59 ~ 1.11 mm) (Packing thickness)		Water temperature 80 °C Total lift 19.34 psi (1mAg)
	Circulation flow rate (Z751-BW and DH1101-B)		26.4 gal/min (100 ℓ/min) or more		
	Impeller dia (Z751-BW and DH1101-B)	2.634 ~ 2.642 in (66.9 ~ 67.1 mm)			Pump speed 3450 ~ 3550 rpm * No pump for Z751B and Z851B
	Thermostat actuation temperature (Z751-BW and DH1101-B)	179.6 ~ 203 °F (82 ~ 95 °C)			
	Radiator cap pressure		12.8 psi (0.9 kgf/cm ²)		
	Fan belt length 5416 5424	HM 40.55in (1030 mm) HM 41.50in (1054 mm)	In perimeter In perimeter		
Battery	Model 5416 5424	12v 70ah 12v 80ah			NS70, dry N70Z, dry
	Electrolyte specific gravity, discharge charge overdischarge	1.120 1.280 1.30	(68°F, 20°C)		
Dynamo	Voltage	12v			Alternator
	Current	20A			
	Check interval	Every 1000 hours			Insulation resistance
	Brush spring pressure		12.8 psi (0.9kgf/cm ²)	± 15%	
	Insulation resistance				No failure at 500MV
Voltage Regulator	Constant voltage		13.8 ~ 14.8 V		
	Current		10A		
	Cut-in voltage		12.5 ~ 13.5 V		

Parts	Items	Specifications	Standard Value	Maximum Limit	Remarks
Starter	Number of teeth, pinion	9			
	Number of teeth, ring gear	89			
	Insulation resistance				No failure at 500MV
	Check interval	Every 1000 hours			Insulation resistance
	Output				Nominal value
	5416 5424	0.8kW 1.0kW			
Important Bolt Torque	Head set bolt and nut	M10 x 1.25	54.2 ~ 57.9 ft.lbs (7.5 ~ 8 kgf-m)		Apply a generous coat of engine oil onto the entire surfaces of all important set bolts.
	Flywheel set bolts	M12 x 1.25	72.3 ~ 79.6 ft.lbs (10 ~ 11 kgf-m)		
	Crankshaft main bearing set cap bolts	M10 x 1.25	47.0 ~ 50.6 ft.lbs (6.5 ~ 7 kgf-m)		
	Crankshaft cap bolts	M8 x 1.25	21.7 ~ 25.3 ft.lbs (3 ~ 3.5 kgf-m)		
	Rocker bracket set studs	M8 x 1.25	17.4 ~ 20.3 ft.lbs (2.4 ~ 2.8 kgf-m)		
	Rod bolts	M8 x 1	26.8 ~ 30.4 ft.lbs (3.7 ~ 4.2 kgf-m)		
Bolt Torques	General set bolts and studs	M12	57.1 ~ 66.5 ft.lbs (7.9 ~ 9.2 kgf-m)		All these torques are applied to those S45C bolts and studs which have relief number "7" or punch marks. 
		M10	35.4 ~ 41.2 ft.lbs (4.9 ~ 5.7 kgf-m)		
		M8	17.4 ~ 20.3 ft.lbs (2.4 ~ 2.8 kgf-m)		
		M6	7.2 ~ 8.3 ft.lbs (1.0 ~ 1.15 kgf-m)		

Bolt Torques

ft.lbs (kgf-m)

Material Grade Nominal Dia	Standard Bolt		Special Bolt		Special Bolt	
	SS41, S20C		S43C, S48C (Refined)		SCR3, SCM3 (Refined)	
M 6	5.8 ~ 6.9	(0.80 ~ 0.95)	7.2 ~ 8.3	(1.00 ~ 1.15)	9.0 ~ 10.5	(1.25 ~ 1.45)
M 8	13.0 ~ 15.2	(1.80 ~ 2.10)	17.4 ~ 20.3	(2.40 ~ 2.80)	21.7 ~ 25.3	(3.00 ~ 3.50)
M10	28.9 ~ 33.3	(4.00 ~ 4.60)	35.4 ~ 41.2	(4.90 ~ 5.70)	44.8 ~ 52.1	(6.20 ~ 7.20)
M12	46.3 ~ 53.5	(6.40 ~ 7.40)	57.1 ~ 66.5	(7.90 ~ 9.20)	75.9 ~ 86.8	(10.50 ~ 12.00)
M14	79.6 ~ 92.6	(11.00 ~ 12.80)	91.1 ~ 108.5	(12.60 ~ 15.00)	123.0 ~ 144.7	(17.00 ~ 20.00)
M16	123.0 ~ 141.0	(17.00 ~ 19.50)	144.7 ~ 166.4	(20.00 ~ 23.00)	191.7 ~ 224.2	(26.50 ~ 31.00)
M18	180.8 ~ 209.8	(25.00 ~ 29.00)	202.5 ~ 235.1	(28.00 ~ 32.50)	253.2 ~ 296.5	(35.00 ~ 41.00)
M20	245.9 ~ 289.3	(34.00 ~ 40.00)	271.2 ~ 318.2	(37.50 ~ 44.00)	361.6 ~ 419.5	(50.00 ~ 58.00)

Bolt material grades are shown by numbers punched on the bolt heads.

Prior to tightening, be sure to check out the numbers as shown below.

Punched Number	Bolt Material Grade
None	Standard Bolts SS41, S20C
7	Special Bolts S43C, S48C (Refined)
8	Special Bolts SCM 3, SCR 3 (Refined)