

GENERAL -DATA:

ENGINE

Engine type	Standard Triumph 1147 c.c.
Number of cylinders	4
Bore	2.718" (69,3 mm)
Stroke	2.992" (76 mm)
Capacity (swept volume)	70 c u. ins. 1147 cc
Compression ratios	8 : 1
Compression pressure	Readings obtained on all 4 cylinders must be within 5 lb.sq.in. (4 kg sq.cm) of each other.

PERFORMANCE Compression ratio (8 : 1)

max. h.p.(S.AE.)	43 at 4,500 r.p.m.
max torque	775 lb.in. at 2.250 r.p.m.
max. B.M.E.P.	139 lb.sq. in. (9.77 sq.cm)

GEARBOX

Type	4 forwards 1 reverse Synchromesh				
Ratio	Top	3rd	2nd	1st	Reverse
	1.05	1.75	2.91	4.5	4.13
Differential	4.714				

WATER TRANSMISSION BOX

Type	1 forward 1 reverse
Ratio	1: 3

DIMENSIONS WEIGHTS

Overall length	170,31"(4326mm)	Weight with filled fuel tank	2.292,80lbs(1040kg)
Overall width 60,31"(1532mm)		Payload	4 Persons
Overall height	59,84" (1520 mm)	Permissible total weight	2.954, 18 lbs (1340 kg)
Overall height with inserted top light	63,97" (1625 mm)	Permissible front axle load	1.128,77lbs(512kg)
Wheel base	82,67"(2100mm)	Permissible rear axle load	1 825,41 lbs (828 kg)
Track front	47,31" 11202 mm)		
Track rear	49,20"11250mm)		
Ground clearance	9,96" (253 mm)		
Turning Circle 36,42ft II110m)			

PERFORMANCE

Top speed on an even roadway approx. 70 mph
Top speed by water driving approx. 7 mph

GEAR SPEEDS AT 4750 ENGINE R. P. M.

1st	approx.	15.6 mph	(25 km/h)
2nd	"	24.4 mph	(39 km/h)
3rd	"	41.3mph	(66 km/h)
4th	"	70 mph	(115 km/h)

CLIMBING ABILITY

1st	approx.	42%	
2nd	"	26%	
3rd	"	14%	fully loaded
4th	"	7%	

FUEL AND LUBRICANT QUANTITIES

Fuel tank capacity	12,4 gal
Reserve capacity	2,1 gal
Engine	4 qts. HD. engine oil
Gearbox	3,5 pts
Water transmission box	1,75 pts. Gear oil SAE 90
Steering box	0,28 pts.

RECOMMENDED OILS

Temperature			
Above 80° F		SAE 30	10 W30 or 20 W/40
30° - 80° F	use Amsoil	SAE 20	10 W/30
Below 30° F	HD oil only	SAE 10	10 W/30
Below 10° F			5 W/20*

* Use under extreme colder conditions.

POSITION OF MODEL IDENTIFICATION PLATES

Each vehicle is identified with an engine and chassis number.

Both numbers are stamped in the identification plate, figure 1.

ENGINE NUMBER

This number is stamped in the engine block r /h side, front, figure 2.

CHASSIS NUMBER

The chassis number is situated on the rear wall at the engine cover right side, figure 3.

When ordering spare parts please pay attention to the directions in the spare parts catalogue.

NOTE: All measurements of the engine are based on the English system.

The measurements of all other groups of the vehicle are based on the metric system.

GENERAL INSTRUCTIONS

It is most important to protect the vehicle body and paint work, interior trimmings, and seats from damage, before commencing repair work, by using protective plastic covers.

To ensure carrying out repair work on the AMPHICAR efficiently, the special tools as illustrated in the spare parts catalogue are very important.

Also it is important that all normal tools are in a good condition.

The repair workshop should be clean with good lighting conditions.

All dismantled parts should be cleaned and stored in a safe place, to avoid damaging.

Reconditioned units etc, must at all times correspond in performance and technically as by anew unit or part. This is only possible when all reconditioning replacement spare parts are original AMPHICAR.

Please pay attention to the instructions given in this workshop manual, for they are given from methods that have been proved to save time and high expenses.

RAISING AND TOWING

The floating body, being self-supporting with longitudinal and transverse stiffeners must be raised with the aid of an hydraulic transportable jack with a cross-member being the same length as the width of the floating body, to prevent damaging when raising (figure 1).

When raising the front of vehicle, position the cross-member under the front axle transverse stiffener (figure 2).

When raising the rear of vehicle, position the cross-member under the rear axle (figure 1).

Should no cross-member be available, a thick wooden plank can be used.

By longer repair work it is advi sable to place two strong metal stands under the floating body (figure 2) .

For towing purposes, a towing hook is situated under the bow of the car (figure 3) .

Operations	Description		Specified torque Min. yield		Remarks
			range (lb.ft.)	torque (lb.ft.)	
Cylinder head	3/8" UNF	nut	42-46	50	Tighten all cyl. head nuts after engine test
Cylinder head	3/8" x 4.28"	stud	10		
Clutch attachment	5/16" UNF x 5/8"	set screw	18-20	20	
Connecting rod bolts		bolt	42-46	50	
Chain wheel attachment	5/16" UNF	set screw	24-26	30	
Dynamo bracket to block	5/16" UNF x 3/4"	bolt	16-18	20	
Dynamo to engine plate	5/16" UNF x 2 7/8"	bolt	16-18	20	
Dynamo to mounting Bracket	5/16" UNF x 1"	bolt	16-18	20	
Flywheel attachment	3/8" UNF	bolt	42-46	50	
Front engine plate & camshaft	5/16" UNF x 3/4"	set screw	18-20	20	
Locating plate to block	5/16" UNF x 7/8"	bolt	18-20	20	
Fan to pulley	1/4" UNF	bolt	6-8	10	
Front engine bracket to front engine plate	5/16" UNF	bolt	18-20	20	
Gearbox and rear engine plate Attachment	5/16" UNF x 1.31"	stud	12-14	16	
Manifold-exhaust outlet	5/16" UNF x 3/4"	set screw	14-16	20	
Manifold attachment	5/16" UNF x 1.31"	stud	12-14	16	
	3/8" UNF x 1.34"	stud	24-26	30	
	3/8" UNF x 1.84"				
Main bearing caps	7/16" UNF x 3"	bolt	55-60	65	
Oil Gallery setscrews	5/16" UNF x 0.44"	set screw	18-20	20	Copper washer
Oil pump to block	1/4" UNF x 2 1/2"	bolt	6-8	10	
Petrol pump	5/16" UNF x 1 1/16"	stud	12-14	16	
Rear oil seal attachment	5/16" UNF x 1 1/8"	bolt	16-18	20	Aluminum seal
Rocker cover nuts	5/16" UNF x 4.13"	stud	1 1/2	16	
Rocker pedestal	3/8" UNF x 3.09"	stud	24-26	30	
Sump attachment to sealing block	5/16" UNF x 5/8"	sem s/screw	10-12		
Sump attachment to oil retaining cover	5/16" UNF x 5/8"	sem s/screw			Should maintain a minimum of 6lb.ft. torque after a setting period
Sump attachment	5/16" UNF x 1"	bolt	16-18	20	
Sump attachment	5/16" UNF x 5/8"	set screw	16-18	20	
Starter motor attachment	3/8" UNF x 1 3/4"	bolt	26-28	30	
Timing cover attachment	5/16" UNF x 3/8"	slotted setscrews		16	
Timing cover & front engine plate to block	5/16" UNF	bolt	14-16	20	
Water pump to combustion	5/16" UNF	bolt	18-20	20	

GROUP 1. ENGINE

DESCRIPTION

The engine of the "AMPHICAR" is a water cooled, four stroke, four cylinder, Otto engine mounted at the rear of vehicle.

The following advantages are gained through being a rear mounted engine:

1. Equal distribution of weight on the axles, especially when leaving the water at difficult angles.
2. Great advantage between total and pay load, giving a very high driving comfort.
3. No long drive shaft, which means no vibration and less repairs.

The cylinder block and cylinder head are made from a special grey cast Iron.

The counter balanced crankshaft is running in three main journal bearings with bores for oil lubrication.

The valves are actuated by means of push rods and rocker arms, the camshaft being situated in the engine block and being driven by the crankshaft through a single-roller chain and chain sprockets.

The down-drought carburettor has a modified cold starting system, and the fuel is fed to the carburettor by a mechanical diaphragm fuel pump, being actuated from a cam mounted on the camshaft.

The vehicle has a 12-volt battery ignition, and starting of the engine takes place from an electric starter motor.

REMOVING ENGINE

- 1) Disconnect plus cable on battery.
- 2) Remove engine hood, by removing the bolts on both hinges (fig. 1), and disconnect electrical cables.
- 3) Drain cooling system, figure 2.
- 4) Remove radiator rubber hoses, both oil cooler hoses, figure 3, radiator-fastening bolts, and finally remove radiator from vehicle.
- 5) Remove air filter together with fresh air hose.
- 6) Remove exhaust pipe end piece, and disconnect exhaust silencer and remove.
- 7) Unscrew and remove heater hose fastening brackets from engine block and rocker cover.
- 8) Disconnect the carburettor controls and pipe on the fuel pump.
- 9) Disconnect the temperature transmitter cable, starter motor cable, oil pressure valve cable, both cables on distributor, and finally both cables connected to the dynamo.
- 10) Remove both bolts with spring washers from the front engine mounting rubbers, figure 4.
- 11) Remove rear seats, complete and seat base.
- 12) Unscrew the four fastening nuts with spring washers connecting engine to gearbox, figure 5.
- 13) Raise the engine out of the vehicle, with the aid of a pulley block tackle attached to the mounted lifting eye brackets, one situated on the dynamo, the other' on the cylinder head, figure 6.

14) After removal clean the engine before finally placing on the working bench.

DECARBONISING AND SERVICING OF THE CYLINDER HEAD AND ASSOCIATED PARTS

The cylinder head should be removed for decarbonising and valve grinding after approximately the first 5.000 miles (8.000 km). This is to give attention to the valves and seats that may have become distorted during the initial stabilizing of the metal. Subsequent attention should not be necessary until a further considerable mileage has been covered, usually about 15.000 miles (24.000 km). Even then, if all compressions are normal and the engine's performance is satisfactory, it is well to delay decarbonising until necessary.

REMOVING THE CYLINDER HEAD WITH THE ENGINE INSTALLED IN VEHICLE.

To carry out this work, proceed as follows:

1. Disconnect battery and drain cooling system.
2. Disconnect the top and bottom radiator hoses.
3. Remove the radiator (unscrew the four holding screws).Also disconnect the oil tubes connected to the oil cooler, figure 1.
4. Remove the air cleaner and intake hose.
5. Disconnect the fastening bracket of the heater hose from the cylinder head and unscrew the nut of the rocker cover, figure 2, "a".
6. Disconnect the carburettor controls, fuel feed pipe and distributor vacuum control pipe. Remove the return spring for throttle cable.
7. Remove exhaust:
 - a. Unscrew and remove the three nuts on exhaust pipe flange.
 - b. Remove the exhaust silencer.
 - c. Unscrew and remove the front and rear mounting brackets.
8. Detach the temperature transmitter cable from thermostat.
9. Slacken the generator mountings, disconnect the adjusting link from the water pump, swing the generator inwards and remove the fan belt.
10. Remove the cover from engine partition figure 2 "b".
11. Detach the rocker shaft assembly complete and withdraw the eight push rods.
12. By reversing the nut tightening sequence, shown on figure 3, starting from the highest number, progressively slacken the cylinder head nuts. Remove the cylinder head, complete with manifold and carburettor, by lifting it vertically from the securing studs, followed by the cylinder head gasket.
13. Place the cylinder head on the bench and remove the manifold, carburettor assemblies and gaskets.

REMOVING THE VALVES

Ensure that before removing the valves, they are suitably marked 1-8 (from front to rear) so that the valves are re-fitted to their original seats during re-assembly.

ENGINE

To facilitate removal of the valve springs, place the cylinder head over a rigid plate with blocks to support the heads of the valves whilst the springs are being compressed. Sufficient force can then be exerted with the fingers, or a tube wrench, to compress the springs and remove the retainers (137) springs (136) and the locating collars (135) .By turning the cylinder head over, the valves may be withdrawn for inspection and servicing.

REMOVING VALVE SPRINGS

If it is necessary to renew a valve spring without removing the cylinder head, turn the crankshaft until the piston is at T. D. C. and insert a steel bar bent as shown on fig. 2 through the sparking plug hole to support the valves. If difficulty is experienced in releasing the spring retainer from the valve stem, a sharp blow given to a suitably sized tube placed over the retainer will usually free this item.

(Figure 1 suggested spigot plate for supporting valve heads.)

DECARBONISING

CYLINDER HEAD

Using suitable scrapers or small power tools, remove carbon deposits from the combustion head surfaces and the inlet and exhaust ports. Thoroughly wash the head with petrol to ensure that all loose carbon is removed and dry off with a high-pressure airline. Do not use abrasives of any kind to remove the carbon.

VALVES

Clean and polish each valve, then examine the stems for straightness and wear, and the faces for burns, pitting or distortion. Renew valves, which are excessively worn, bent or too badly pitted to be salvaged by re-facing. When re-facing valves, perfect concentricity of the valve stem with the chuck or collet is of the utmost importance. Remove only sufficient metal as is necessary to clean up the valve face. **If** the head thickness above the seat edge is reduced to less than 1/32" (8 mm) , the valve must be renewed.

IMPORTANT. No attempt should be made to clean up a burnt or badly pitted valve face by extensive "grinding in" of valve to seat, as the latter, being the softer of the two surfaces, will merely be ground away without rectifying the valve face.

PISTONS

Before scraping the piston crowns, carefully clean the tap of the cylinder block with petrol. To prevent the entry of carbon particles into the engine and the cylinder head all feed drilling, cover all possible entry points with masking tape or rag.

Carefully remove the carbon from the tops of the pistons, leaving a ring of carbon around the outside of each piston crown at least 1/8" (3 mm) in width. An aid piston ring placed in the tap of the cylinder bore helps to maintain this carbon seal when decarbonising.

DIMENSIONS AND TOLERANCES

Parts and Descriptions		Dimensions new Ins.	Clearance new mm
<u>Valve Springs</u>			
Total number of coils	7 1/4		
Fitted length		1.36	34.54
Fitted load		27 to 30 lbs.	12.25 to 13.61 kg
Rate		150 lb/in.	68 kg/cm
Solid length (max.)		0.93	23.62
<u>Valve guides</u>			
Length		2.25	57.15
Bore		0.313	7.95
		0.312	7.92
Outside dia		0.502	12.75
		0.501	12.72
Press fit in cylinder head			
Amount valve guide		0.749	19.025
Protrudes above cylinder head tap face		0.751	19.075

VALVE SEAT INSERT DIMENSIONS

	Insert Dimensions				Bore Out				Insert Part No.
	External Bore		Width		Diameter		Depth		
	ins.	mm	ins.	mm	ins.	mm	ins.	mm	
Exhaust	1.253	31.83	0.25	6.35	1.25	31.75	0.25	6.35	132242
	1.252	31.8	0.248	6.15	1.249	31.72	0.248	6.15	
Inlet	1.441	36.6	0.25	6.35	1.438	36.52	0.25	6.35	132241
	1.440	36.576	0.248	6.15	1.437	36.5	0.248	6.15	

DIMENSIONS AND TOLERANCES

Parts and Description	Dimensions new		Clearances new	
	ins.	mm	ins.	mm
Valves				
Inlet valve head dia.	1.308	33.22		
	1.304	33.12		
Inlet valve stem dia.	0.311	7.89	0.001	.03
	0.31	7.87	0.003	.08
Exhaust valve head dia.	1.152	29.26		
	1.148	29.16		
Exhaust valve stem dia.	0.309	7.85	0.003	0.08
	0.308	7.82	0.005	0.13

SERVICING

VALVE GUIDES

Should excessive wear necessitate the replacement of valve guides, these must never be drifted in or out as the impact of the hammer blows may swell the guides and scare their accommodating bares in the cylinder head.

The worn guides can be removed and the replacements fitted in one operation by utilizing the special tool. Where this tool is not available, the guides can be pulled out and replaced by use of a long screwed rod and a suitable arrangement of nuts, washers and tubing.

The valve guides should be drawn into position until the tops of both the inlet and exhaust valve guides protrude the requisite amount above the rocker cover joint face as illustrated.

Carefully examine each valve seating for signs of pitting or burning and if such faults are present or if a new valve guide has been fitted, then the seat must be re-cut true to its guide.

VALVE SEATS

If a gloze cutter is not available, an old valve of correct size may be used with coarse grinding paste to break through the skin. Special care must be exercised to clean up the valve seat. Heavy pressure on the cutting tool will cause shudder marks in the seat, thus necessitating an excessive amount of "lapping in" to remove them.

Using a glaze cutter break through the hard glazed skin on the seat before using a 45-degree valve seat cutter, figure 1.

NOTE. The finished valve seat face must be concentric with the bore of the valve guide. The pilot of the facing tool should, therefore, be a close fit in the valve guide and without side play. (See valve guide replacement.)

When re-cutting the seats to the correct angle of 45 degrees, remove only sufficient metal to obtain a clean concentric face. If the width of the valve seat face exceeds 0.1" (2.5 mm) after cutting, then a 15-degree cutter and pilot must be used to reduce the width of the seat to 0.060" (1.25 mm). This is necessary to avoid "pocketing" of the valve, a condition which would impede the gas-flow.

When it becomes necessary to use a 15-degree cutter the outer diameter of the seat cut by it should never exceed 1.25" (31.75 mm) exhaust and 1.438" (36.52 mm) inlet. Any excess of these dimensions will render the head unsuitable for the fitting of valve seat inserts.

VALVE SEAT INSERTS

When valve seat wear has become more than can be corrected by the methods described under "valve seats", then it will be necessary to fit valve seat inserts.

To fit an inlet valve insert, use a 1.45" to 1.446" (36.83 to 36.73 mm) diameter cutter to remove metal from the side of the combustion chamber, figure 2. If both inlet and exhaust valve inserts are to be fitted, the inserts will overlap, therefore, fit one insert and bear into it when machining the recess for the second insert.

Having removed all swarf, lay the new insert over the recess in the cylinder head and press the insert squarely into place, using a pilot drift for this purpose and making sure that the insert is driven fully home.

Finally peen or roll the adjacent metal of the cylinder head over the slightly chamfered upper edge of the insert and re-face the insert as described under "valve seats".

OIL LEAKS FROM PUSH ROD TUBES

Should an oil leak occur between the push rod tube and cylinder head, the leak may be cured by swaging the end of the tube into its countersunk face in the cylinder head.

The lower mandrel shown on fig. 1 should be held in a vice and the cylinder head supported over it whilst the upper mandrel is lightly tapped with a hammer as it is slowly rotated.

VALVE GRINDING

After all valves, guides and valve seats have received the attention necessary, each valve should then be finally ground into its seat by the normal "grinding in" process, using fine corborundum paste for this operation.

Continue the process until narrow continuous seating has been obtained both on the valves and their seating. Carefully wash the valves and seats to remove 011 traces of grinding paste and when dry, lightly smear the valve face with engineers' marking blue.

Insert the valve into its seating and rotate it not more than 1/8" (3 mm) in each direction. A complete circle should appear on the valve seating, thus indicating a satisfactory seal.

VALVE SPRINGS

Wash the valve springs and examine them for fatigue cracks and distortion. If they appear serviceable, check their "free" lengths and their "fitted" load, as shown on fig. 2. Spring data is given on page]7.

ROCKER SHAFT ASSEMBLY (Figure 3)

This is serviced as follows:

(A) To dismantle. Drift the mills pin (3) from a cap (2) at each end of the shaft (1) and remove both caps. Withdraw the locating setscrew (9) from the rear pedestal (7) and remove all components from the shaft.

(B) To assemble. Locate the rear pedestal on the shaft and, after aligning the locating hole in the shaft with the tapped hole in the pedestal, insert and tighten the setscrew. Assemble the remaining components as shown and insert a new mills pin through each end cap.

ASSEMBLY AND INSTALLATION

VALVES

After carrying out all necessary operations on the cylinder head and associated parts, thoroughly clean all components. Lubricate each valve stem and guide with engine oil and re-fit the valves in their correct sequence.

VALVE SPRINGS

Single carburettor engine. Place the cylinder head on a spigot plate, fit the spring locating collars (135) followed by the valve springs (136) and finally secure the valves and springs with the retainers (137) , pushing these on to the valve stems with the fingers, or by means of a suitable tube spanner.

MANIFOLD

Remove all carbon from the inlet and exhaust manifold, and clean up the joint faces by careful scraping and the use of a wire brush. Re-fit the manifold to the cylinder head with a new manifold gasket between the faces. Secure the manifold with nuts, spring washers and bridge clamps.

CYLINDER HEAD

Stipple both sides of the cylinder head gasket with jointing compound. Clean the cylinder block face and lower the gasket over the studs.

Install the cylinder head and secure it with plain washers and nuts, tightening the latter to the correct torque and in the sequence shown on page 14. Note that the accelerator abutment bracket is attached to one of the cylinder head studs and the rear engine-lifting eye is secured to the r/h. Rear studs.

VALVES

Working clearances (cold)

Exhaust and inlet 0.010" (0.254 mm)

Clearances for valve timing

-No.4 exhaust and inlet 0.040" (1.016 mm) 45°

Valve seat angle 45 deg.

When setting the rocker clearances, ensure that the tappet is resting on the back or rounded portion of the cam contour. This position is obtained by first turning the crankshaft until no.1 push rod has reached its highest point, then rotating a further full revolution. After adjusting this rocker to the required clearance, treat each remaining rocker in a similar manner, figure 1.

Rocker clearances are: Inlet and exhaust 0.010" (0,25 mm) cold.

Ensure that the rocker cover joint washer is in good condition, attach the cover to the engine and secure it by fitting a fibre washer, plain washer and nyloc nut to each attachment stud.

Coat both sides of the water pump joint washer with jointing compound, and attach both this and the water pump to the cylinder head. Secure the generator adjusting link to the water pump by means of a bolt and spring washer (2). Fit the fan belt and tension this to give 3/4" (19 mm) side play at its longest run by swinging the generator outwards on its mountings and tightening the adjustment bolt. Do not attempt to lever the belt over the plastic generator pulley. Finally, tighten the generator lower mounting bolts

Attach the drain pipe to the manifold securing the lower end of the pipe in the clip attached to the sump flange bolt (7) using a new gasket between joint faces, secure the front exhaust pipe (60) to the manifold flange (5).

Clean the carburettor jets and float chamber then re-fit the carburettor to the manifold, using a new insulating washer between the flange faces. Connect up the accelerator and choke cables ensuring that the choke control returns the strangler to the "off" position. Attach the fuel pipe and distributor vacuum pipe, securing these to the front of the cylinder block by means of clip (1) and a bracket (5) attached to the lower water pump bolt, (3), figure 2.

SPARK PLUGS

Lodge CNY 1/2" (12.7 mm) reach

8 : 1 0.025" (0.65 mm) gap.

6.8: 1 0.030" (0.762 mm) gap.

TESTING

The purpose of spark plug tester is (A) to locate any cracks or breakdown of the insulator and (6) to check on the pressure required to quench the spark at the points at a given voltage. There is a great deal of misapprehension about these testers and many plugs are discarded unnecessarily because the results obtained are misunderstood.

Connection is made to an electrical supply with a good earth, and to an air supply of not less than 100 p.s.i. Preferably with water trap.

Clear the plugs before testing and set the spark gap to 0.025" (.635 mm) by bending the earth electrode only. Screw the plug into the pressure chamber, using the appropriate thread adaptor. Lifting the operating arm until contact is made with the terminal completes the electrical, place at the plug electrodes circuit and sparking should then take place at the plug electrodes.

Increase the air pressure by rotating the air control; if sparking at the electrodes ceases when the pressure gauge pointer is in the red section of the scale the plug is faulty; If sparking continues or ceases when the pointer is in the yellow sector the plug is satisfactory.

It is possible that there will be insufficient pressure to quench the spark at all. This, of course, still indicates that the plug is sound provided there is sufficient pressure to bring the gauge needle into the yellow zone

CLEANING AND RENEWAL

The life of spark plugs and the periods at which they should be cleaned varies with the condition of the engine and the work it performs. As a general recommendation, electrode gaps adjusted to 0.025" (.635 mm) every 3.000 miles, and the plugs renewed at 12.000 miles.

Fig. 1 provides an easy guide for identifying the various plug conditions.

Correct grade	Too hot running	Too cool running	Mixture too rich	Worn out plug
A	B	C	D	E

Smear the threads of new plugs with graphite grease to prevent possibility of seizure and damage to the cylinder head. Incidentally, plugs should be screwed in with a torque wrench, but if this is not available use a Tommy bar not more than 6 inches long.

H. T. CABLES

Re-connect the high tension leads to the spark plugs **in** the order shown on page 58. Renew any leads which have become chaffed or perished.

HOSES

Re-fit the tap and bottom radiator hoses, securing them with hose clips. Similarly, re-connect the heater feed pipe to the adaptor at the rear of the cylinder head. Pass the heater return pipe beneath the manifold, attach the securing lug beneath the rear r.h. cylinder head nut and tighten the union nut into the adaptor in the water pump body. Reconnect the temperature transmitter cable to the Lucas connector on the transmitter unit.

Clean the air cleaner and re-fit it to the carburettor.

Re-fill the radiator with water or anti-freeze mixture. Re-connect the battery terminal. Start the engine, warm it up and road test the vehicle, making adjustments to the ignition timing and carburettor idling and mixture controls as necessary to obtain the best possible idling and performance.

After the vehicle has covered a few hundred miles, remove the rocker cover and rocker shaft assembly, check the tightness of the cylinder head nuts with a torque wrench and re-fit the rocker assembly. Re-adjust the valve rocker clearances to 0.010" (0.254 mm) before fitting the rocker cover. Check the tightness of manifold; exhaust flange and water pump attachment nuts and bolts.

ENGINE DISMANTLING

Dismantle the engine by carrying out the following operations:

Slacken the clip and remove the oil cleaner.

Detach, the retaining nuts (70) , plain and fibre washes (71 and 72) , then remove the rocker cover (73) .

Progressively slacken and remove the nuts (J39) and spring washers (J38), then detach the rocker shaft assembly (75) .

Withdraw the push rods (7) .Dismantle the rocker shaft assembly as described on page 23.

Disconnect the fuel pipe and vacuum ignition advance pipe at the carburettor and fuel pump and carburettor and distributor respectively. Remove the bolt from the top water elbow which also retains the fuel pipe clip and detach the pipes from engine.

Remove the nuts (2) spring washers (1) and detach the carburettor with gasket (3) from the manifold (5) .

Remove the manifold drain pipe (6) .

Remove the nuts (13 and J6) , spring washers (14 and 17) and bridge clamps (15) , then detach the inlet and exhaust manifold (5) and the gasket (18) .

Slacken the generator attachment bolts. swing the generator inward. and remove the fan belt. Do not attempt to lever the belt over the plastic generator pulley. Remove the generator adjusting link generator pivot bolts (7 and 8) .then detach the generator. Remove the bolts and spring (124) and detach the generator bracket (127) from washers, mounting the crankcase.

Remove the water pump attachment bolts and detach the water pump complete with gasket.

Detach the plug leads from the sparking plugs, slacken the clamp bolt and withdraw the distributor from the pedestal.

Remove the sparking plugs (131) .

Reversing the sequence shown On page 14 slacken and remove the cylinder head nuts (134) and plain washer, r 133). Detach the throttle cable abutment bracket (3) and lift off the cylinder head (79) and gasket (84).

Dismantle the cylinder head components as described on page 15.

Remove the nuts and spring washers, then detach the fuel pump and gasket (98) .

Unscrew and remove the oil filter.

Unscrew and remove the oil pressure switch (99) .

Remove the domed plug (103) , copper washer (102), spring (101) and oil pressure relief valve plunger (100) .

Suitably wedge the flywheel and remove the crankshaft pulley retaining nut (65). Remove the crankshaft pulley (64) .

Remove the screws (118), bolts (19) and spring washers (120), then detach the timing cover (122) and gasket (123) .

Remove the chain tensioner (65) from the cover by springing one blade over the pivot pin. Drive out the oil seal (121) .

Release the lock tab (2). remove the bolts (1) and detach the camshaft timing sprocket (3) and chain (6) .Lift the tappets (8) from the cylinder block, remove the bolts (67) with spring washers (68) and detach the camshaft retaining plate (4) .Withdraw the camshaft from the cylinder block.

Remove the bolts (114) and detach the engine front mounting feet (113 and 117) from the front engine plate (111) .

Release the retaining bolts and spring washers, then detach the front engine plate (111) and gasket (108) .

Progressively slacken and remove the setscrews and spring washers, then detach the clutch unit and driven plate from the flywheel.

Release the lock tab (22) , slacken and remove the bolts (23) and detach the flywheel (20) .

Remove the bolts (93) , spring washers (92) and detach the rear engine plate (91) .

Invert the cylinder block and remove the sump attachment bolts (49) and spring washers (50) .

Remove the engine breather pipe (27) and the manifold drain pipe clip (36) secured beneath two of the bolts. Lift off the sump (51) and sump gasket (52) .

Remove the bolts (94) , spring washers (95) and detach the oil return scroll (96) , followed by the gasket (97) .

Remove the screws (53) and detach the front sealing block (55) .

Release the lock plates (38). Remove the bolts (39) and detach the connecting rod big end caps (37) .

Withdraw the pistons (11) and connecting rods (15) through the cylinder bores. Detach the connecting rod shell bearings and refit the big end caps to their respective connecting rods.

Using circlip pliers, remove the piston pin circlips (9) and press the piston pin from each piston and connecting rod .

Detach the compression rings (13) and oil control rings (14) from each piston.

Remove the main bearing cap bolts (56) and spring washers (57), then detach the main bearing caps (41, 42 and 58) and lower bearing shells (40, 47 and 59).

Lift out the crankshaft (48), followed by the thrust washers (18) and upper bearing shells.

Remove the timing sprocket (62) from the crankshaft, followed by the shims (61) .By use of a 0.5" (12.7 mm) dia shaft, and grease packed in the bushing, extract the constant pinion shaft oilite bush from the rear of the crankshaft by striking the shaft with a mallet .

Complete the dismantling by removing all studs, plugs and dowels from the crankcase.

DIMENSIONS AND TOLERANCES

Parts and Description	Dimensions new		Clearances new		Remarks
	ins.	mm	ins.	mm	
CRANKSHAFT					
Main bearing journal dia.	2.0005 2.001	50.81 50.83	0.0005 to 0.0032	0.0020 to 0.0813	
Main bearing internal dia.	2.0015 2.0037	50.84 50.89			Undersize bearings available: -0.010", -0.020", -0.030", -0.040" (-.254 mm, -.508 mm, -.762mm,-1.016mm).
Main bearing housing int dia.	2.1460 2.1465	54.51 54.52			
Rear journal width	1.2995 1.2975	33.01 32.95			
Rear main bearing housing Width plus thickness of two thrust washers	1.2855 1.2915	32.65 32.8	0.006 to 0.014	0.152 to 0.3556	0.004" to 0.008" preferred.
Thrust washer thickness	0.091 0.093	2.31 2.36			
Oversize thrust washers	0.096 0.098	2.44 2.49			
Main bearing width	0.995 1.005	25.273 25.527			
Crank pin dia.	1.6255	41.28	0.0005	0.0127	

	1.6250	41.27	to 0.0020	to 0.0508
Big end bearing internal dia.	1.627 1.626	41.32 41.3		
Big end bearing width	0.692 0.682	17.58 17.32		
Crank pin width	0.9085 0.9086	23.076 23.078		

Undersize bearings avoidable:
-0.010", -0.020", -0.030",
-0.040", (-.254 mm, -.508 mm,
-.762mm, -1.016mm).

ASSEMBLY OPERATIONS

DISTRIBUTOR DRIVE GEAR BUSH

Excessive wear in the drive gear bush is indicated by rocking the distributor shaft when partly withdrawn from the bush.

Excessive side movement of the shaft indicates the need for renewal of the bush, as follows:

Using a suitable diameter stepped drift, drive out the old bush from below and fit a new one from above, ensuring that the bushing flange goes fully home against the cylinder.

CRANKSHAFT REGRINDING

Crankshaft end float is controlled by the flanks of the rear main journal. The flanks of the front and center main journals run clear of the bearing shells.

Axial alignment of the crankshaft relative to the con-rods and pistons is, therefore, dependent on the rear main bearing.

If it is necessary to regrind the rear journal flanks, then an equal amount should be removed from each, and when ground, the distance between the flanks must not exceed 1.2995" (33.01 mm). This is the maximum amount which oversize thrust washer can accommodate, figure 1.

BALANCE

The crankshaft should be dynamically balanced. When balanced on knife edges, the maximum "out of balance" should not exceed 1/2 oz. ins.

RUN-OUT

When the crankshaft is mounted between centers, the maximum permitted run-out of the center journal must not exceed 0.001" (0.25 mm) total indicator reading. The reading also applies to the run-out the periphery and rear face of the flywheel mounting flange, figure 2.

UNDERSIZE BEARINGS

These are supplied for servicing purposes in the under sizes stated in the technical data.

GRINDING FINISH

All pins and journals to have a ground surface finish of 7.12 micro inches and to extend over the whole fillet radius.

CRANKSHAFT INSTALLATION

Lubricate and position the main bearing shells in the crankcase, taking care to properly locate their tags in the recesses provided. Blowout the oil-ways in the crankshaft with compressed air, clean all journals and position the shaft in the crankcase.

Lubricate the two semi-circular thrust washers and pass these around the rear crankshaft journal. It is important that the grooved white metal faces bear against the crankshaft .

The main bearing caps are not interchangeable and must not be filed to take up bearing wear. The identification numbers on the caps must correspond with those on the oil sump face of the crankcase. Whilst the front and center bearing caps appear identical, the latter is distinguished by being double stamped, as shown in figure 3.

Lubricate and fit the main bearing shells into the caps, then install the caps in the crankcase, taking care that they occupy their correct positions, and secure with the main bearing bolts and spacing washers. To prevent oil leakage, the front and rear caps must be tapped into alignment with the machined faces of the crankcase. Finally tighten the bolts to the correct torque.

Check the end float of the crankshaft; this should be 0.004" -0.008" (0.1- 0.2 mm) .If the end float is excessive; correct it by fitting over size thrust washers.

FRONT SEALING BLOCK AND BEARER PLATE. Figure 1 and 2.

Using "Wellseal" jointing compound on the joint faces, fit the front main bearing sealing block and during the tightening process, align the front face of the block with the machined face of the crankcase. Tap the wood filler pieces into the end recesses of the block and trim the excess material level with the oil sump face of the crankcase.

Fit the two dowels to the front of the crankcase, attach the front bearer plate and greased paper joint washer and secure with appropriate bolts and spring washers.

REAR OIL RETURN SCROLL AND BEARER PLATE. Figure 3.

Position a new paper joint on the rear face of the crankcase with grease and lightly bolt the rear oil return scroll to this face. Insert a feeler gauge of

approximately 0.003" (0.076 mm) thickness and tap the return scroll until equal clearance between the crankshaft and oil scroll has been obtained all round. Finally, tighten the baits to the correct torque and re-check clearance.

Insert two dowels in the rear crankcase face, position the rear engine bearer plate and secure this with baits and spring washers. Insert the input shaft spigot oilite bushing into the rear of the crankshaft and rotate the latter to bring numbers one and four crankpins to T. D.C.

FLYWHEEL

REPLACING STARTER RING GEAR

The starter ring gear is an interference fit and is shrunk onto the flywheel during initial assembly. If damaged or unserviceable, it can be removed with a copper drift whilst the flywheel itself is supported on blocks sufficiently thick to raise the ring gear above the bench surface.

The new gear is fitted by first heating it and then locating it on the cold flywheel. If heated to a sufficiently high temperature the expansion of the gear will be such as to enable it to be easily positioned on the flywheel, but unfortunately, due to the danger of destroying its hardness, there is a Limit to the amount of heating permissible.

A recommended method, free from the afore-mentioned danger, is to immerse the gear ring in boiling water for at least ten minutes. Then, by use of a fly press or a number of "G" clamps, as shown on fig. 4, carefully press the gear into position of the flywheel. To avoid loss of heat this operation must be carried out with the least possible delay.

Attach the flywheel to the end of the crankshaft with the flywheel timing mark also at T. D.C. This should automatically occur if the dowel in the end of the shaft has located in the flywheel. Tighten the securing baits, but before locking the tab washers, check the flywheel clutch face for run-out. If the maximum tolerance of 0.003" (0.076 mm) is exceeded, then the cause must be established and corrected, after which the tab washers can be finally lapped up.

DIMENSION, AND TOLERANCES

Parts and description	Dimensions new		Clearances new		Remarks
	ins.	mm	ins.	mm	
CONNECTING RODS					
Connecting rod width	0.898	22.81	0.0105	0.0381	
	0.896	22.76	to 0.0126	to 0.32004	
Bore for small end bushing	0.938	23.83			Press fit in rod
	0.937	23.8			
Small end bushing external dia.	0.940	23.88			
	0.938	23.85			

Internal dia. of small end bushing	0.8126	20.64	0.0003	0.0076	Light push fit in bushing
	0.8122	20.63	to 0.00034	to 0.00863	
Piston pin dia.	0.81250	20.64			
	0.81226	20.63			

PISTONS

Grade	Bore		Top dia of piston ring lands "D"		Top dia of skirt "C"		Skirt dia 1/2"(12.7mm) below "C"		Top dia of skirt "C"		Skirt dia 1/2"(12.7mm) below "C"		Bottom dia of skirt "8"	
	ins.	mm	B.P.R. co. and Wellworthy		British piston ring co.		British piston ring co.		Wellworthy		Wellworthy		B.P.R. co. and Wellworthy	
			ins.	mm	ins.	mm	ins.	mm	ins.	mm	ins.	mm	ins.	mm
F	2.7282	69.3	2.712	68.88	2.7258	69.24	2.7267	69.26	2.7245	69.2	2.7263	69.25	2.7271	69.27
	2.7279	69.29	2.709	68.81	2.7253	69.23	2.7262	69.24	2.7242	69.19	2.7267	69.24	2.7268	69.26
G	2.7286	69.31	2.712	68.88	2.7262	69.25	2.7271	69.27	2.7249	69.21	2.7267	69.26	2.7275	69.28
	2.7283	69.3	2.709	68.81	2.7257	69.24	2.7266	69.25	2.7246	69.20	2.7264	69.25	2.7272	69.27
H	2.7290	69.32	2.712	68.88	2.7264	69.26	2.7275	69.28	2.7253	69.27	2.7271	69.27	2.7271	69.29
	2.7287	69.31	2.709	68.81	2.7261	69.25	2.7270	69.26	2.7250	69.26	2.7268	69.26	2.7268	69.28

PISTON RINGS

	Dimensions new		Clearances new	
	ins.	Mm	ins.	Mm
Compression ring width	0.0787	1.99	0.0015	0.038
			to	to
Groove width	0.0777	1.97	0.0035	0.089
	0.0812	2.06		
Oil control ring width	0.802	2.03		
	0.1563	3.97	0.0007	0.02
	0.1553	3.94	to	to
			0.27	0.07
Oil control ring groove width	0.158	4.01		
	0.157	3.99		
Piston ring cap in cylinders	0.008	0.20		
	0.13	0.33		

PISTONS

Type	Aluminum split skirt (graded F. G. and H to suit bores)
Fitting	Slot in piston skirt to camshaft side of engine and / or piston grown stamped "front".
Number of rings	2 compression rings, 1 oil control ring

Cap	0.008" to 0.013" (0.20 to 0.33 mm)
Maximum oversize for rebore	+ 0.030" (0.76 mm)
Oversize pistons available	+0.010" (.25 mm), +0.020" (.51 mm) + 0.030" (.76 mm)

If the leading edge of the ring gear teeth are only slightly damaged at the two points of starter engagement, i. e., the points at which the engine always stops, the flywheel may be turned through 90 degrees relative to the crankshaft, thus presenting new teeth to the starter pinion. This will necessitate re-marking of the T.D.C. position on the flywheel rim.

NOTE. When correctly positioned the leading edges of the gear ring teeth should be facing the starter motor.

RE-MARKING FLYWHEEL

Mount a dial gauge indicator with its plunger on the piston crown and rotate the crankshaft until the piston moves to its highest point. Scribe a line across the flywheel to correspond with the line on the cylinder block.

This should be heavily marked with a small chisel, and numbers 1 and 4 punched each side of the line. The original T.D.C. mark must be obliterated with a ball peen hammer.

PISTONS, CONNECTING RODS AND PISTON PINS

During manufacture of the cylinder blocks the bores are graded "F", "G" or "H" according to their limits. These letters are stamped on the drain tap side of the block adjacent to each bore. The bore sizes corresponding to these symbols are given on page 39. Pistons are also supplied in similar grades, the appropriate letter being stamped on the crown of the pistons.

When new pistons are fitted, it is advisable that they should bear the same identification symbols as the cylinder bores.

Before fitting pistons to the connecting rods, check the piston pin and small end bushings for wear. If new bushings are required, the old ones can be withdrawn and new bushings inserted, figure 1, in one operation by utilizing a special tool. The bushings must then be reamed to suit the pins.

With the bushings and piston pins in satisfactory condition, check the alignment of the connecting rods. If necessary, correct any inaccuracies of alignment by using a suitable setting wrench.

To avoid piston distortion and also to facilitate easy fitting of the piston, it is advisable to heat the pistons in a can of hot water. When fitting the pistons to the connecting rods it must be remembered that the split side of the piston and the bearing cap side of the con-rod must both be at the camshaft side of the engine as shown on fig. 2. It is also important that the piston pin circlips are properly located in the piston pin bore grooves and that the con-rod small end is centrally disposed in the piston.

Using a suitable clamp to compress the piston rings, figure 2, lower the con-rod and piston assembly down the bore with the split side of the piston on

the camshaft side of the engine until the big ends engage the crankpins. After fitting the caps and tightening the big end cap bolts to correct torque secure these by turning up the lock plate tabs.

NOTE. The big end caps are not interchangeable and must not be filed to take up bearing wear.

LUBRICATION

A pressed steel oil sump of 4 qts. (4.5 liters) capacity is banded to the bottom face of the cylinder block. Oil is drawn from the sump by a Hobourne-Eaton double rotor type oil pump which passes the oil under pressure to an annular space around the vertical pump drive shaft.

From this space, oil is forced through a passage cast in the cylinder block to the input side of a full-flow filter. The oil passes through the filter, which incorporates a non-return valve and a by-pass valve, returning through the central threaded filter base to the oil gallery, which runs the whole length of the cylinder block.

The oil passes from the oil gallery through various drilled passageways to the main bearing, camshaft and cylinder head. Oil fed to the main bearings is then conveyed through drillings in the crankshaft webs to the big end bearings. Surplus oil forced out of these bearings serves to lubricate the cylinder walls, pistons and piston pins.

Each camshaft journal is provided with a scroll, which serves to distribute oil across its width. The rear journal is also provided with two flats. A vertical drilling in the rear of the block carries oil from the rear camshaft bearing, metered by the two flats on the journal, up through a hole in the cylinder head and via a matched hole in the rear pedestal into the hollow rocker shaft.

The oil then passes along the rocker shaft to lubricate each rocker before being ultimately splashed on to the valve guides, push rods and tappets. The timing chain and tensioner are lubricated by oil escaping from the front camshaft bearing, the oil being thrown outwards by the timing sprocket before finally returning to the sump.

PRESSURE RELEASE

The delivery of oil from the pump will increase as the engine is speeded up and at high engine speeds; the quantity of oil available is greatly in excess of the normal requirements of the engine and will result in increased oil pressure. Excess pressure is released and the surplus oil returned to the oil sump by a non-adjustable valve which consists of a spring-loaded plunger designed to blow off at 65 to 70 lbs. per sq. in. (4.57 to 4.92 kg/cm²) and housed in a large dished cap, screwed into the L. H. side of the crankcase above the oil pump. Apart from cleaning during an engine overhaul, this assembly should not require maintenance or attention.

OIL PRESSURE INDICATION

Pressure is indicated by a warning light mounted in the speedometer dial and controlled by a hydraulic switch which is screwed into a tapped hole in

the centre of the oil gallery. The switch contacts are designed to open, and thus cut-off the electrical supply to the warning light when the oil pressure reaches 5 to 7 lbs. per sq. in. (0.35 to 0.49 kg/cm²). The contacts remaining open at all pressures above this figure. The switch is non-adjustable and does not require maintenance.

OIL FILTRATION

The engine is fitted with a full flow oil filter which may be of Purolator, A.C. or Tecalemit manufacture. The filter element is housed in a pressed steel container, which screws onto a machined face on the L.H. side of the cylinder block. A synthetic rubber seal secured between a flange on the filter container and its mounting face on the cylinder block prevents oil leakage.

Oil under pressure enters the filter container through hole, in its base and lifts the spring-loaded non-return valve disc (6) off its seating. Oil is then forced around the outside of the filter element and passes through the element to the centre. The filtered oil then passes through the hollow central threaded filter boss to the oil gallery as shown on figure 1 at "A"

If the filter element becomes blocked, the by-pass valve (2) opens at a predetermined differential pressure between the input and output sides of the filter, permitting the oil to by-pass the filter element as shown on figure 1 "B".

RENEWING THE OIL FILTER. Figure 3

1. After removing the old filter, clean all trace, of adhesive from the adaptor surface.
2. Smear sufficient grease in groove of filter, and always fit a new sealing ring and smear with grease.
3. Screw in filter as tight as possible using bath hands, filter body and hands to be dry and clean to achieve max. tightening torque (this should be equivalent to 15 - 18 lbs ft. torque) .
4. Check that there is metal-to-metal contact between ridge on filter body and adaptor face all round. It is essential that this condition is, achieved, if there are any gaps reject filter and fit another.
5. Run engine at varying speeds for five minutes to ensure repeated operation of pump relief valve to fully pressurize filter.
6. Retighten filter to 15.18 ft/lbs of. torque or equivalent by hand. Check for oil leaks.
7. Finally, check oil level in sump and top up if necessary.

OIL COOLER ADAPTOR

DESCRIPTION

The oil cooler adaptor fits between the cylinder block and the oil filter. In addition to forming a connection point from the engine to the oil cooler, the

adaptor also provide' a degree of thermostatic control over operation of the oil cooler.

The oil cooler adaptor is secured to the cylinder block by a central hollow bolt.

The adaptor lower face is sealed to the mounting face on the cylinder block with a synthetic rubber ring. The hollow attachment bait of the normal full flow filter screws into the cooler adapter attachment bait, whilst the outer edge of the filter body seals on the face of the adaptor.

A chamber on the cylinder block side of the adaptor communicates with an outlet union bass. A pipe from this bass connects the adaptor to the cooler. A return pipe from the cooler connects to a chamber formed in the filter side of the adaptor. The inner chamber also communicates with the outer one through a spring-loaded ball valve.

OPERATION. Figure 2

Oil passes from the passage in the cylinder block, into the filter adaptor. When the oil is cold, the viscosity and pressure is sufficient to lift the ball off its seat, permitting the bulk of the oil to flow directly through the filter and returning to the oil gallery through the central drilling as shown at "A".

As the oil temperature increases, the viscosity, and therefore, the pressure, decreases until a point is reached when the oil pressure will no longer lift the ball off its seat. Under this condition, oil is pumped into the inner adaptor chamber and through the oil cooler before returning to the outer adaptor chamber.

DIMENSIONS AND TOLERANCES

Parts and Description	Dimensions new		Clearances new		Remarks
	ins.	mm	ins.	Mm	
OIL PUMP					
Depth of rotor	0.9995	25.37			A combined warn clearance of 0.004" (1.1016 mm) indicates necessity for lapping of the cover and housing face.
Housing depth	0.9985	25.36			
	1.002	25.45			
	1.01	25.43			
Max. permissible clearance between outer and inner and body			0.008	0.2032	Renew outer rotor

Max. permissible clearance between outer and inner rotors			0.010	0.254	and/or housing if worn beyond this limit.
Distributor drive gear end float			0.003 0.07	.08 .18	Renew inner and outer rotors if worn beyond this limit. Adjust by fitting paper shims beneath distributor pedestal
Distributor drive gear spindle dia.	0.499	12.67	0.0005	0.0127	
	0.498	12.65	to 0.003	to 0.0762	
Distributor drive gear bush bore	0.5005 0.501	12.71 12.73			

OIL PRESSURE RELIEF VALVE

Free length	1.53	38.86		
Fitted length	1.25	31.75		
Load at fitted length	14.5 Lb. 6.58 Kg.			
Rate	56 lb/in.			

ROCKER SHAFT

Diameter	0.5612	14.26	0.0023	0.06
			To	to
	0.5607	14.24	0.0008	0.02

From this chamber it passes through the filter before returning to the oil gallery through the central drilling, as shown at "B".

Should the oil cooler become blocked with foreign matter, oil pressure lift the ball valve from its seating and permit oil circulation directly through the filter.

OIL PUMP

To check the rotors for excessive wear, fit the rotors to the pump body and measure the clearance between the lobes of the inner and outer rotors as shown on figure 2 (centre). This should be less than 0.010" (0.254 mm).

Determine the clearance between the outer rotor and body by inserting a feeler gauge as shown on figure 3 (right). This should be less than 0.008" (0.2032 mm). With the rotors in position, place a straight edge across the pump body as shown on figure 1 (left). Check the clearance with feeler gauges between the straight edge and the ends of the rotors. This should be less than 0.004" (0.102 mm).

Renew the oil pump components as necessary if the clearances exceed those quoted.

Fit the inner rotor to the oil pump housing, followed by the outer rotor with its chamfered face leading. Seat the assembly in the crankcase with the intake pipe facing rearwards and tighten the three long bolts with spring washers to a torque of 6 to 8 lbs/ft.

There is no proper joint between either the pump housing and block or the housing and end cover.

GENERAL DATA

VALVE TIMING

Inlet valve opens	12° B.T.D.C.
Inlet valve closes	52° A.B.D.C.
Exhaust valve opens	52° B.B.D.C.
Exhaust valve closes	12° A. T.D.C.

VALVE TIME MARKINGS

Scribed lines on crankshaft camshaft sprockets correspond with no. 1 cylinder at top of compression stroke. Centre punch mark on camshaft sprocket corresponds with cut away on camshaft boss.

IGNITION TIMING

6.8: 1 compression ratio	9° B. T .D.C
8 : 1 compression ratio	15° B. T.D.C.

CAMSHAFT

	Dimensions new		Clearances new	
	ins.	mm	ins.	Mm
Camshaft journal diameters	1.8407	46.75	0.0026	0.07
			to	to
Bore in block	1.8402	46.74	0.0046	0.12
	1.8433	46.82		

	1.8448	46.86		
End float	0.008	0.20		
	0.004	0.10		
Tappet dia	0.6871	17.45	0.0002	0.00508
			To	to
	0.6867	17.44	0.0013	0.03302
Tappet bore in cylinder block	0.688	17.47		
	0.6873	17.46		

TIMING CHAIN

Roller dia.	0.250	6.35		
Number of pitches	62			
Timing chain pitch	0.375	9.525		
Oil pump (outer rotor) outside dia.	1.598	40.59	0.005	0.127
			to	to
	1.597	40.56	0.007	0.178
Housing internal dia.	1.603	40.72		
	1.604	40.74		

OIL SUMP AND BREATHER PIPE

Fit the pipe to the crankcase and using a new gasket, attach the oil sump, the longer setscrew being used for the breather pipe clip attachment. Secure the manifold drainpipe clip to the appropriate sump set screw.

CAMSHAFT AND TAPPETS

Lubricate the camshaft bearings and fit the camshaft. Secure this by attaching the camshaft retainer. After cleaning and oiling each tappet, insert these into the cylinder block.

PUSH RODS, CYLINDER HEAD AND ROCKER SHAFT ASSEMBLY

Fit the above items as described on page 25.

VALVE TIMING AND SPROCKETS

Fit the original shim pack to the front of the crankshaft and position the woodruff key, press the crankshaft timing sprocket with its internally chamfered end leading, over the woodruff key, until the shims are fully compressed (figure 1).

Using two setscrews, temporarily attaches the camshaft sprocket to the camshaft and checks the alignment of both sprockets with a straight edge

(figure 2). Where misalignment is evident, correct this by increasing or decreasing the shim pack thickness as necessary then remove the camshaft sprocket.

UTILIZING TIMING MARKS TO RE-SET TIMING

If the original sprockets are being refitted, it should be noted that the front face of the sprocket is marked with a center punch, near one of the attachment holes. The camshaft itself is provided with a cut-away, which should be aligned as shown on figure 3. Both sprockets are also marked with scribed lines.

Utilizing these marks for re-setting the valve timing, the procedure is as follows;

- a) Rotate the crankshaft until numbers one and four pistons are at T. D. C. An arrow on the flywheel will then be aligned with a similar mark on the cylinder block and the sprocket's driving key will be pointing upwards. A mark scribed on the front face of the crankshaft sprocket will also be pointing towards the center of the camshaft.
- b) Placing the markings as shown on figure 3, temporarily attach the camshaft sprocket to the camshaft and rotate this in order to align its scribed line with a similar one on the face of the crankshaft sprocket.
- c) Without disturbing the camshaft, carefully remove its sprocket and, after encircling both this and the crankshaft sprocket with the chain, refit the camshaft sprocket in exactly the same position as before, and finally secure by tightening the two setscrews and turning the lockplate tabs.

This completes the valve timing, but before continuing to describe further assembly the following instructions are included for dealing with new and unmarked components or where the accuracy of existing marks is in doubt.

SETTING VALVE TIMING WITH UNMARKED GEARS

This necessitates the use of special rocker clearances as follows:

- a) Temporarily attach the camshaft sprocket and, numbering from the front, turn the camshaft until number one push rod has reached its highest point.

In this position, adjust number eight rocker clearance to 0.040" (1.016 mm).

- b) Repeat the procedure with number two pushrod and adjust number seven rocker until it's clearance is identical to that of number eight rocker.
- c) Again rotate the camshaft until numbers seven and eight valves have reached the point of balance, that is where one valve has just closed and the other is about to open. With careful movement, adjust the camshaft until the largest feeler possible is equally nipped by both numbers seven and eight rockers.
- d) Without disturbing the position of the camshaft, carefully remove the timing sprocket and set numbers one and four pistons at T. D. C.

Four holes are provided in the camshaft timing sprocket which are equally spaced but offset from a tooth centre. When the sprocket is fitted at 90 degrees to its initial position, which location is identified as position "A", a half tooth of adjustment is obtained.

If the sprocket is turned "back to front" from position "A", a quarter of a tooth adjustment is obtained, whilst a 90-degree movement in this reversed position will give three quarters of a tooth variation from that given by position "A". It will be appreciated, therefore, that with careful manipulation of the camshaft sprocket, extremely fine adjustment can be obtained.

- e) Encircle the two sprockets with the timing chain and offer up the camshaft sprocket. If the holes are not in alignment with those of the camshaft, release the sprocket and work it around the inside of the chain, one link at a time repeatedly offering up the sprocket and examining the attachment holes for alignment whilst pressure is exerted on the top side of the chain.
- f) When alignment is satisfactory, secure the sprocket by tightening the attachment bolts and turning up the lockplates. To ensure that no errors have been made, re-check the timing. This involves turning the flywheel a few teeth backwards, then slowly forward in normal direction of rotation until numbers seven and eight rocker clearances became equal. This position should coincide exactly with numbers one and four pistons at T.D.C.

Suitably mark the sprocket and finally re-set 011 rockers to the correct clearance of 0.010" (0.254 mm).

TIMING COVER AND CRANKSHAFT PULLEY_ Figure 2.

Fit the oil thrower (63) with its dished face towards the timing cover. Grease the timing cover gasket (123) and place it over the two dowels. Having fitted a new oil seal (121) in the timing cover and, if necessary, a new chain tensioner (1) compress this with a suitable tool and locate the cover on the two dowels. Secure by fitting and tightening the various attachment setscrews.

Fit the crankshaft pulley (64) followed by the retaining nut (65).

DISTRIBUTOR AND IGNITION TIMING

Distributor drive gear end float (figure 1) .

- a) Place a washer (3) having an internal diameter of 1/2" (12.7 mm) and a thickness of 0.030" (0.76 mm) over the oil pump drive spindle (4). Then enter the gear and spindle assembly into its bushing in the cylinder block, taking care to engage the oil pump driving spindle tongue with the corresponding slot in the oil pump spindle.
- b) Fit the distributor pedestal (1) and evenly tighten the securing nuts until the end float of the distributor drive gear is just eliminated.
- c) Using feeler gauges, measure the clearance between the distributor pedestal and the cylinder block faces.
- d) The thickness of proper shims required to give the specified distributor drive gear end float of 0.003" to 0.007" (0.08mm to 0.18mm) is

determined as follows.

Subtract the clearance between the pedestal and cylinder block faces from the thickness of the washer (3)

The resultant dimension, plus the specified end float, is the thickness of the shim pock required.

- e) Remove the distributor pedestal, gear, spindle assembly and washer (3) .The washer must not be re-fitted.

With no.1 piston at T. D.C. on the compression stroke, re-enter the spindle and *gear* in such a position that when the gear is fully home the driving slot assumes a position as shown on figure I with the slot offset nearest to the cylinder block.

- f) Place the paper shim pock (see paragraph d) aver the pedestal studs, followed by the pedestal (1) and secure with nuts and spring washer.

DISTRIBUTOR

Lucas type D.M. 2.

Lucas no.40755.

6.8:1 compression ratio Advance curve ECM 737

8:1 compression ratio Lucas no.40743 A. Advance curve ECM 734

Contact breaker gap 0.015" (0.4 mm)

DISTRIBUTOR TIMING

Enter the distributor into the pedestal, engaging the driving tongue with its corresponding slot in the gear boss.

With the contact breaker gap set at 0.015" (0.4 mm) adjust the position of the distributor so that the points commence to open at the specified setting, depending on compression ratio, see page 2. If correctly timed, the rotor arm will face no.1 segment in the distributor cap. Clomp the distributor in position by tightening the nut on the pedestal pinch bolt. It may be necessary to modify this setting during rood test to obtain the best performance.

ROCKER COVER, MANIFOLD, 01 L PRESSURE RELEASE VALVE AND OIL FILTER

Coat one side of a new cork rocker cover gasket with jointing compound, and when tacky, attach the gasket to the flange face of the cover. Place the rocker cover, face downwards, on a flat surface, and place a weight on the top of the cover, leaving until set.

Position the cover over the two studs on the cylinder head, and secure with fibre washers, plain washers and nyloc nuts.

Fit and secure the inlet and exhaust manifold (5) with the gasket (18) steel face outwards.

Fit the oil filter, joint. tightening it sufficiently to form an oil-tight

Fit the oil pressure release valve (100) spring (101) , domed cap (103) and copper washer (102) to the cylinder block.

WATER PUMP AND GENERATOR

Position the water pump gasket on the block with grease and fit the water pump to the cylinder head. The longest of the three attachment bolts are fitted to the upper left-hand hole viewed from the front of the engine. The upper right-hand bolt carries the generator-adjusting strap. Fit the thermostat with its packing washer and the water outlet body. The fuel pipe and suction advance pipe clip is fixed to the right-hand bolt. Attach the generator bracket to the crankcase and the generator, pedestal to the front engine bearer plate. Mount the generator in position, fit and adjust the fan belt to give 1" (25.4 mm) slack on its longest run and finally secure all generator attachment bolts.

CARBURETTOR, FUEL PUMP AND PIPES

Position an asbestos insulating gasket over the carburettor mounting studs on the manifold. Attach the carburettor and secure this with spring washers and nuts. Connect up the choke and throttle cables.

Fit the fuel pump and the original thickness of packing washers to the cylinder block, ensuring that the operating lever engages correctly with the eccentric on the camshaft. Secure with nuts and spring washers.

Note that the extension nut with screwdriver slot fits on the rear stud.

Utilizing a clip, attach the fuel and vacuum advance pipes to the water elbow attachment bolt.

Fit the breather pipe by driving its upper end into the hole on the R. H. side of the cylinder block and secure the lower end with the combined clip and baffle plate, attaching the clip to one of the sump bolts.

SPARKING PLUGS, H T. LEADS, AIR CLEANERS ETC.

FIRING ORDER 1, 3, 4, 2.

After setting the gaps at 0.025" (0.65 mm), figure 1, or 0.030" (0.762 mm) on 7: 1 compression ratio engines, fit the sparking plugs. Fit the distributor cover and attach the H. T. leads in the firing order 1,3, 4, 2, as shown on figure 2. Attach the air cleaner.

Fit the cylinder block drain plug, the dipstick and the oil pressure warning light switch, which screws into the tapped hole in the oil gallery. Check that the manifold drain pipe is free from obstruction and fit this into position with its lower end carried by the smaller clip attached to one of the oil sump bolts.

AIR CLEANER, Figure 3

Every 3,000 miles (5,000 km), unscrew the retaining screw (11) and detach the cover (9) from the air cleaner. Remove the paper element (8) from the casing and, with a low pressure compressed air line or a soft brush, clean between the folds of the paper. Clean the interior of the casing and re-fit the

element (8) and cover (9) , securing this by tightening the screw (11)

Every 12.000 miles (20.000 km) renew the paper element. Under dusty conditions clean or renew the element more frequently.

To remove the complete air cleaner, slacken the clip (5) and rift the air cleaner from the carburettor Re-fit the air cleaner by positioning the rubber grommet (2) on the air cleaner, fitting the cleaner to the carburettor and tightening the screw.

COOLING SYSTEM

DESCRIPTION

The cooling system is sealed, pressurized and thermostatically controlled, water circulation is assisted by an impeller type pump to which is attached a six-bladed fan assembly driven by a "V " belt from the crankshaft pulley.

Water drawn from the radiator bottom tank by the pump is fed into a brass tube in the cylinder head, a number of haes in the tube directing the coolant around the inlet and exhaust valve seats.

After circulating around the remainder of the combustion head and cylinder black, the w1ter returns to the radiator header tank via a passage in the water pump body, tap water elbow and hose. A small by-pass drilling is provided between the inlet and outlet passages of the pump body to allow water to circulate when the thermostat is closed.

THERMOSTAT

This is incorporated in the cooling system to enable the engine to warm up mare rapidly by restricting the flow water to the radiator until the engine reaches its normal working temperature.

As the temperature of the engine increases, the thermostat opens, allowing the coolant to circulate past the thermostat valve and into the radiator.

FILLER CAP, Figure 1

The special filler cap is fitted to the radiator tap tank incorporates a spring-loaded rubber-faced valve which seals the cooling system, until a pressure of 6 1/4 to 7 1/4 lbs. per sq. in. (4 to 5 kg/cm) is generated. At this pressure the release valve opens and allows excess pressure to escape through the release pipe.

By pressurizing the system, the bailing point of the water is raised, so enabling the engine to operate at higher temperature.

To relieve the vacuum which is created as the system coals, a small spring-loaded relief valve built into the centre of the filler cap, opens to admit atmospheric pressure.

CAUTION

If the engine is hot, exercise extreme care when removing the filler cap. Turn it half-turn and allow pressure to be fully released before completely removing the cap, figure 2.

DRAINING

To drain, open the drain tap situated in the bilge on the heater hose, remove attached nylon hose, placing end outside the door, open drain plug at the rear of cylinder block on the left-hand side, open the heater air vent, and owing to the system being pressurized it is also necessary to remove the radiator filler cap.

FILLING

When filling, close the drain tap, and then fill the system with water (if available, clean rain water). After filling start the engine to circulate the coolant through the heater unit. When the coolant is warm, stop the engine and tap up the radiator to the correct level if necessary.

FLUSHING

Efficient cooling is maintained by thoroughly flushing the entire system twice a year. The seasons most suitable for this service are during autumn before adding antifreeze mixture and during spring immediately after the anti-freeze has been drained off.

Before flushing the system, remove the filler cap and open the drain taps (or preferably completely remove them), whilst the engine is still hot. Allow time for the engine to cool after the water has been drained. When cold, insert a hose in the radiator filler neck and flush the system to remove all sediment.

Sludge, which may have collected in the heater unit, should also be removed by disconnecting the heater feed pipe and attaching it to a high-pressure hose. When draining is complete, reconnect the heater and close the drain taps or re-fit them if they have been removed. Fill the system to the normal level with a solution of cleansing compound and run the engine as directed by the manufacturers of the compound. It is most important that the compound is drained off after the period described, finally flush the system thoroughly with running water.

IMPORTANT

When using cleansing solutions, avoid splashing the paintwork of the vehicle as this may have injurious effects.

THERMOSTAT, Figure 1

The thermostat is housed in the upper portion of the water pump body, its flange being located between the upper recessed face of the latter and the joint face of the water outlet elbow.

TESTING

The thermostat may readily be tested for correct operation by placing it, together with an accurate thermometer, in a bowl of water. Raise the temperature at which the thermostat valve commences to open. This should be within the tolerances given in the technical data. Provided that the opening temperature is within these limits, there is no need to check the temperature at which the thermostat valve is fully open, as this automatically follows.

The element is not adjustable or repairable and when a test shows inaccuracies or damage on inspection, it will be necessary to renew the complete unit.

REFITTING

Clean the pump body and elbow joint faces, use a new joint washer and reverse the removal procedure. Refill the radiator.

WATER PUMP REMOVAL

The water pump assembly is secured to the cylinder head by three bolts of unequal length. The upper left-hand bolt being used to also secure the generator-adjusting link. Drain the cooling system and remove the pump as follows:

1. Slacken the two generator bolts and remove the adjusting bolt together with two plain washers. Move the generator towards the cylinder block and remove the fan belt.
2. Disconnect the top and bottom water hoses from the pump body. If a heater is fitted, it will also be necessary to disconnect the return pipe by slackening the union nut from the rear of the pump body.
3. Remove the bolts securing the pump body to the cylinder head and lift the complete pump assembly from the engine.

NOTE:

Provided that the radiator is first removed the water pump bearing housing can be detached separately if required, leaving the pump body in position.

REFITTING

Renew all joint washers and reverse the removal procedure.

DISMANTLING, Figure 1

1. Withdraw the four retaining screws (16) and remove fan blades (20) together with the balancer (19) (if fitted) .
2. Remove the nut (17) and washer securing the fan pulley (21) and using a suitable extractor, withdraw this from the spindle (28) .

3. Having withdrawn the impeller (31) from the pump spindle (28) by utilizing an extractor remove the bearing retaining circlip from the housing bare and withdraw the spindle complete with bearings.
4. Remove the following items from the spindle-key (13) , bearings (24), distance piece (25), circlip (26), washer,(14),and rubber spinner (27) .
5. Complete the pump dismantling by removing the sealing gland (30) from the recess in the back of the impeller.

RE-ASSEMBLY

Reverse the dismantling procedure and note the following points.

1. When fitting the bearings, repack these with pump grease and position them so that the grease seal incorporated in each bearing faces outwards. Pock the inside of the seal bellows with water pump grease.
2. Press the impeller on to the shaft until a clearance of 0.030" (.76m~ is obtained between the bearing housing and the impeller. Before fitting the bearing assembly, solder the impeller to the shaft to prevent the possibility of water leakage along the spindle.
During manufacture, the fan and pulley assemblies are statically balanced by adjusting the length of the fan blades. Final adjustment is then made by attaching and moving a balance weight (19) to the desired position. When the fan, pulley and balance weight ore in perfect balance, drilling a small hole through the complete assembly marks the position of these items.

To maintain the original degree of balance when the components ore reassembled the drillings should be aligned by inserting the shank of o 1/16" (1.6 mm) drill through the holes whilst the fixing bolts ore being tightened.

FAN BELT ADJUSTMENT, Figure 1

Slacken the bolt (1) and generator pivots (2), swing the generator outwards until there is approximately 1" (25.4 mm) side movement in the belt at its longest run, i. e. between crankshaft pulley and generator.

Maintaining the belt tension, retighten the bolt (1) and generator pivots (2)

Do not over-tension the belt, as excessive loads will be imposed on the generator and water pump bearings.

TRANSMITTER (THERMOMETER), Figure 2

The transmitter is mounted in the top water elbow, and the gouge unit which is mounted in the instrument panel, both units ore connected by a cable.

No provision is mode for the repair of these components, but they may be renewed independently if necessary.

WATER PUMP DIMENSIONS AND TOLERANCES

Fan pulley bore	0.6296" -0.6291"	15.99 mm -15.98 mm
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Dia. of spindle	0.6299" -0.6296"	16.0 mm- 15.99 mm
Interference between spindle and pulley bore	nil to -0.0008"	nil to -0.02 mm
Impeller bore	0.6265" -0.6270"	15.93 mm -15.91 mm
Interference between spindle and impeller bore	0.0026" -0.0034"	0.07 mm -0.09 mm
Bearing housing internal diameter	1.3779" -1.3773"	35.0 mm -34.98 mm
Depth of gland face below joint face	0.235" -0.225"	5.97 mm -5.71 mm
Maximum permissible depth of gland face below joint face		0.265" 6.7 mm
Distance between impeller and joint face of bearing housing		0.030" .76 mm

COOLING SYSTEM THERMOSTAT

Thermostat opening commences at	154° F to 163.40 F
Fully open at	185° F
Maximum lift	0.312" (7.92 mm)

COOLING SYSTEM FAULT DIAGNOSIS

Fault	Cause	Remedy
Overheating	Insufficient coolant	Refill system and inspect for leaks
	Fan belt slack or worn	Adjust or replace
	Cooling system blocked	Clean the system
	Ignition timing incorrect	Re-time ignition
	Thermostat stuck in closed position	Replace thermostat
Overcooling	Radiator hose fabric loose in bore	Replace hose
	Thermostat stuck in open position	Replace thermostat
	Extremely low temperatures	Block off lower part of radiator
Loss of water	Radiator leaking	Repair or renew radiator
	Radiator hoses defective or hose clips loose	Tighten clips or replace hoses
	Water pump leaking	Overhaul water pump
	Heater unit leaking	Repair or renew heater element or connections
	Cylinder head gasket defective	Replace gasket and tighten nuts evenly
	Welsh plugs in cylinder head or block leaking	Renew plugs
	Cylinder head or block crocked	Replace cylinder head or block
Water pump noisy	Pump bearing rough	Renew spindle and bearings
	Seal squeaking	Replace seal
	Belt squeaking	Dress sides of belt with dressing or soar

DESCRIPTION OF THE FUEL SYSTEM

The fuel system of the "Amphicar " comprises of the fuel tank with filler cap, fuel cock, fuel hose, fuel pump with pipe and carburettor with air filter .

The fuel tank is located below the trunk lid, its capacity being 12,4 U.S. galls. ; 47 liters. The fuel cock is screwed into a welded-an nozzle at the

discharge opening of the fuel tank.

The fuel is drawn by the fuel pump from the fuel tank and is then delivered to the carburettor.

The fuel cock cup and strainer should be removed and cleaned every 6000 miles, for foreign matters and even water will accumulate in the strainer, and if left too long without being cleaned, it could cause clogging of the carburettor jets.

ANCILLARY EQUIPMENT

FUEL PUMP

Attention to the fuel pump may be restricted to cleaning the filter bowl, and ensuring that the attachment bolts and pipe unions are tightened sufficiently to prevent leaks.

CARBURETTOR

The single Solex carburettor installation requires little attention. This may be confined to cleaning out the float chamber and jets.

FUEL PUMP, Figure 1

The fuel pump is an A. C. mechanically operated diaphragm type pump that is mounted on the side of the engine, and is driven by an eccentric of the camshaft.

As the camshaft (G) turns, the cam (H) lifts the pump rocker arm (D) pivoted at (E) which pulls the rod (F) together with the diaphragm (A) downwards against the compression spring (C) thus creating a vacuum in the pump chamber (M).

The fuel is drawn from the tank and enters at (J) through a gauze filter screen and inlet valve (N) into the pump chamber (M). In the return stroke the compression spring (C) pushes the diaphragm upwards, forcing fuel from the pump chamber through the delivery valve (O) and outlet (P) to the carburettor.

The fuel delivery is automatically regulated according to engine requirements. The spring (S) keeps the rocker arm (D) in constant contact with the push rod and the eccentric (H) to eliminate noise.

CLEANING FILTER

It is advisable to examine the filter every 3,000 miles (5,000-km) and clean if necessary. Under conditions of dust-laden atmosphere this interval should be reduced as conditions dictate. Access to the filter is gained by removing the dome cover, after unscrewing the retaining screw, when the filter gauze itself may be lifted off its seating as shown in figure 1 clean the filter gauze with air jet or gasoline and replace the cork gasket if this is

hardened or is broken.

When refitting the cover, make certain that the fibre washer is replaced under the head of the screw. Tighten the filter cover retaining screw just sufficiently to make a leak-proof joint. Complete this service by checking the pump attachment screws and the fuel pipe unions for tightness

FUEL PUMP DISMANTLING, Figure ,

After removing the pump from the engine and before commencing dismantling operations, thoroughly wash the pump exterior with paraffin to remove all dirt and grease. To ensure that the components are reassembled in their original position, mark across the diaphragm flanges of the pump with the sharp edge of a file. Having removed the securing screws and separated the two main castings, further dismantling of the components associated with each is quite straightforward. The diaphragm and pull rod assembly can be withdrawn by pressing down and turning it through 90 degrees.

NOTE

Being permanently riveted together, no attempt should be made to separate the diaphragm layers from their protective washers and pull rod, as this is at 011 times serviced as 0 complete assembly.

INSPECTION OF PARTS

All ports must be thoroughly cleaned to ascertain their condition. Wash all ports associated with the valves in a clean paraffin bath separate from that employed for the other and dirtier components. Diaphragm and pull rod assemblies should normally be replaced unless in entirely sound condition without any signs of cracks or hardening of the diaphragm layers.

The upper and lower castings should be examined for cracks or damage and if the diaphragm or pump mounting flanges are distorted, these should be lapped to restore their flatness. All bad ports should be replaced and very little wear should be tolerated on the rocker arm pin (22) , the holes and engagement slot in the link (18) and the hole in the rocker arm (19) .On the working surface of the rocker arm, which engages with the camshaft eccentric slight wear is permissible, but should not exceed 0.010" (0.254 mm) in depth. The valve seat incorporated in the valve plate (7) should be examined, and if at all roughened, it should be carefully lapped on a smooth carborundum stone. Similarly of the corresponding outlet valve seat incorporated in the upper casting (1) should be examined and, if worn unevenly, both the upper casting and valve seat assembly must be replaced. It is not practicable to refit new valve seats into the castings, as this calls for special equipment.

Fuel pump valve, (7) should be replaced if at all worn, although in an emergency they can be turned over to provide a fresh surface to the valve seat. Valve springs should preferably be replaced, although they can be refitted, providing that they do not bear undue evidence of rubbing away on the outside diameter. In no circumstances should valve springs be stretched in an endeavor to increase their length.

Diaphragm spring (12) seldom calls for replacement, but where necessary ensure that the replacement spring has the same identification color and

consequently the same strength as the original. All gaskets and joint washers should be replaced as a matter of routine.

Proceed as follows:

RE-ASSEMBLY OF FUEL PUMP

A) UPPER PORTION

Having swilled the valves in clean paraffin fit the valve in the centre of the four cost webs.

Place the valve (7) on the valve seat located in the upper casting.

Fit on the top of the valves the gasket (9) and the valve plate (8) which is then secured with the two screws (10) .

At this stage, use a piece of wire to make sure that the valves work freely. Place the filter screen (2) in position on top of the casting, making certain that this fits snugly.

Fit cork gasket (4), cover (3), fibre washer (6) and retaining screw (5) as previously detailed under "cleaning filter".

B) LOWER PORTION

Assemble the link (18), packing washers (21), rocker arm (19) and rocker arm spring (20) in the body.

Insert the rocker arm pin (22) through holes in the body, simultaneously engaging the packing washers, link and rocker arm, then spring the retaining clips (23) into the grooves on each end of the rocker arm pin. The rocker arm pin should be a tap fit in the body. If necessary, in order to achieve this fit, it is permissible to burr the edges of the pinholes.

NOTE;

The fitting of the rocker arm pin can be simplified by first inserting a piece of 0.240" (6.096 mm) diameter rod through the pin hole in one side of the body far enough to engage the rocker arm washers and link and then pushing the rocker arm pin in from the opposite side, removing the temporary rod as the pin takes up its proper position.

C) DIAPHRAGM ASSEMBLY TO PUMP BODY

Insert the fabric washer (14) ,metal washer (13) and place the diaphragm spring (12) in position on the pump body. Place the diaphragm assembly (11) over the spring, the pull rod being downwards, and centre the upper end of the spring in the lower protector washer .

Press downwards on the diaphragm until the slots on the pull rod engage with the fork in the link, then turn the diaphragm assembly a complete quarter turn to the right, which will place the pull rod in the proper working position in the link and at the same time permit matching up of the holes in

the diaphragm with those on the pump body flanges. When inserting the diaphragm assembly into the pump body the locating "tab" on the outside of the diaphragm assembly should be at 6 o'clock position. After turning the diaphragm assembly a quarter turn to the left, the "tab" should be at 3 o'clock position.

D) RE-ASSEMBLY OF UPPER AND LOWER SUB-ASSEMBLIES.

Push the rocker arm towards the pump until the diaphragm is level with the body flanges. Place the upper half on the pump into the proper position, i. e., aligning the two marks made during dismantling operations. Install the cover screws and lock washers and tighten only until the heads of the screws just engage the washers. Hold the rocker arm at its innermost position and, whilst thus held, tighten the cover screws diagonally and securely.

TESTING THE PUMP AFTER RE-ASSEMBLY

The best method is by using on A.C. bench test stand on which the inlet side of the pump is piped to a tin of clean fuel at floor level and the outlet side of the pump connected to a stop tap and pressure gauge.

First flush the pump through to wet the valves and seats, and then completely empty it again by continuing to operate the rocker arm by hand with the inlet pipe clear of the fuel. Again operate the pump. Not more than twenty strokes should be necessary to secure delivery of fuel from the pump outlet. With the same apparatus a second test can be made by working the pump with the tap on the delivery side closed, pressure then being recorded on the gauge. After ceasing to work the pump it should take several seconds for this pressure to return to zero, thus denoting that the valves are seating properly.

Also whilst there is pressure, the outer edge of the diaphragm, visible between the pump body flanges, should be carefully examined for leakage and the retaining screws tightened if necessary. When working the pump by hand, a somewhat longer stroke is obtained and the pressure developed may be higher than when fitted to the engine.

OPERATING PRESSURE

The fuel pump is designed to operate at a pressure of 1 1/2 to 2 1/4 lbs. per sq. in. (1 to 16 kg/cm²). If the pressure exceeds this figure, flooding of the carburetor is liable to occur, with a resultant rich mixture and heavy fuel consumption.

Where necessary, a reducing in fuel delivery may be obtained by inserting additional paper joints between the pump flange and mounting face on the block, thus reducing the effective stroke of the pump diaphragm.

NOTE

The actual mounting of the pump on particular engine affects the fuel delivery owing to machining tolerances of the flange faces. Therefore, testing the pump pressure by means of the priming lever or by mounting it on a jig may give a false result. The pump pressure should be checked with the unit in

its normal position by rotating the engine with the starter.

REFITTING THE PUMP

Position the same thickness of joint washer on the mounting studs as were removed, then refit the pump taking care that the rocker arms contact the camshaft eccentric correctly. Re-connect the fuel pipes to the pump.

THE SOLEX B.30 ZIC.5 CARBURETTOR

The Solex B 30. ZIC. 3 and B.30 ZIC.5 carburetors are similar in construction and principles of operation to the B 28 ZIC.2 model carburetor. The B.30 ZIC.5 carburetor has, however, a modified cold starting system and incorporates an external float chamber air vent.

The cold starting system consists of a starter fuel jet (7) in the side of the float chamber. This jet supplies fuel from the float chamber to a well in the carburetor body. A tube which is partly immersed in fuel in the well is pressed into the carburetor top cover at its upper end and communicates with the cold starter unit through a passage cast in the top cover. The tube has a small hole (3) near its upper end which is open to atmosphere, and a larger hole (5) approximately half way down the tube, which, in the static condition, is below the fuel level in the well. The cold starting unit itself is otherwise similar to that used on the 8.28 ZIC.2 carburetor. When starting the vehicle from cold, pulling the choke knob out brings the cold starting unit into operation.

The depression created by rotation of the crankshaft causes fuel to be drawn up the tube. The fuel is emulsified by air drawn through the small bleed hole (3) and then passes through the cold starter unit, supplying a rich initial starting mixture. If the engine does not start immediately, the fuel level in the well falls rapidly and uncovers the larger hole (5), which further emulsifies the starting mixture to prevent over-richness. A short pause when attempting to start the engine will enable the well to re-fill through the starter fuel jet, again providing an initially rich mixture when cranking is recommenced. When the engine starts, the increased depression acting on the starter unit disc valve lifts it from its seat and admits more air. The mixture is progressively weakened as the choke knob is pushed in until, when the engine is sufficiently warm the cold starting unit is put out of action.

SOLEX 8.30 P.S.E.I. CARBURETTOR DESCRIPTION

The 30 mm Solex 8.30 P.S.E.I. carburetor is dust proofed and incorporates a strangler with automatic mixture weakening characteristics, a special Econostat fuel economy device and a mechanically-operated acceleration pump.

The strangler consists of a butterfly valve (2), mounted on an off-set spindle. Operation of the dashboard control opens the throttle (23) slightly and at the same time, by means of an interconnecting rod and cam, closes the butterfly valve.

OPERATION, Figure 1, page 78

STRANGLER

Depression created in the cylinder and inlet manifold when the crankshaft is rotated causes fuel to discharge from the main spraying well (8) through the orifice (3) .The restriction on the air intake imposed by the strangler butterfly provides a suitably enriched mixture for cold starting.

Opening of the throttle by a pre-determined amount provides for fast idling after the engine has started.

The increase in depression acting on the carburettor when the engine fires causes the strangler butterfly to pivot on its offset spindle against the resistance of a light coil spring, thus admitting more air and automatically weakening the mixture.

2. IDLING CIRCUIT

The idling circuit supplies, through the orifice (21), the mixture required for idling when the engine is warm. It also supplies, through the by-pass orifice (22) , the mixture required as the throttle is opened, but before it opens enough for the main spraying orifice to begin to discharge. Fuel is supplied from the reserve well (9) and is metered by the pilot jet (7) , the pilot jet air bleed (6) emulsifying the mixture from (7) .When the engine is idling, additional air passes through the by-pass orifice (22) , the volume of the resultant mixture being controlled by the screw (20).

On leaving the idling orifice (21) the mixture is further emulsified by air passing the throttle (23) which is held slightly open by the idling speed adjustment screw. As the throttle is opened, manifold depression is directed to the by-pass orifice (22) which discharges additional mixture to meet engine requirements until the throttle has opened sufficiently for the main spraying system to come into operation.

3. MAIN SPRAYING CIRCUIT, Figure 1

As the throttle (23) is opened further and air speed through the choke tube (24) increases, depression acting on the spraying orifice (3) brings the main spraying system into operation. Under this condition fuel flows from the float chamber and is metered by the main jet (19) before passing into the main spraying well (9) fuel in the main spraying well (9) is emulsified with air metered by the air correction jet (4) .Air from the correction jet (4) enters the fuel stream through small holes in the emulsion tube (5) .From the main well the mixture finally discharges through the orifice (3) into the main air stream.

As the engine speed increases the fuel level in the well (9) falls and uncovers the remaining holes in the emulsion tube (8) .Additional air enters the fuel stream through the uncovered holes in the emulsion tube and corrects the fuel output from the mixing jet according to engine speed and load.

4. ACCELERATION PUMP

The acceleration pump consists of a diaphragm (16) , spring (15) and lever (17) .The lever is connected by a push rod to a crank on the end of the throttle spindle.

KEY to figure 1

1. Accelerator pump jet.
2. Strangler flap.
3. Main spraying orifice.
4. Air correction jet.
5. Emulsion tube.
6. Pilot jet air bleed.
7. Pilot fuel jet .
8. Air emulsion haies.
9. Main spraying well.
10. Econostat fuel jet .
11. Econostat discharge tube.
12. Econostat air bleed.
13. Needle valve.
14. Accelerator pump breather valve.
15. Accelerator pump diaphragm spring.
16. Accelerator pump diaphragm.
17. Accelerator pump lever.
18. Non-return ball valve.
19. Main jet.
20. Idling mixture volume adjustment screw.
21. Idling mixture orifice.
22. Secondary idling mixture orifice.
23. Throttle disc.
24. Choke tube.

Depression of the accelerator pedal moves the actuating rod and lever, causing the pump diaphragm to be displaced against the farce of the spring (15) .The pump diaphragm (16) forces fuel through the calibrated pump jet (1) into the main air stream, providing a momentarily enriched mixture for rapid acceleration. A non-return valve (18) prevents fuel returning to the float chamber when the pump diaphragm is displaced. An anti-siphon valve is

provided to prevent over-spill from the pump injector pipe, which could cause difficult hot re-starting.

5. ECONOSTAT CIRCUIT

The Econostat circuit maintains maximum fuel economy over the cruising speed range of the engine whilst providing accurate metering of the fuel under full throttle conditions.

The circuit comprises an air bleed (12) and fuel jet (10) providing an emulsified mixture that is discharged into the air intake above the choke tube (23) .

As the engine speed increases the discharge will take place only when the depression inside the discharge tube (11) has become great enough to lift the fuel up to the inner end of the discharge tube. The depression inside the tube is determined by the depression at the outer end of the tube and the relative sizes of the air bleed (12) and outlet orifice. The size of the air bleed (12) determines the point at which the Econostat comes into operation and the jet (10) controls the rate at which the fuel is supplied. The Econostat thus supplements the mixture supplied by the main jet from a pre-determined engine speed up to maximum r.p.m. This allows the main jet to be of a size to give maximum cruising speed economy, whilst over-richness under full throttle conditions at low engine speed is avoided.

The level of fuel in the float chamber is controlled by slight rise and fall of the float, closing or opening the needle valve to cut off or admit fuel from the pump as required.

6. FUEL LEVEL

STARTING THE ENGINE FROM COLD

Pull the strangler control knob on the dashboard out to its maximum travel. Starting the engine in moderate climates may be accomplished with the mixture control in the half-way position. Switch on the ignition and operate the starter motor until the engine fires. Do not depress the throttle pedal.

As soon as the engine gathers speed, push in the strangler control knob to approximately a quarter of its travel.

The vehicle may then be driven away, and the strangler control pushed progressively in as soon as possible.

HOT RE-STARTING

Do not use the strangler control when the engine is warm. If the engine and ambient temperatures are high and it does not start at the first attempt, depress the throttle pedal approximately one-third of its travel and maintain this position whilst operating the starter motor until the engine fires. Do not pump the throttle pedal.

IDLING ADJUSTMENT, Figure 1

To obtain perfect idling, the engine compression must be good and equal, tappet clearances, distributor point gap and ignition timing correct and the sparking plugs clean and set to the correct gaps as detailed.

1. Set the throttle (slow-running adjustment) screw until the idling speed is approximately 500 r.p.m.
2. Unscrew the volume control screw (20) until the engine begins to hunt.
3. Screw it in again until the hunting disappears and the engine idles smoothly.
4. If the engine speed has risen then reset the slow running screw to bring it back to about 500 r.p.m.
5. This may cause a slight resumption of hunting. If so, gently screw in the volume control screw (20) until idling is perfect. (Under no circumstances should (20) be screwed hard home) .

REMOVAL

1. Slacken the clip {6} figure 1 and detach the air cleaner assembly. Disconnect the fuel pipe (8) and detach the vacuum ignition control pipe by drawing the rubber sleeve (12) from the stub pipe on the carburettor.
2. Release the strangler inner and outer cables (4) from the abutment bracket and con plate solder less nipple.
3. Disconnect the throttle cable (5) from the throttle lever. Remove the nuts {10} figure 1, spring washers (11) and detach the carburettor from the manifold, followed by the flange gasket (13) .

RE-FITTING

Re-fit the carburettor by reversing the foregoing dismantling procedure. Fit a new gasket (13) and adjust the length of the inner strangler cable so that when the strangler knob is fully in, the strangler butterfly cam plate is against its stop on the abutment bracket .

DISMANTLING AND CLEANING, Figure 1, page 84

Periodically, dismantle the carburettor to clean out the float chamber jets and passages as follows:

Detach the air cleaner and disconnect the fuel pipe.

Remove the screws (3) , spring washers {4} and detach the tap cover (5) and gasket (6) .lift out the spindle (60) , float lever (59) and float {7}.

Remove the plug {51} , aluminum washer (52) and using a long screwdriver, remove the main jet (53) .

Unscrew the pilot jet {14} and the air correction jet (8) from the carburettor body (II) .Remove the valve {54} and plunger {58} .Then detach the accelerator pump nozzle (57) , taking care to catch the ball valve (55) from beneath it.

Detach the screw (43) from the accelerator pump body {42}, remove the body and swing it to one side on the pump lever .

Remove the diaphragm (46) and spring (47). Take care not to lose the ball valve (45) from its seating within the accelerator pump chamber. Using clean fuel and a compressed air line, clean out the float chamber, and passages within the carburettor body and the various jets.

RE-ASSEMBLY

Re-fit the ball (45), spring (47), diaphragm (46) with its boss outwards and the pump body (42), securing these with the screw (43).
Re-fit the main jet (53), washer (52) and plug (51), the pilot jet (14), compensating jet (8), non-return valve (55) and accelerator pump nozzle (57).
Fit the float (7), lever (59) and spindle (60). Position a new gasket (6) on the carburettor body, hold the strangler butterfly open and fit the top cover (5) to the body, securing with the screw (3) and spring washers (4).
Re-connect the fuel feed pipe union and re-fit the air cleaner.

COMPLETE DISMANTLING

To completely dismantle the carburettor, carry out the foregoing dismantling operations plus the following:

TOP COVER.

Remove the needle valve (61) and fibre washer (64).
Detach the screw (1), withdraw the strangler butterfly from its slot in the spindle and then detach the spindle (62) and return spring (63) from the top cover (15).

MAIN BODY.

Remove the nut (16), throttle lever (17), idling stop bracket (18), washer (19) and strangler inter-connection lever (20) from the throttle spindle.
Remove the screw (50), slide the throttle butterfly (48) from its slot in the throttle spindle (49) and withdraw the spindle (49) by sliding it towards the front of the carburettor. Remove the circlip (32), detach the push rod (31) from the pump lever and remove the spring (29). Unscrew the rod (31) from the lever (49). Slacken the screw (41) and detach the connecting rod (26) and lever (20). Withdraw the split pins (27) and remove the washer (23) followed by the lever (20), spring (24) and second washer (25).
Remove the idling mixture adjusting screw (22) and spring (21). Withdraw the Econostat jet (9) from the carburettor body.
Remove the set screw (44), pivot bolt (30) and detach the cam plate (28), spring (38) and abutment bracket (37). Release the screw (10) and withdraw the spraying assembly (12) from the carburettor.

RE-ASSEMBLY

Re-assemble the carburettor by reversing the dismantling procedure, but note the following:

The return spring (38), on the cam plate pivot bolt (30), must be fitted with the narrow hook in the slot of the cam plate (28) .

The return spring (63) , must be fitted with the hooked end over the strangler lever (62) .

Fit the circlip (32) on to the first groove in the accelerator pump connection rod (31) .

Adjust the length of the throttle strangler interconnecting rod (26) by inserting a length of 0.027" (0.7 mm) dia. Rod between the throttle butterfly and the bore of the carburettor body; then, with the strangler butterfly fully closed, tighten the screw (41) .

Should complaints be made about excessive fuel consumption it is not always the cause that the fault is due to the carburettor.

1. Manner of driving and operation of the car.
2. Speed.
3. Terrain (level ground, upland, high mountains) .
4. City traffic, door to door traffic, etc .
5. Condition of car
6. Tire pressures.
7. Atmospheric influences.
8. Condition of roads (snow, slippery roads, etc.)

The proper consumption figure may, therefore, be computed only when taking these factors into account. In general, the average touring consumption is 10 % above the standard consumption. Constant city driving in uneven districts, frequently in low gear, the consumption may eventually rise considerably above the average consumption.

STANDARD FUEL CONSUMPTION

The fuel consumption figures stated by the car manufacturers are based on general directions for the evaluation of fuel consumption, they are shown in standard specification DIN 70030 of the standard association of motive vehicle industries. Therefore car owners are able to check the fuel consumption figures for correctness when referring to the above standard specification.

The standard fuel consumption may be determined in the following manner.

1. VEHICLE - Correct carburettor adjustment and ignition timing. Tire pressures, viscosity of the engine and gearbox oil must meet the manufacturer's specifications. The engine must be run-in and brought to its usual operational temperature before the test is made.
2. LOAD -The vehicle must be loaded to a weight between full load and empty.

3. TEST ROAD -A dry level highway approximately about 7 miles long. Grades of short length and descents with a maximum gradient of 1,5 %. In and return without interruption.
4. WEATHER CONDITIONS -must be dry, and wind still. Air temperature + 50 to 86° F.
5. SPEED -If possible drive at 3/4 of the stopped top speed throughout the entire test .
6. FUEL- Commercial grade of fuel.
7. MEASURING DEVICE -The fuel quantity consumed during the fuel consumption test must be determined exactly in a calibrated measuring vessel, a quantity of 0. 1 liter.
8. CALCULATION OF FUEL CONSUMED -The consumption should be calculated according to the following formula:

FUEL CONSUMPTION

In the following enumeration of courses first the factors are mentioned which are of decisive importance on the fuel consumption of a vehicle.

$$KN = 1, 1 K/W . 100$$

KN = Fuel consumption in liter/100 km.

W = Distance covered in km.

K = Quantity of fuel consumed.

The tolerance of 10 % included in this formula serves to compensate for, unfavorable condition for checking fuel consumption tolerance of. +5 is admissible. Therefore, the consumption figure determined on a trial run be compared with the standard consumption figure given by the car manufacturer only if the above described test conditions are prevailing. In most cases a higher consumption will result as a consequence of wrong uneconomical driving methods or of unfavorable test run conditions.

If in spite of the observance of all test conditions studied, the consumption stated exceeds the standard fuel consumption more than 5 0, it is good practice to make a new adjustment check the engine *and* running gear for proper condition.

In doing so, the following hints should be taken;

Check for leakage of the fuel system.

1. Check carburetor float.
2. Check needle valve
3. Damaged or leaking fuel pump diaphragm.
4. Excessive pump pressure
5. Check sparking plugs
6. Wrong timing.

7. Burnt valves.
8. Worn or broken piston rings
9. Engine oil of the wrong viscosity rating.
10. Dragging brakes or handbrake
11. Thick tread of tire, crass country M and Styles.
12. Insufficient tire pressures.

All of these points must be taken into consideration for these be the cause of high fuel consumption.

Fault	Cause	Remedy
Excessive fuel consumption	High pump pressure	Reduce fuel delivery by consumption by fitting extra washers behind pump Check diaphragm spring tension.
Insufficient washer thickness beneath needle valve		Fit thicker fibre washers
Leakage from jets, past face of starter disc valve, or leaking jet gland packing.		Tighten jets, reface starter disc valve, renew gland packing
Faulty needle valve seating		Clean or replace needle valve.
Punctured float		Check and replace if faulty.
Faulty ignition		Check and rectify if faulty.
Incorrect adjustment		Re-adjust.
Poor slow running and starting	Blocked manifold pipe	Check and clean.
Induction air leak		Check manifold and carburettor joints. Replace if required.
Loss of compression		Check and re-grind valve seats if

		required.
Choked jet		Remove and clean jets.
Faulty ignition	Induction air leak	Check and rectify. Check and replace manifold and carburettor joints.
Loss of compression		Check and re-grind valve seats if required.
Throttle not opening fully		Check and adjust limit stop or cable.
Fuel starvation		Check delivery from rump needle valve for sticking and blocked jets.
Air cleaner choked		Remove and clean.
Silencer choked		Check and replace if faulty.

ELECTRICAL AND IGNITION EQUIPMENT

BATTERY

Battery persists in a low state of charge. First consider the conditions under which the battery is used. If the battery is subject to long periods of discharge without suitable opportunities for re-charging, a low state of charge can be expected. Neglect of the battery during a period of low or zero mileage may be responsible for the trouble. A defect in the charging system can also result in a discharged battery.

VENT PLUGS

See that the ventilating holes in each vent plug are clear.

LEVEL OF ELECTROLYTE

The surface of the electrolyte should be level with the tap of the separator guard. If necessary, top up with distilled water. Any loss of acid from spilling or spraying (as opposed to the normal loss of water by evaporation) should be made good by dilute acid of the same specific gravity as that already in the cell.

CLEANLINESS

See that the top of the battery is free from dirt or moisture which, might provide a discharge path. Ensure that the battery connections are clean and tight.

HYDROMETER TEST, Figure 1

Measure the specific gravity of the acid in each cell in turn with a hydrometer to avoid misleading readings, do not take hydrometer readings immediately after topping-up.

The readings given by each cell should be approximately the same. If one cell differs appreciably from the others, an internal fault in the cell is indicated.

The appearance of the electrolyte drawn into the hydrometer when an indication of a reading gives the state of plates. If the electrolyte is very dirty, or contains small particles in suspension, it is possible that the plates are in a bad condition.

The specific gravity of the electrolyte varies with the temperature, therefore, for convenience in comparing specific gravity, this is always corrected to 60° F, which is adapted as a reference temperature. The method of correction is as follows:

For every 5° F below 60° F deduct .002 from the observed reading to obtain the true specific gravity at 60° F.

For every 5° F above 60° F add .002 to the observed reading to obtain the true specific gravity at 60° F. The temperature must be that indicated by a thermometer actually immersed in the electrolyte, and not the air temperature.

Compare the specific gravity of the electrolyte with the values given in the table and so ascertain the state of charge of the battery. If the battery is in a discharged state, it should be re-charged, either on the vehicle by a period of daytime running or on the bench from an external supply.

DISCHARGE TEST

A heavy discharge tester (150 -160 amps) consists of a voltmeter 2 or 3 volts full scale, across which is connected a shunt resistance capable of carrying the current. Point prongs are provided for making contact with the intercell connectors.

A good cell will maintain a reading of 1.2- 1.5 volts, depending on the state of charge, for at least 6 seconds. If, however, the reading rapidly falls off, the cell is probably defective. This test should not be carried out immediately after the car has completed a journey otherwise a misleading reading may be obtained.

RECHARGING FROM AN EXTERNAL SUPPLY

If the above tests indicate that the battery is merely discharged, and is otherwise in a good condition, it should be recharged, either on the vehicle by a period of daytime running or on the bench from an external supply.

Climates ordinarily below 90° F (32° C). Specific gravity of electrolyte, corrected to 60° F.

Climates frequently over 90° F (32° C). Specific gravity of electrolyte, corrected to 60° F.

STATE OF CHARGE

	15,6° C	15,6° C
Fully charged	1.270- 1.290	1.210-1.230
About half discharged	1.190- 1.210	1.130 -1.150
Completely discharged	1.110 -1.130	1.050 -1.070

If the latter, the battery should be recharged at the rate given, until the specific gravity and voltage show no increase over three successive hourly readings. During the charge the electrolyte must be kept level with the top of the separator guard by the addition of distilled water.

A battery that shows a general falling-off in efficiency, common to all cells, will often respond to the process known as "cycling". This process consists of fully charging the battery as described and then discharging it by connecting it to a lamp board, or other load, taking a current equal to the charging current.

The battery should be capable of providing this current for at least 7 hours before it is fully discharged, as indicated by the voltage of each cell falling to 1.8. If the battery discharges in a shorter time, repeat the "cycle" of charge and discharge.

MAINTENANCE

After filling, a dry-charged battery needs only the attention normally given to other lead-acid type batteries.

GENERAL

Examine the level of the electrolyte in the cells and if necessary, add distilled water to bring the level up to the top of the separators.

The use of a battery filler will be found helpful when topping-up. Ensure that the battery filler is filled with distilled water and insert it into a filler plug orifice until it rests gently on the separators. Sufficient water will pour into the cell to bring the electrolyte to its correct level. Check each cell in turn.

IMPORTANT

Never use a naked light when examining the battery as the mixture of oxygen and hydrogen given off by the battery can be dangerously explosive.

Examine the battery terminals and, if necessary, clean and coat them with petroleum jelly. Wipe away any foreign matter or moisture from the top of the battery and ensure that the connections and fixings are clean and tight.

IGNITION COIL

Model	L. A.12
Primary resistance (at 68° F 10° C)	3.2 to 3.4 ohms.
Running current at 1000 r.p.m.	1.25 Amps.

IGNITION COIL

The ignition coil is an oil filled hermetically sealed unit.

A coil, which has become suspect, should be tested in conjunction with the distributor.

The only maintenance that is required is to keep it and the surrounding area clean, by a coil break, then it must be replaced.

DISTRIBUTOR

The ignition distributor is mounted on the side of the cylinder block, and is driven in a counter clockwise direction by the oil pump shaft, which is driven by a skew gear on the camshaft.

On the distributor-driving shaft, immediately beneath the contact breaker, is a centrifugal operated timing control mechanism. It consists of a pair of spring loaded governor weights, linked by lever action to the contact breaker cam. At low engine speeds, the spring force maintains the cam in a position in which the spark is slightly retarded.

Under the centrifugal force imported by high engine speeds, the governor weights swing out against the spring pressure to advance the contact breaker cam, and thereby the spark, to suit engine conditions at the greater speed.

A built-in vacuum-operated timing control is also included, designed to give additional advance under part-throttle conditions.

The inlet manifold of the engine is in direct communication with one side of a spring-loaded diaphragm. This diaphragm is linked to the contact breaker plate and rotates the contact breaker heel about the cam, thus advancing the spark for part-throttle operating conditions.

There is also a micrometer adjustment for making fine alterations in timing to allow for changes in running conditions, e. g. state of carbonization, change of fuel, etc.

A completely sealed metallized paper capacitor is utilized. This has the property of being self healing, should the dielectric break down, the metallic film around the point of rupture is vaporized away by the heat of the spark, so preventing a permanent short circuit.

The H. T. pick-up brush is of a composite construction, the middle portion being made of a resistive compound and the ends of softer carbon. The resistive portion of this carbon brush which is in circuit between the coil and the distributor.

MAINTENANCE

Lubrication is recommended every 6.000 miles taking great care to avoid oil or grease from getting on or near the contact.

Add few drops of thin engine oil (S.A.E. 30) through the aperture at the edge of the contact break, to lubricate the centrifugal timing control smear the cam with Amsoil grease

Lift off the rotor arm and apply to the spindle a few drops of Ragosine Molydenised non-creep ail or thin machine oil to lubricate the cam bearing. It is not necessary to remove the exposed screw, since it affords a clearance to permit the passage of oil.

Replace the rotor arm. Carefully, locating its molded projection in the key way in the spindle and pushing it on as far as it will go.

CLEANING -EVERY 6.000 MILES

Clean the distributor cover, inside and out, with a soft dry cloth paying attention to the spaces between the metal electrodes. Ensure that the carbon brush moves freely in its holder

REPLACING THE CONTACTS

Warn contacts should never be renewed individually. If the contacts are worn badly, these must be removed and replaced with a new set to obtain satisfactory operation of the ignition system.

The contacts can be removed for cleaning or renewal as follows:

1. Disconnect the cables from the battery.
2. Take off the distributor cap and remove the rotor arm.
3. Remove the nut and insulating sleeve.
4. Lift off the moving contact assembly and insulating washer.
5. Remove the screw, spring washer, the plain washer, and then lift all the fixed contact plate.

Examine the contacting surfaces of both contacts far traces of burning and "pitting and piling".

Clean the contacts with a small corborundum stone, but care must be taken to keep the surfaces flat with each other to maintain maximum contact area.

"Pitting and piling" is inevitable after an extended mileage, but where this condition is excessive, a check should be made on the efficiency of the capacitor. This is best effected by substitution as relatively few people have access to an efficient capacitor tester.

The capacitor is secured to the base plate with one screw and shockproof washer.

SERVICING

Before starting to test, make sure that the battery is not fully discharged, as this will often produce the some symptoms as a fault in the ignition circuit.

1. TESTING IN POSITION TO LOCATE CAUSES OF UNEVEN FIRING

Run the engine at a fairly fast idling speed.

Remove each plug connector in turn. Removal of the connection to the defective cylinder will cause no noticeable change in the running note, but there will be a definite increase in roughness when the other plugs are disconnected. Having thus located the defective cylinder, stop the engine and remove the cable from the sparking plug terminal. Restart the engine and hold the cable about 3/16" fro'1' the cylinder head. If sparking is strong and regular, the fault lies with the sparking plug, and it should be removed cleaned and adjusted, or a replacement fitted. If, however, there is no spark, or only weak irregular sparking, examine the cable from the plug to the distributor cap for deterioration of the insulation, renewing the cable if the rubber is cracked or perished.

ELECTRICAL AND IGNITION EQUIPMENT

Clean and examine the distributor-molded cap for free movement of the carbon brush. If a replacement brush is necessary, it is important that the correct type is used. If tracking has occurred indicated by a thin black line between two or more electrodes or between one of the electrodes and the body, a replacement distributor cap must be fitted.

2. TESTING IN POSITION TO LOCATE CAUSE IF IGNITION FAILURE

Spring bock the clips on the distributor head and remove the molded cover. Lift off the rotor, carefully levering with a screwdriver if necessary.

Switch on the ignition and, whilst the engine is slowly cranked, observe the reading on an ammeter connected in series with the battery supply cable.

The reading should rise and foil with the closing and opening of the contacts if the low-tension working is in order. When a reading is given which does not fluctuate, a short circuit, or contacts remaining closed, is indicated. No reading indicates an open circuit in the low-tension circuit or badly adjusted or dirty contacts.

Check the contacts for cleanliness and correct gap setting as described. Ensure that the contact breaker lever moves freely on the pivot. If sluggish, remove the arm and polish the pivot post with a strip of fine emery cloth. Smear the post with Ragosine Molybdenised non-creep oil or Amsoil.

Replace the lever. If the fault persists, proceed as follows;

3. LOW TENSION CIRCUIT-FAULT LOCATION

a) No reading in ammeter test.

Refer to circuit diagram and check circuit for broken or loose connections, including ignition switch. Check the ignition coil by substitution.

b) Steady reading in ammeter test.

Refer to circuit diagram and check wiring for indications of a short circuit.

Check capacitor (either by substitution or on a suitable tester) Check ignition coil by substitution.

Examine insulation of contact breaker.

4. HIGH TENSION CIRCUIT

If the low-tension circuit is in order, remove the high-tension lead from the centre terminal of the distributor cap. Switch on the ignition and turn the engine until the contacts close. Flick open the contact breaker lever whilst the high-tension lead from the coil is held about 3/16" from the cylinder block. If the ignition equipment is in good order, a strong spark will be obtained. If no spark occurs, a fault in the circuit of the secondary winding of the coil is indicated and the coil must be replaced.

The high-tension cables must be carefully examined, and replaced if the rubber insulation is cracked or perished, using 7-mm neoprene-covered rubber ignition cable.

To make connections to the terminals in distributor cap, remove the cap and slacken the screws on the inside of the cap and push the cable firmly home in the holes in the cap. Tighten the screws, which will pierce the rubber insulation to make good contact with the cable core, figure 1.

The cables from the distributor to the sparking plugs must be connected in the correct firing order.

NOTE

The conductor in the cable between the coil and the top of the distributor is composed of carbon impregnated nylon cords which form a resistive path to the H. T. current.

This cable must not be replaced with cable having copper conductors.

Special replacement cable is available from the factory parts division.

5. DISMANTLING, Figure 1

When dismantling, carefully note the positions in which the various components are fitted, in order to ensure their correct replacement on re-assembly. The tongue of the driving dog is offset; note the relation between it and the rotor electrode and maintain this relation when re-assembling the distributor. The amount of dismantling necessary will obviously depend on the repair required. Spring back the securing clips and remove the molded cap. Lift the rotor arm off the spindle carefully levering with a screwdriver if it is tight.

Disconnect the vacuum unit link from the contact moving plate, and remove the two screws at the edge of the contact breaker base plate. The contact breaker assembly, complete with external terminal, can now be lifted off. Remove the circlip on the end of the micrometer timing screw, and turn the micrometer nut until the screw and the vacuum unit assembly are free. Take care not to lose the ratchet and coil type springs located under the micrometer nut.

The complete shaft assembly, with centrifugal timing control and cam float can now be removed from the distributor body and knocking out the dog-securing pin.

a) CONTACT BREAKER

To dismantle the assembly further, remove the nut, insulating piece and connections from the pillar on which the contact breaker spring is anchored. Slide out the terminal molding.

Lift off the contact breaker lever and the insulating washers beneath it. Remove the screw securing the fixed contact plate, together with the spring and plain steel washers, and take off the plate. Withdraw the single screw securing the capacitor.

Dismantle the contact breaker base assembly by turning the base plate clockwise and pulling to release it from the contact breaker moving plate.

b) SHAFT AND ACTION PLATE

To dismantle the assembly further, take out the screw inside the cam and remove the cam and cam foot. The weights and springs of the centrifugal timing control can now be lifted off the action plate. Note that a distance collar is fitted on the shaft underneath the action plate.

6. RE-ASSEMBLY

The following instructions assume that complete dismantling has been undertaken.

- a) Place the distance collar over the shaft, smear the shaft with Ragosine Molybdenised.
- b) Refit the vacuum unit into its housing and replace the springs, milled adjusting nut and securing circlip.
- c) Reassemble the centrifugal timing control. See that the springs are not stretched or damaged. Place the cam and cam foot assembly over the shaft, engaging the projections on the cam foot with the weights and fit the securing screw.
- d) Before reassembling the contact breaker base assembly, lightly smear the plate with Ragosine Molybdenised non-creep oil or Amsoil grease. Fit the contact breaker moving plate to the contact breaker base plate and secure using a reversal of the dismantling procedure. Refit the contact breaker base plate into the vacuum unit. Insert the two base plate-securing screws, one of which also secures one end of the contact breaker earthing cable.

- e) Refit the capacitor. Place the fixed contact plate in position and secure lightly with the securing screw. One plain and one spring washer must be fitted under the securing screw.
- f) Place the insulating washers, etc., on the contact breaker pivot post and on the pillar on which the end of the contact breaker spring locates.
- g) Slide the terminal block into its slot.
- h) Thread the low-tension connector and capacitor eyelets on to the insulating piece, and place these on to the pillar which secures the end of the contact breaker spring. Refit the washer and securing nut.
- i) Set the contact gap to 0.014" to 0.016" and tighten the fixed contact securing screw.
- j) Refit the rotor arm, locating the molded projection in the rotor arm with the key way in the shaft, and pushing fully home. Refit the distributor cap.

7. REPLACEMENT CONTACTS

If the contacts are so badly worn that replacement is necessary, they must be renewed as a pair and not individually.

The contact gap must be set to 0.014" to 0.016"; after the first 500 miles running the new contacts fitted, the setting should be checked and the gap reset to 0.014" to 0.016". This procedure allows for the initial "bedding-in" of the heel.

STARTING SYSTEM

GENERAL

The starting system comprises the battery, ignition and starter switch, starter solenoid and the starter motor.

IGNITION AND STARTER SWITCH

The starter ignition switch has three positions (1) "off", (2) "on" and (3) "start", the latter position being spring loaded which returns the switch to the "on" position when the key is released.

OPERATION

Turn the switch clockwise to switch "on", turn further clockwise against the spring pressure to energize the starter solenoid.

STARTER SOLENOID DESCRIPTION

The starter solenoid is an electro-magnetic switch housed within a cylindrical casting and located on the dash panel on the right-hand side of the engine compartment.

It is a sealed unit and cannot be dismantled for re-assembly.

GENERATOR

Model	C 39 PV-2 and C 40-1.		
2 pole 2 brush	Shunt wound ventilated compensated voltage control		
Rotation	Clockwise (drive end)		
Brush spring tension	22 to 25 oz		
Cutting-in speed			
C 39 PV-2	1050 to 1200 r.p.m		
C 40-1	1250 to 1450 r.p.m		
'Maximum output at 13.5 volts			
C 39 PV-2	19 omps,	at 1900 to	2150 r.p.m.
C 40-1	22 amps,	at 2050 to	2250 r.p.m.
Field resistance			
C 39 PV-2	6, 1 ohms	(approx.)	
C 40-1	6,0 ohms	(approx.)	

ROUTINE MAINTENANCE

Routine maintenance of the starter solenoid is restricted to an occasional check on the tightness of the terminal nuts and to keeping them, and the surrounding area clean.

No servicing is required or provided for, and where this unit breaks down it must be replaced.

GENERATOR MODELS C 39 PV-2 and C 40-1

GENERAL

One of two models of generator may be fitted to this engine. They are model C 39 PV-2 and C 40-1.

Except for minor details both generators are identical and are fully interchangeable. The principles of operation, maintenance and overhaul which are described apply equally to both model,. The model number may be readily identified by the method of fitting the Lucas terminals on the commutator end bracket.

The connectors are secured to the commutator end terminals and field terminal post on generator model C 39 PV-2 with nuts and washers. The connectors on model C 40-1 are integrally constructed.

The generator is a shunt-wound two-pole Two-brush machine, arranged to work in conjunction with a compensated voltage control regulator unit. The output of the generator is controlled by the regulator and is dependent on the state of charge of the battery and the loading of the electrical equipment in use. When the battery is in a low state of charge, the generator gives high output, whereas if the battery is fully charged, the generator gives only sufficient output to keep the battery in good condition without any possibility of over-charging. An increase in output is given to balance the current taken by lamps and other accessories when in use. Further a high boosting charge is given for a few minutes immediately after starting.

PERFORMANCE DATA:

Cutting in speed at 13 volts.

C 39 PV-2

V 40-1

1.050-1.200 r.p.m.

1.250-1.450 r.p.m.

Maximum output at 135 volts

C 39 PV-2

19 amps at 1.900 -2.150 r.p.m. (connected to a load of 0.7 ohms)

Field resistance

C 40-1

6 x 1 ohms {approx}

22 amps at 2.050- 2.250 r.p.m. {connected to a load of 0.61 ohms} Field resistance .

6 x 0 ohms (approx)

ROUTINE MAINTENANCE LUBRICATION

Every 12.000 miles, inject a few drops of high quality medium viscosity (S.A.E. 30) engine oil into the hole marked "oil" in the end of the bearing housing, figure 1.

INSPECTION OF BRUSH GEAR AND COMMUTATOR

Every 24.000 miles; the brush gear and commutator should be inspected by a competent automobile electrician.

SERVICING

Testing in position to locate fault in charging circuit. In the event of a fault in the charging circuit, adopt the following procedure to locate the cause of the trouble.

1. Inspect the driving belt and adjust if necessary, figure 2.

2. Check that the generator and control box are connected correctly.

The larger generator terminal must be connected to control box terminal "D" and the larger generator terminal to control box terminal "E".

3. Switch off all lights and accessories, disconnect the cables from terminals of generator and connect two terminals with a short length of wire.
4. Start the engine and set to run at nor~1 idling speed.
5. Clip to negative lead of a moving coil type voltmeter, calibrated 0-20 volts, to one generator terminal and the other lead to a good earthing point of the yoke.
6. Gradually increase the engine speed, when the voltmeter reading should rise rapidly and without fluctuation. Do not allow the voltmeter reading to reach 20 volts and do not race the engine in an attempt to increase voltage. It is sufficient to run the generator up to a speed of 1.000 r.p.m.
If the voltage does not rise rapidly and without fluctuation the unit must be dismantled for internal examination.
7. Excessive sparking at the commutator in the above test indicates a defective armature, which should be replaced.
8. If the generator is in good order, remove the link from between the terminals and restore the original connections, taking care to connect the larger generator terminal to control box terminal "D" and the smaller generator terminal to control box terminal "F".

TO DISMANTLE

1. Take off the driving pulley.
2. Unscrew and withdraw the two through bolts.
3. The commutator end bracket can now be withdrawn from the generator yoke. Take care not to lose the fibre thrust washer.
4. The driving end bracket, which on removal from the yoke has withdrawn with it the armature and armature shaft ball-bearing, need not be separated from the shaft unless the bearing is suspected and requires examination or the armature is to be replaced. In this event the armature should be removed from the end bracket by means of a hand press.

INSPECTION OF COMMUTATOR AND BRUSH GEAR

Every 24.000 miles remove the generator from the engine. Inspect the commutator through the ventilator, which is the larger of the two apertures in the end bracket.

The commutator should be clean, free from oil and dirt and have a polished appearance. If it is dirty should be cleaned, through the smaller aperture in the end cover using a soft cloth. This operation will be facilitated if the cloth is wrapped round a piece of hard wood and pressed on the commutator while the armature is revolved by hand. In the event of the commutator being very dirty, the cloth should be moistened with petrol.

Examination of the brush gear is carried out by removing the two through bolts, commutator end bracket and yoke.

Partly lift both brushes and trap them in this raised position with the tension springs, figure 2.

Loosely assemble the end cover to the armature and release the brushes so that they resume their correct position on the commutator.

Check that the brushes move freely on the holders, by holding back the tension springs and pulling gently on the flexible connectors. If a brush is inclined to stick, remove it from its holder and clean its sides with a petrol-moistened cloth.

In order to retain the "bedding", brushes must always be replaced in their original position. Brushes which have worn so that they will not "bed" properly on the commutator or have worn to 11/22" (8,5 mm) must be renewed.

Test the brush spring tension using a spring scale. The tension of the spring when new is 22-25 oz. In service it is permissible for this value to fall to 15 oz., before performance may be effected. Fit new springs if the tension is low.

COMMUTATOR_Figure 3 and 4

A commutator in good condition will be smooth and free from pits or burned spots. Clean the commutator with a gasoline-moistened cloth. If this is ineffective, carefully polish with a strip of fine glass paper while rotating the armature. To remedy a badly worn commutator, mount the armature, with or without the drive end bracket, in a lathe rotate at high speed and take a light cut with a very sharp tool. Do not remove more metal than is necessary. Polish the commutator with very fine glass paper. Undercut the insulators between the segments to a depth of 1/32" (0.8 mm) with a hack saw blade ground to the thickness of the insulator.

ARMATURE

Indication of an open circuited armature winding will be given by burnt commutator segments. If armature testing facilities are not available, an armature may be checked by substitution.

To remove the armature shaft from the drive end bracket and bearing, support the bearing retaining plate firmly and press the shaft out the drive end

bracket and bearing, support the bearing retaining plate firmly and press the shaft out of the drive end bracket. When fitting the new armature, support the inner journal of the ball bearing, using a mild steel tube of suitable diameter, whilst pressing the armature shaft firmly home.

FIELD COILS

Measure the resistance of the field coils without removing them from the generator yoke, by means of an ohmmeter connected between the field terminal and yoke. If the ohmmeter is not available, connect a 12 volt D. C. supply with an ammeter in series between the field terminal and generator yoke. The ammeter reading should be approximately 2 amperes. Zero reading on the ammeter, or an "infinity" ohmmeter reading, indicates an open circuit in the field winding. Current readings of much more than 2 amperes or ohmmeter readings much below 6.0 ohms are indications that the insulation of one of the field coils has broken down. In either case, unless a substitute generator is available, the field coils must be replaced. To do this, carry out the procedure outlined below.

1. Drill out the rivet securing the field coil terminal assembly to the yoke, and unsolder the field coil connection.
2. Remove the insulation piece that is provided to prevent the junction of the field coils from contacting with the yoke.
3. Mark the yoke and pole shoes so that the latter can be fitted in their original positions.
4. Unscrew the two pole shoes retaining screw by means of a wheel-operated screwdriver, figure 1.
5. Draw the pole shoes and coils out of the yoke and lift off the coils.
6. Fit the new field coils over the pole shoes and place them in position inside the yoke. Take care to ensure that the taping of the field coils is not trapped between the pole shoes and the yoke.
7. Locate the pole shoes and field coils by lightly tightening the fixing screw.
8. Fully tighten the screw by means of the wheel-operated screwdriver and lack them by caulking.
9. 9. Replace the insulation piece between the field coil connections and the yoke.
10. Re-solder the field coil connections to the field coil terminal tags and rivet the assembly to the yoke.

BEARINGS

Bearings that have worn to such an extent that they will allow side movement of the armature shaft must be replaced.

To replace the bearing bushing in a commutator end bracket, proceed as follows:

Remove the old bearing bushings from the end bracket, this can be done by screwing a 5/8" tap into the bushing for a few turns and pulling out the

bushing with the tap, screw the tap squarely into the bushing to avoid damage to the bracket.

Insert the felt ring and aluminum disc in the bearing housing, then press the new bearing bushing into the end bracket (using a shouldered, highly polished mandrel of the same diameter as the shaft which is to fit in the bearing) until the bearing is flush with the inner face of the bracket.

NOTE;

Porous bronze bushing must not be opened out after fitting, or the porosity of the bushing may be impaired. Before fitting the new bearing bushing it should be allowed to stand for 24 hours completely immersed in thin engine oil, this will allow the pores of the bushing to be filled with lubricate.

The ball bearing at the driving end is replaced as follows: Figure 1.

1. Drill out the rivets, which secure the bearing retaining plate to the end bracket, and remove the plate.
2. Press the bearing out of the end bracket and remove the corrugated washer, felt washer and oil retaining washer.
3. Before fitting the replacement bearing see that it is clean and pack it with high melting point grease.
4. Place the oil retaining washer, felt washer and corrugated washer in the bearing housing in the end bracket.
5. Locate the bearing in the housing and press it home.
6. Fit the bearing retaining plate. Insert the new rivets from the inside of the end bracket and open the rivets by means of a punch to secure the plate rigidly in position.

RE-ASSEMBLY

1. Fit the drive end bracket to the armature shaft. The inner journal of the bearing must be supported by a tube, approximately 4" long, 1/8" thick, and internal diameter 5/8" .Do not use the drive end bracket as a support for the bearing whilst fitting an armature.
2. Fit the yoke to the drive end bracket.
3. Lift the brushes up into the brush boxes and secure them in that position by positioning each brush spring at the side of its brush.
4. Fit the commutator end bracket on the armature shaft until brush boxes are partly over the commutator. Place a thin screwdriver on top of each brush in turn and press the brush down on the commutator. The brush springs should then position themselves on top of the brushes.
5. Fit the commutator end bracket to the yoke so that the projection on the bracket locates in the yoke.
6. Refit the two through bolts.
7. After re-assembly lubricate the commutator end bearing.

CONTROL BOX

Model

R. B. 106/2

Cut-out	Cut in voltage 12.7 to 13.3, Drop off voltage 8.5 to 11 Reverse current 3.5 to 5 amps.
Regulator	Open circuit settings at 3.000 r.p.m. at ambient temperature.

CONTROL BOX MODEL RB 106-2

The control box contains two unit" o voltage regulator and o cutout. Although combined structurally, the regulator and Cutout are electrically separate. Both are accurately adjusted during manufacture, and the cover protecting them should not be removed unnecessarily.

REGULATOR

The regulator is set to maintain the generator terminal voltage between close limits at all speeds above the regulating point, the field strength being controlled by the automatic insertion and withdrawal of a resistor in the generator field circuit. When the generator voltage reaches predetermined value, the magnetic flux in the regulator core due to the shunt or voltage winding becomes sufficiently strong to attract the armature to the core. This causes the contacts to open, thereby inserting the resistor in the generator field circuit.

The consequent reduction in the generator field current lowers the generator terminal voltage and this in turn, weakens the magnetic flux in the regulator core. The armature, therefore, returns to its original position, and the contacts closing allow the generator voltage to rise again to its maximum value.

The cycle is then repeated, and an oscillation of the armature is maintained. As the speed of the generator rises above that at which the regulator comes into operation, the periods of contact separation increase in length and, as a result, the generator voltage undergoes little change once this regulating speed has been attained.

The series or current winding provides compensation on this system of control. If the control were arranged entirely on this basis of voltage there would be a risk of overloading the generator when the battery was in a low state of charge, particularly if the lamps were simultaneously in use.

Under condition of reduced battery voltage, the output to the battery rises and but for the series winding would exceed normal rating of the generator.

The magnetism due to the series winding assists the shunt winding, SO that when the generator is delivering a heavy current into a discharged battery the regulator comes into at a somewhat reduced voltage, thus limiting the output accordingly.

By means of a temperature-compensating device the voltage characteristic of the generator is caused to conform more closely to that of the battery under all climatic conditions. If cold weather, the voltage required to charge the battery increases, whilst in warm weather the voltage required is lower. The method of compensation takes the form of a bimetallic spring located behind the tensioning spring of the regulator armature. This bimetallic spring, by causing the operating voltage of the regulator to be increased in cold weather and reduced in hot weather, compensates for the changing temperature characteristics of the battery and prevents undue variation of the charging current which would otherwise occur.

The bimetallic spring also compensates for effects due to increases in resistance of the copper windings from cold to working values.

The cutout is an Electro-magnetically operated switch connected in the charging circuit between the generator and the battery. Its function is to connect the generator with the battery when the voltage of the generator is sufficient to charge the battery, and to disconnect it when the generator is not running, or when its voltage falls below that of the battery, and so prevents the battery from discharging through and possibly damaging the generator windings.

The cutout consists of an Electro-magnetic fitted with an armature which operates a pair of contacts. The electromagnet employs two windings, a shunt winding of many turns of fine wire, and a series winding of a few turns of heavier gauge wire. The contacts are normally held open, and are closed only when the magnetic pull of the magnet on the armature is sufficient to overcome the tension of the adjusting spring.

OPERATION OF THE CUT -OUT IS AS FOLLOWS, Figure 1 and 2

The shunt coil is connected across the generator. When the vehicle is starting, the speed of the engine and thus the voltage of the generator rises until the electromagnet is sufficiently magnetized to overcome the spring tension and close the cut-out contacts.

This completes the circuit between the generator and the battery through the series winding of the cutout and the contacts. The effect of the charging current flowing through the series windings creates a magnetic field in the same direction as that produced by the shunt winding. This increases the magnetic pull on the armature so that the contacts are firmly closed, and cannot be separated by vibration. When the vehicle is stopping, the speed of the generator falls until the generator voltage is lower than that of the battery.

Current then flows from the battery through the cutout series winding to generator in a reverse direction to the charging current. This reverse current through the cutout will produce a differential action between the two windings and partly de-magnetize the Electro-magnet. The spring, which under constant tension, then pulls the armature away from the magnet and so separates the contacts and opens the circuit.

Like the regulator operation of the cutout is temperature-controlled by means of a bi-metallic tensioning spring.

SETTING-DATA

All settings are accurately adjusted before control boxes leave the factory and must not be disturbed unnecessarily. A qualified automobile electrician should only carry out any subsequent attention that may be required.

A) PRELIMINARY CHECKING OF CHARGING CIRCUIT

Before disturbing any electrical adjustment, examine as follows to ensure that the fault does not lie outside the control box.

1. Check the battery by substitution or with any hydrometer and a heavy discharge tester.
2. Inspect the generator driving belt. This should be just tight enough to drive without undue tension.
3. Check the generator by substitution or by disconnecting the generator cables and linking large terminal "D" to small terminal "P", then connect a voltmeter between this link and earth and run the generator up to about 1.000r.p.m. when a rising voltage should be shown.
4. Inspect the wiring of the charging circuit and carry out continuity tests.
5. Check earth connections, particularly those of the control box.
6. In the event of reported undercharging, ascertain that this is not due to low mileage.

CHECKING REGULATOR ELECTRICAL SETTING

Checking and adjusting should be completed as rapidly as possible to avoid errors due to heating of the hunt coil.

1. Connect a first-grade 0.20 moving coil voltmeter between central box terminals "D" and "E"
2. Withdraw the connectors from terminal "A" and "A 1", and join the two larger connectors together temporarily, thereby proving a supply from the battery to the ignition system. Take care that these connectors are not allowed to make contact with the car body.
3. Start the engine and run the generator at approx. 3.000 r.p.m. The voltmeter reading should now lie between the appropriate limits, as follows:

Ambient temperature	Open-circuit voltage
10°C (50°F) 16.1-16.7	
20° C (68° F)	16.0 -16.6
30° C (86° F)	15.0 -16.5
40° C (104° F)	15.8 -16.4

An unsteady reading may be due to unclean contacts but if the reading is outside the appropriate limits, an adjustment must be made.

4. Stop the engine.

C) REGULATOR ELECTRICAL ADJUSTMENT, Figure 1 and 2

1. Remove the central box cover.

2. Restart the engine and run the generator at 3.000 r.p.m.
3. Turn the spring-Loaded adjustment screw {clockwise to raise the setting a, anti-clockwise to lower it) until the correct setting is obtained.
4. Check the setting by stopping the engine and then again raising the generator speed to 3.000 r.p.m.
5. Restore the original connections and refit the control box cover.

D) CHECKING CUT -OUT RELAY ELECTRICAL SETTING

Checking and adjustment should be completed as rapidly as possible to avoid errors due to heating of the shunt coil.

1. Connect a first-grade 0.20 moving coil-voltmeter between control box terminals "D" and "E".
2. Remove the control box cover in order to note the instant of contact closure. Alternatively, switch on an electrical load such as a pair of headlamps, when the instant of contact closure will be indicated by a slight flick in the voltmeter reading.
3. Start the engine and slowly increase its speed.
4. Observe the voltmeter pointer. If contacts closure or a flick of the pointer occurs outside the limits
5. 12 x 7- 13 x 3 volts, an adjustment must be made.
6. Stop the engine.

E) CUT-OUT RELAY ELECTRICAL ADJUSTMENTS

- 1) Method of cut-in voltage adjustment.
 - a) Remove the control box cover.
 - b) Turn the cutout relay adjustment screw (clockwise to raise the setting or counter-clockwise to lower it) until the correct setting is obtained. Re-check the setting by again increasing the engine speed from zero.
- 2) Method of drop-off adjustment.
 - a) Withdraw the connectors from terminals "A" and "A 1", and join the two larger connectors together temporarily. Connect a first-grade 0.20 moving coil voltmeter between terminal "A" and "A 1" on earth.
 - b) Start the engine and run up to speed. Slowly decelerate and observe the voltmeter pointer.
 - c) Opening the contacts, indicated by the voltmeter painter dropping to zero, should occur between the limits 8 x 5 -11 x 0 volts, if the drop-off occurs outside these limits, an adjustment must be made. In this event, continue as follows:
 - d) Stop the engine and remove the control box cover. Adjust the height of the fixed contact by carefully bending the fixed contact blade towards the bobbin to reduce the drop-off voltage or away from it to raise the drop-off voltage.
 - e) Re-check the setting and, if necessary; re-adjust until the correct drop-off setting is obtained.
 - f) Restore the original connections and refit the cover.

F) CLEANING CONTACTS

1. Regulator contacts.
To clean the voltage regulator contacts, use fine corborundum stone on silicon carbide paper.
2. Cutout relay contacts.
To clean the cut-out relay contacts, use o strip of fine glass paper never corborundum stone or emery cloth.

Circuit diagram of generating system, Figure 1.

BENCH SETTING OF AIR GAPS

1. VOLTAGE REGULATOR

With the armature in the free position and correctly set, the distance between the core face and the underside of the armature is 0.030" of which 0.015" is through air when the copper separator consists of a disc and 0.021" when a square of copper is used to obtain this air gap proceed as follows:

Slacken the fixed contact locking nut and unscrew the contact screw until it is well clear of the armature moving contact.

Slack the voltage adjustment spring-loaded screw until it is well clear of the armature tension spring.

Slacken the two-armature assembly securing screws. Insert a 0.015" gauge (when a copper disc separator is fitted) or a 0.021" gauge (when a square copper separator is used) between the armature and copper separator. The gauge must be wide enough to cover completely the core face. Take care not to pry up the copper separation when inserting the gauge.

Press the armature squarely down against the gauge and retighten the two armature assembly securing screws. Without removing the gauge, screw in the fixed contact adjustment screw until it just touches the armature contact. Retighten the locking nut.

Re-adjust the electrical setting of the regulator.

2. CUT-OUT RELAY

Slacken the adjustment screw until it is well clear of the armature tension spring.

Slacken the two armature securing screws.

Press the armature squarely down against the core face (copper sprayed in some units, fitted with a square of copper in others) and retighten the armature securing screws. No gauge is necessary.

With the armature still pressed against the core face and, using suitable pliers, adjust the gap between the armature stop arm and the armature tongue to 0.025" - 0.04" by carefully bending the stop arm.

Adjust the fixed contact so that it will be deflected from between 0.010" - 0.02" by the armature moving contact when the armature is pressed against the core face.

Re-adjust the electrical setting of the cutout.

STARTER MOTOR MODEL M 35 G (INBOARD DRIVE)

GENERAL, Figure 1

The electric starter motor is a series-parallel wound four-pole four-brush machine having an extended shaft which carries the engine engagement gear, or starter drive that is more usually named. The diameter of the yoke is 3 x 5".

The starter motor is of similar construction to the generator except the heavier copper wire is used in the construction of the armature and field coils.

The field coils are parallel connected between the field terminal and the insulated pair of brushes.

The only maintenance normally required is the occasional checking of brush gear and commutator.

Approx. every 24,000 miles, remove the metal band cover. Check that the brushes move freely in their holders by holding back the brush springs and pulling very gently on the flexible connectors. Should a brush incline to stick, remove it from its holder and clean its sides with petrol moistened cloth. Be sure when refitting the brushes that they return to their original positions in order to retain the "bedding". If the brushes have worn to 5/16" in length then these must be replaced.

The commutator should also be cleaned free from oil or dirt. If dirty, clean by pressing a fine dry cloth against it while the starter is turned by hand by means of a wrench applied to the squared extension of the shaft.

PERFORMANCE DATA

Lock torque 7 x 2 lb/ft. with 320- 340 amps, at 7 x 25- 7 x 5 volts. Torque at 1,000 r.p.m. 4 x 4- 4 x 6 lb/ft. with 230- 250 amps, at 8 x 25 -8 x 45 volts.

Light running current: 80 amps, maximum at 7,000 -8,000 r.p.m.

SERVICING-TESTING IN POSITION

1. Switch on the lamps and operate the starter control. If the lights dim, but the starter motor is not heard to operate, an indication is given that current is flowing through the starter motor windings but that the armature is not rotating for some reason, possibly the pinion is meshed permanently with the geared ring on the flywheel. In this case, the starter motor must be removed from the engine for examination.

In this event, a variable resistor of suitable current-carrying capacity should be connected in the battery circuit and adjusted until the lock voltage is the same as that quoted. Take readings of current and torque of this value.

3. FAULT DIAGNOSIS

An indication of the nature of the fault or faults may be deduced from the results of the no-load and lock torque tests.

DISMANTLING

Remove the cover band, hold back the brush springs and lift the brushes from their holders.

Unscrew the terminal nuts from the terminal post on the commutator end bracket.

Unscrew the two through bolts from the commutator end bracket, and remove the commutator end bracket from the Yoke.

Remove the driving end bracket complete with armature and drive from the starting motor yoke.

BENCH INSPECTION

After the motor has been dismantled, individual items must be examined as follows:

BRUSH GEAR

When necessary, the brushes and brush-holders must be cleaned using a clean, fluff less petrol-moistened cloth.

To prevent damage to the commutator, brushes must be replaced when worn to 5/16" in length.

(Figure 1 Testing brush spring tension)

(Figure 2 Commutator end bracket brush connections)

To fit new brushes proceed as follows:

1. Cut off the original brush flexible 1/8" (3 mm approx.) from the aluminum.
2. Clean up and tin the original resistance brazed joint.
3. Open up the loop of the replacement brush flexibles.
4. Tin the loop, taking great care not to allow any solder to run towards the brush.
5. Plate the original joint within the loop.
6. Squeeze up and solder.

NOTE

Providing the necessary equipment is available for refitting and tightening the pole shoes, the above operation will be found easier to carry out if the field coils are removed from the yoke.

The brushes are pre-formed so that bedding to the commutator is unnecessary.

Check the tension of the brush springs using a spring scale, see figure 1, page 1/120. The Correct tension is 32- 40 oz. Fit new springs if the tension is low. To fit a new spring, open the spring anchor Slot in the brush spring support post and lift the old spring away. Place the new spring in the slot in the same position as occupied by the old spring. Re-close the Slot. Check the tension of the new spring and ensure that it makes contact with the

center of the brush.

COMMUTATOR

The commutator must be clean and have a polished appearance. If it is dirty it must be cleaned, using a clean fluffless gasoline-moistened cloth or, if necessary, by polishing it with a strip of very fine emery cloth.

STARTER MOTOR

Model.	M 35 G
4 brush 4 pole.	Series parallel
Rotation	Clockwise
Drive.	S. B. inboard
Brush spring tension.	23 to 40 ozs.
Lock torque	72 to 7.6 lbs. with 320 to amps at 7.5 to 7.25 volts
Torque at 1000 r.p.m.	4.4 to 4.6 with 230 to 250 amps at 7.45 to 8.25 volts
Light running current.	80 amps maximum at 7000 to 8000 r.p.m.
Brushes.	Change brushes when worn to 5/16" (8 mm) in length.

1. Should the lamps retain their full brilliance when the starter switch is operated, check the circuit for continuity from battery to starter motor via the starter switch and solenoid and examine the connections at these units. If the supply voltage is found to be applied to the starter motor when the switch is operated an internal fault in the motor is indicated and the unit must be removed from the engine for examination.
2. Sluggish or slow action of the starter motor is usually due to a loose connection causing high resistance in the motor circuit. Check as described previously.
3. If the motor is heard to operate, but does not crank the engine, indication is given of damage to the drive.

BENCH TESTING

1. REMOVING THE STARTER MOTOR FROM THE ENGINE.

Disconnect the earth terminal on the battery to avoid any danger of short circuits. Remove the heavy cable from the starter motor. Withdraw the mounting bolts and remove the starter motor from the engine.

2. MEASURING THE LIGHT RUNNING CURRENT

Secure the starter motor in a vice.

Connect the motor in series with a starter switch, an ammeter capable of carrying 600 amperes and an appropriate voltage supply. Use cables of a similar size to those in the vehicle motor circuit. A fixing lug on the drive end bracket is a suitable earthing point on the starter motor. Connect a voltmeter between the motor terminal and the yoke.

Operate the switch and note the speed of armature rotation, using a tachometer, and the readings given by the ammeter and voltmeter. While the motor is running at speed examine the brush gear and check if there is any undue sparking at the commutator or excessive brush movement.

3. MEASURING LOCK TORQUE AND LOCK CURRENT, Figure 1

With the motor firmly clamped in a vice, attach an arm to the driving pinion, connect the free end of this arm to a spring scale. Operate the switch and note the current consumption, voltage, and the reading on the spring scale, the measure of torque can be calculated by multiplying the reading on the spring scale in pounds by the length of the arm in feet.

If a constant-voltage bus-bar supply is used when carrying out the lock torque test, a higher lock voltage may be shown on the voltmeter than the appropriate value given under performance data.

To remedy a badly worn commutator, dismantle the starter drive and remove the armature from the end bracket. Mount the armature in a lathe, rotate at a high speed and take a light cut with a very sharp tool.

Do not remove any more metal than is necessary. Finally, polish with a very fine gloss powder. The INSULATORS between the commutator segments MUST NOT BE UNDERCUT.

ARMATURE

Check for lifted commutator segments and loose turns in the armature winding. These may be due to the starter motor having remained engaged while the engine is running, thus causing the armature to be rotated at excessive speed.

A damaged armature must always be replaced -no attempt should be made to machine the armature core or to true a distorted armature shaft. An indication of a bent shaft or a loose pole shoe may be given by scored armature laminations.

To check armature insulation, use an ohmmeter or a 110 volt a. c. test lamp. A high reading should be shown on the meter when connected between

the armature shaft and the commutator segments. If a test lamp is used, it must not light when connected as above. Faulty insulation will be indicated by a low reading or by lighting of the test lamp.

If a short circuit is suspected, check the armature on a "growler". The motor overheating may cause blobs of solder to short circuit the commutator segments.

If an armature fault cannot be located and remedied, a replacement armature must be fitted.

FIELD COILS

Continuity test:

Connect a battery and suitable bulb in series with two pointed probes, figure 1.

If the lamp fails to light in the following test an open circuit in the field coils is indicated and the defective coils must be replaced. Place one probe at the terminal post and the other at each brush topping in turn. The bulb should light.

Lighting of the lamp does not necessarily indicate that the field coils are in order. It is possible that a field coil may be earthed to a pole shoe or to the yoke.

(Figure 2 Circuit diagram of internal connections) .

Insulation test:

Connect an ohmmeter or a 110 volt a. c. test lamp between the terminal post and a clean part of the yoke. Lighting of the test lamp or a low ohmmeter reading indicates that the field coils are earthed to the yoke and must be replaced.

Replacing the field coils:

Unscrew the four pole-shoe retaining screws using a wheel-operated screwdriver.

Remove the insulation piece, which is fitted to prevent the inter-coil connectors from contacting with the yoke. Mark the yoke and pole shoes in order that they may be refitted in their original positions.

Draw the pole shoes and coils out of the yoke and lift off the coils.

In obstinate cases, the use of a pole shoe expander will be found helpful.

ROUTINE MAINTENANCE

If any difficulty is experienced with the starting motor not meshing correctly with the flywheel, it may be that the drive requires cleaning. The barrel assembly should move freely on the screwed sleeve. If there is any dirt or other foreign matter on the sleeve it must be washed off with paraffin.

In the event of the pinion becoming jammed in mesh with the flywheel, it can usually be freed by turning the starter motor armature by means of a wrench applied to the shaft extension at the commutator end. This is accessible by removing the cap, which is a push fit.

DISMANTLING AND RE-ASSEMBLY

Remove the split pin {A} from the shaft nut {B} at the end of the starter drive. Hold the squared starter shaft extension at the commutator end by means of a wrench and unscrew the shaft nut (B) .

Lift off the main spring (C) and buffer washer { D) and remove the retaining (E) from inside the end of the pinion and barrel assembly (F) . Control nut (G), sleeve (H) and retaining spring (J) will now slide off .

Withdraw the splined washer (K) from the armature shaft and remove the pinion and barrel. The re-assembly of the drive is a reversal of the dismantling procedure.

NOTE:

Should either the control nut or screwed sleeve be damaged, then a replacement assembly of screwed sleeve and control must be fitted . These components must not be renewed individually.

CLUTCH

Description

The clutch of the Amphicar is a dry plate clutch It consists of: Pressure plate assembly, Driven plate, Shift fork with shift bearing, Clutch housing.

Method of operation

The cover, mounted on the flywheel by means of six bolts, encloses the pressure plate assembly, the driven plate and the clutch springs with their casings. Three release levers, acting upon the driven pins of the pressure plate assembly rest with their longer, inner arms on the release lever plate. The latter is held against the release levers by three retaining springs.

permissible play between the pin and the bushing guide is 006". Replace bushing, if play is excessive

At each dismantling of the clutch housing it must be checked for cracks as well for deformation, warping and unevenness of the joined surfaces If faulty, replace

This inspection must be carried out with extreme care, as, in case of warping of the clutch housing, not only will the driven plate be subject to excessive stress, but also the drive shaft of the gear-box

The bearing of the release fork for the clutch in the gearbox, as well as the springs and the clutch ring with the form springs must be checked If the parts are worn out, they must be replaced

Clutch automat

To replace the release lever plate bolt the clutch to a clutch-tensioning device and tighten the release lever plate with the center pinion. The retaining release lever springs are removed from their support on the release lever plate and the center pinion of the tensioning device is loosened

Note: If no clutch tensioning device is available, use a post drill by pressing the mandrel of the drill against the release lever plate and thus being able easily to lift the retaining release lever springs (Fig 4)

It is not recommended to dismantle a clutch pressure plate assembly if no clutch tensioning device is available (for example, if the pressure assembly plate is worn out, or the release lever is worn out, or in cases of reduced pressure of the springs due to overheating).

In such cases it is recommended to replace the clutch.

Checking of driven plate

Check clutch facings for wear If worn facings, oily facings or scarring is found, the facing must be replaced. When the facings are riveted on, the driven plate must not be deformed. The rivets must be headed correctly, for they must not, under any circumstances, protrude from the facings Driven plate with damaged torsion springs, or their mountings, must be replaced Maximum permissible side play is 12". Check the vertical play of the hub on the splines (04") and the backlash .16".

If the driven plates do not glide freely on the splined shaft, the fault must be remedied, for this could cause difficulty when disengaging the clutch

Assembly

When reassembling the clutch, act in reverse order than during dismantling. Pay special attention to the following

When fitting the driven plate and the pressure plate, a guiding tool is absolutely required in order to center the clutch exactly Otherwise difficulties may

arise when fitting the engine into the gearbox, as the drive shaft of the gearbox will not line up with the spline of the driven plate and into the guide bush of the crankshaft (Fig 1)

Pay attention to the marking of the flywheel and of the pressure plate (to be done when dismantling), so that it can be remounted in its original position.

Tighten the securing bolts of the clutch pressure plate assembly evenly and alternately.

Fig 2 shows the release assembly in the gearbox