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# SERVICE MANUAL

## NISSAN CEDRIC

### MODEL 31 SERIES



**NISSAN MOTOR CO., LTD.**

**OTEMACHI BLDG., OTEMACHI, CHIYODA-KU,  
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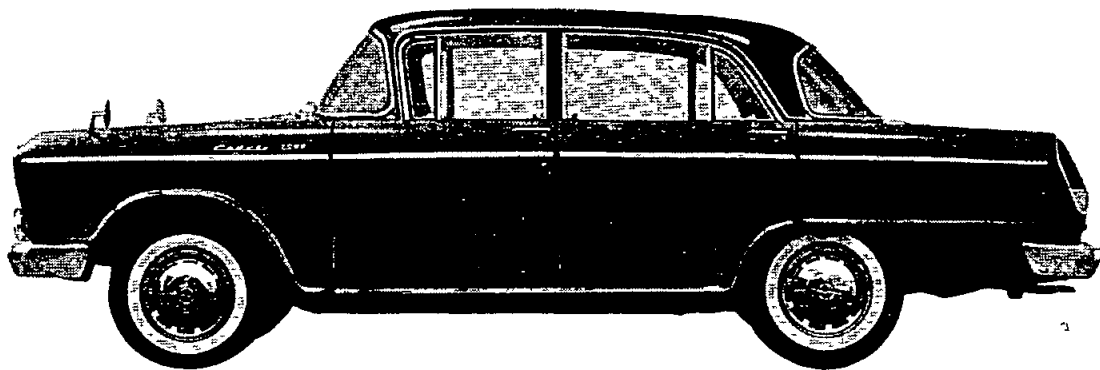
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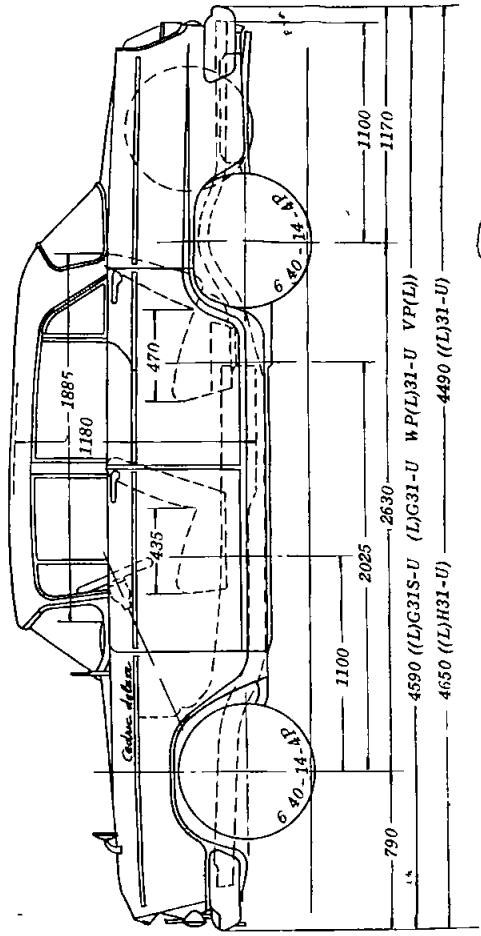
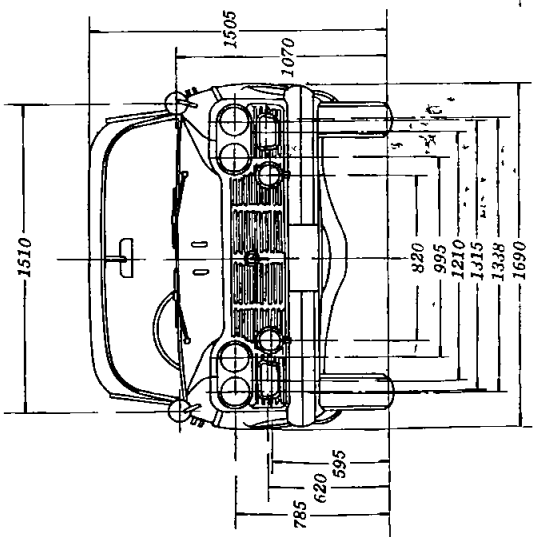
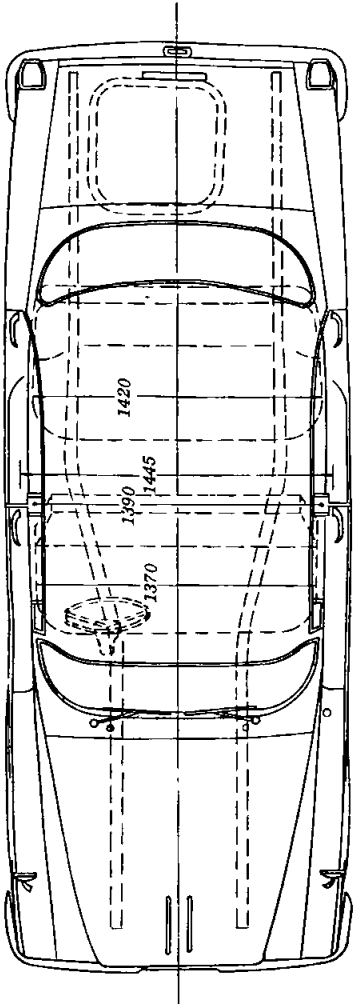
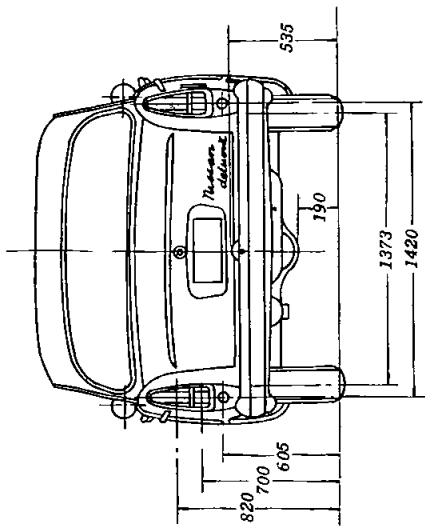
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**NISSAN CEDRIC Model 31**



# DIMENSIONS OF NISSAN CEDRIC

# INTRODUCTION

This manual has been compiled for purpose of assisting our distributors and dealers for effective service and maintenance of the model 31 Series. Each assembly of the major components is described in detail. In addition, comprehensive instructions are given for complete dismantling, assembling, and inspection of these assemblies

It is emphasised that only genuine Spare Parts should be used as replacements

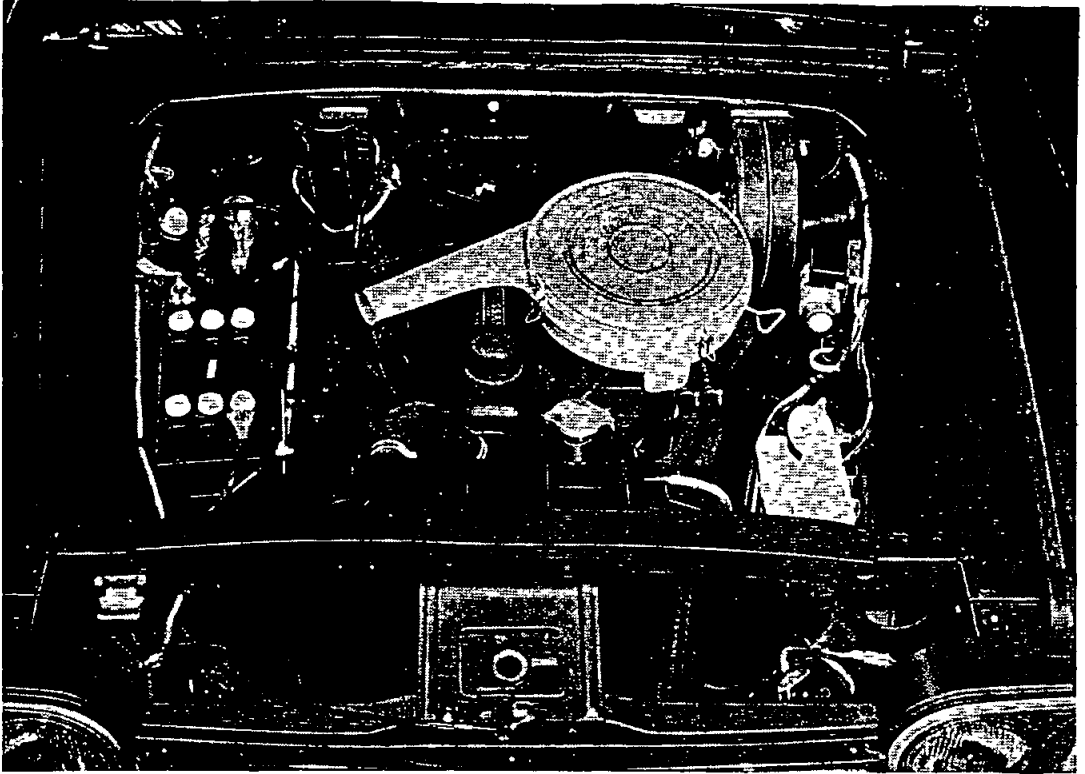
## GENERAL SPECIFICATION

DIMENSIONS	(L)G31S-U *((L)G31-U Delux	L31-U	WP(L)31-U **((VP(L)31-U)	(L)H31-U
Overall length	4590mm.	4490mm.	4690mm.	4650mm.
Overall width	1690mm.	1690mm.	1690mm.	1690mm.
Overall height	1505mm.	1505mm.	1520mm. (**1530mm.)	1505mm.
Wheel base	2630mm.	2530mm.	2530mm.	2690mm.
Tread, front	1338mm.	1338mm.	1338mm.	1338mm.
Tread, rear	1373mm.	1373mm.	1373mm.	1373mm.
Road clearance (Room or Rear Body)	190mm.	190mm.	190mm. (200mm.)	190mm.
Interior length	1885mm.	1785mm.	2730mm. *(1750/990mm.) (3 persons (6 persons +500kg.) +400kg )	1945mm.
Interior width	1390mm.	1390mm.	1390mm.	1390mm.
Interior height	1180mm.	1180mm.	1185mm. (950mm.)	1180mm.
<b>WEIGHT</b>				
Vehicle weight	1210kg. (*1240kg.)	1180kg.	1350kg. ***(1315kg.)	1260kg.
Seating capacity (persons)	6	6	8 (3   6)	6
Max. loadage	-	-	- (500/400kg )	-
Gross vehicle weight	1540kg. (*1570kg )	1510kg.	1790kg ***(1980/2045kg.)	1590kg.
<b>PERFORMANCE</b>				
maximum speed	140km/h (88m/h)	130km/h (81m/h)	140km/h (130m/h)	140km/h
Fuel consump- tion	15km/liter	17km/liter	- (**15.5km/liter)	15km/liter
Grade ability (sin θ)	0.506 (*0.496)	0.420	0.433 (**0.370)	0.490
Minimum turning radius	5.6m.	5.4m.	5.4m.	5.7m.
Stopping distance (Initial speed 50 km/h)	14.3mm.	14.3m	14.3m.	14.3m.

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# ENGINE





# ENGINE

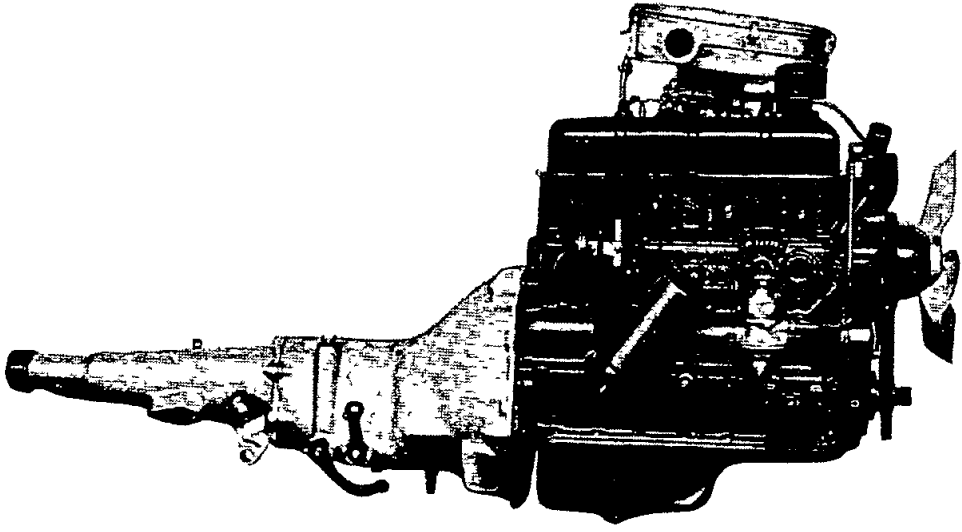
The engine is of monobloc construction, and is fitted with overhead valves operated by rockers and push rods from the camshaft. Oil seals are fitted to the valves. Three steel backed bearings support the camshaft which is chain driven.

The oil pump and distributor are driven from the camshaft, each component having its own drive shaft.

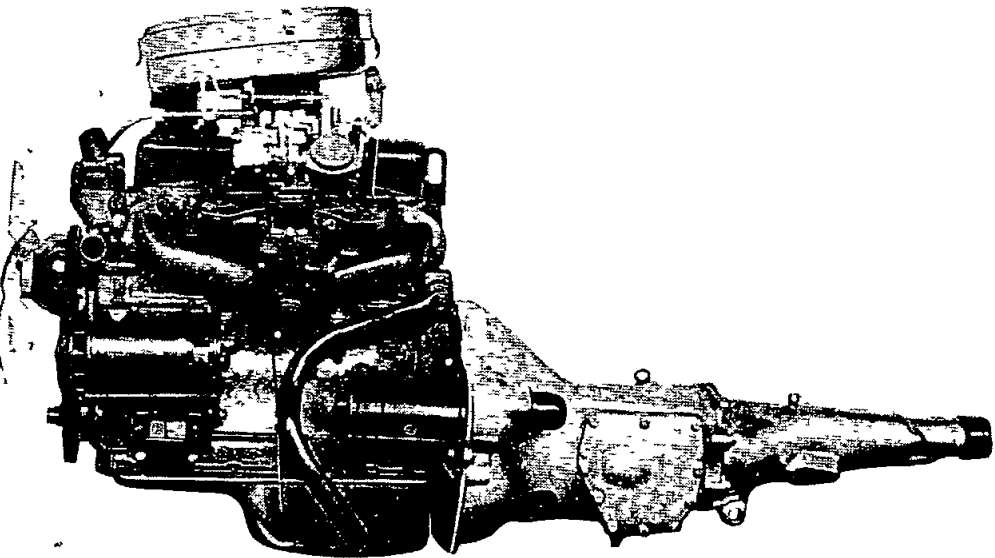
The pistons are each fitted with two compression rings and a slotted oil control ring. Bearings of the thin shell preformed type are fitted to the connecting rod big ends and to the main bearings. A counter-blanced crankshaft is fitted. The centrifugal water pump and cooling fan are driven by the dynamo belt.

## GENERAL SPECIFICATIONS

Model	H (Engine)	G (Engine)
Type	Over head valve 4 cly. 4 cycle	
Bore x Stroke	85 x 83 mm (3.35 x 3.27 in)	80 x 74 mm
Total piston displacement	1.883 cc	1.488 cc
Compression ratio	8.5 : 1	8.0 : 1
Brake horse power	88/4800 (PS) 95/5000 ((SAE))	71/5000 (PS) 77/5200 ((SAE))
Max. torque	15.6 kg(113.7 lb. ft / 3200 rpm (PS)) 16.6 kg(120 lb. ft ((SAE))	11.5 kg(83 lb. ft / 3200 rpm (PS)) 12.0 kg(87 lb. ft / 3600 ((SAE))
Firing order	1 - 3 - 4 - 2	1 - 3 - 4 - 2
Compression	12.0 kg/cm <sup>2</sup> (172 lb/in <sup>2</sup> ) 300 rpm	11.0 kg/cm <sup>2</sup> (158 lb/in <sup>2</sup> ) 300 rpm



Engine-Right Side



Engine-Left Side

## Draining the Oil

The oil pan is a metal pressing with the drain plug.

On new and reconditioned engines the oil must be drained and refilled with new oil after the first 1,000 km, and subsequently at intervals of 5,000 km.

Drain the oil when the engine is hot since warm oil flows freely and takes with it any sludge or sediment which may have accumulated.

Never use petrol or paraffin for flushing purposes. Such cleaning mediums are never completely dispersed from the engine lubrication system and will remain to contaminate any fresh oil. This may cause premature bearing failure.

## Oil Pressure

The normal operating oil pressure is 1 kg/cm<sup>2</sup>/550 rpm (14.22 lb/in<sup>2</sup>/550 rpm) at idling speed, and 3.4 kg/cm<sup>2</sup>/2000 rpm (26.56.8 lb/in<sup>2</sup>/2000 rpm).

## Refilling

When refilling the sump do not pour the oil in too quickly, as it may overflow from the filler orifice and mislead the operator as to the quantity of lubricant in the engine.

Before testing the level of the oil, ensure that the vehicle is as near level as possible. Always wipe the dipstick clean with a non-fluffy cloth before taking the reading. It should be remembered that time must be allowed for new oil to reach to sump before reading the dipstick.

## Check for Low Oil Pressure

The oil pressure gage is installed at the instrument panel. The ignition switch is turned on and when the engine started firing and the oil pressure increase normally as before mentioned.

Should it keep normal pressure during the engine running, it is result of the oil pressure down too low or the shortage of oil in the oil pan. Check the level of oil in the oil pan by means of the level gage and top up if necessary. If the pressure is still too low after refilling the oil, switch

off and ascertain that the strainer is clean and not choked with sludge, also that no air leakage exists at the strainer union on the suction side of the pump.

In the case of oil pump being defective, remove the unit to rectify the fault

If the engine bearings are worn the oil pressure will be reduced. A complete bearing overhaul and the fitting of replacement parts is the only remedy, necessitating the removal of the engine from the chassis

# LUBRICATION

## Circulation

Pressure lubrication is used throughout the unit and is provided by gear pump nondraining

The oil pump is bolted under the crankcase, and is driven from the camshaft gear by a short vertical shaft. Oil drawn into the pump through the strainer and is delivered through internal oil ways

The flow then passes through drillings in the crankshaft. The connecting rod linds are drilled for jet lubrication to the cylinder walls. From the rear camshaft bearing the oil passes upward through a drilling in the cylinder block and the rear rocker shaft bracket, to lubricate the rockers, and then drains back into the oil pan via the push rod apertures

Oil from the center camshaft bearing enters a gallery on the left-hand side of the engine and lubricates the tappets through individual drillings

As the camshaft rotates, groove in the front journal register with a small hole in the camshaft locating plate thus all owing a small amount of oil to pass into the timing case during each revolution of the camshaft to provide lubrication for the timing chain and gears

From the timing case the oil returns via a drain hole back to the oil pan.



Fig 1

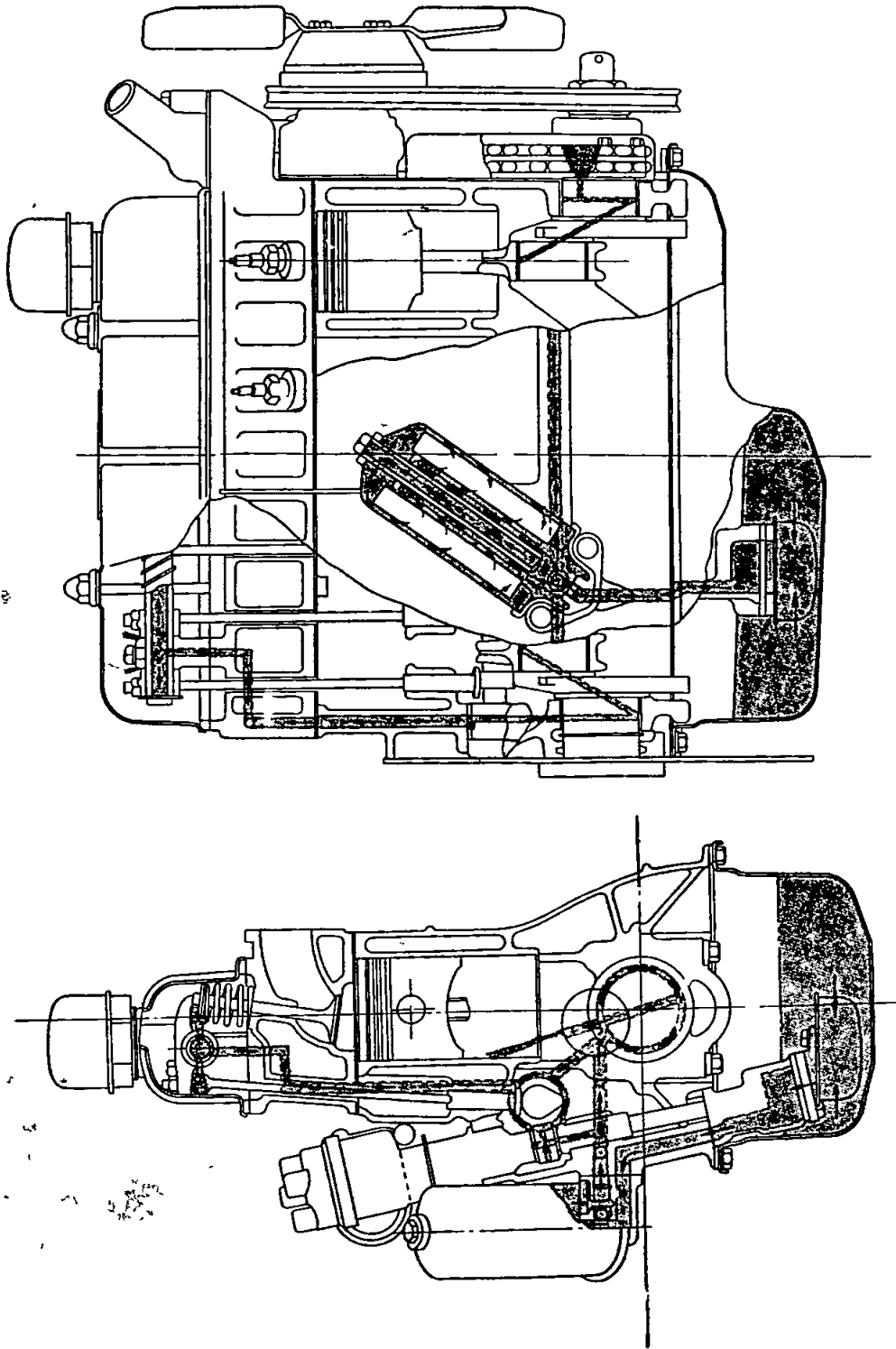


Fig 2 Oil Lubrication System

This illustrates the flow of oil from the oil pan through the oil pump to the main gallery, bearing and overhead rocker arm.

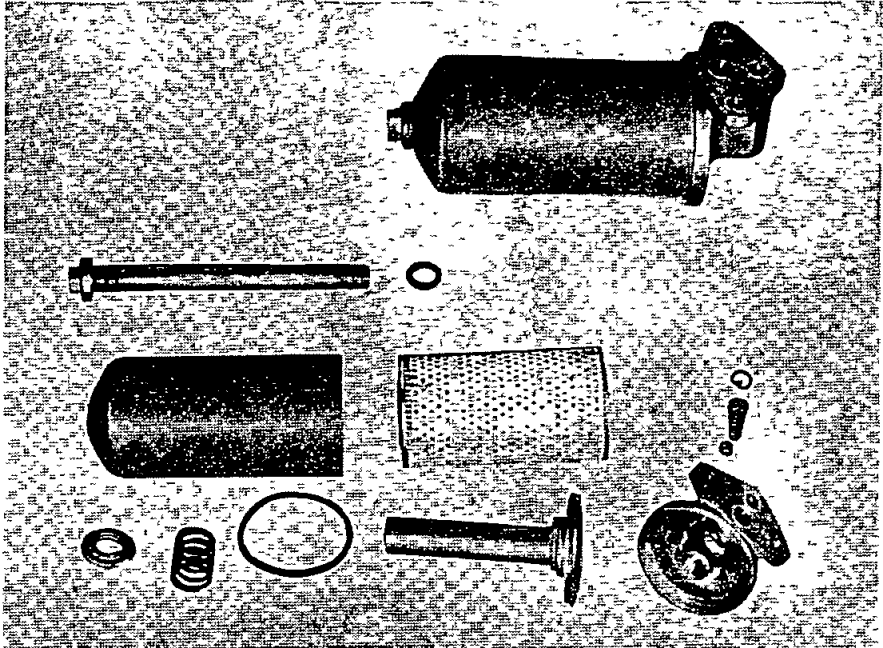


Fig 3 Component of oil filter

## Removing the By-pass Filter

A new filter element should be fitted every 15,000 km

The filter forms part of the main oil gallery of the engine. To remove the filter it is only necessary to unscrew the center bolt when the bowl can be removed from the crankcase, complete with the element. Take care not to lose the rubber sealing ring. Remove the element and note the assembly of the components.

Wash out the bowl with petrol, so that it is clean. It is important to thoroughly dry the bowl to obviate any contamination of the lubricating oil.

## Replacing the Filter

With the center bolt, the washer and the spring together with the collar in position in the bowl, insert a new element. Place the distance piece over the center bolt with the flanged end towards the element. The bowl of filter must now be filled with oil. Offer up the complete assembly to the engine and secure into position by means of the center bolt.

## Removing the Oil Pan

The sump capacity is 3.1 litres. Drain the oil and replace the drain plug.

Remove the set screw bolts which are inserted from the underside of the securing flange, and the lower bolts from the bottom edge of the bell housing. Lower the oil pan from the engine, taking care not to damage the joint washers in the process.

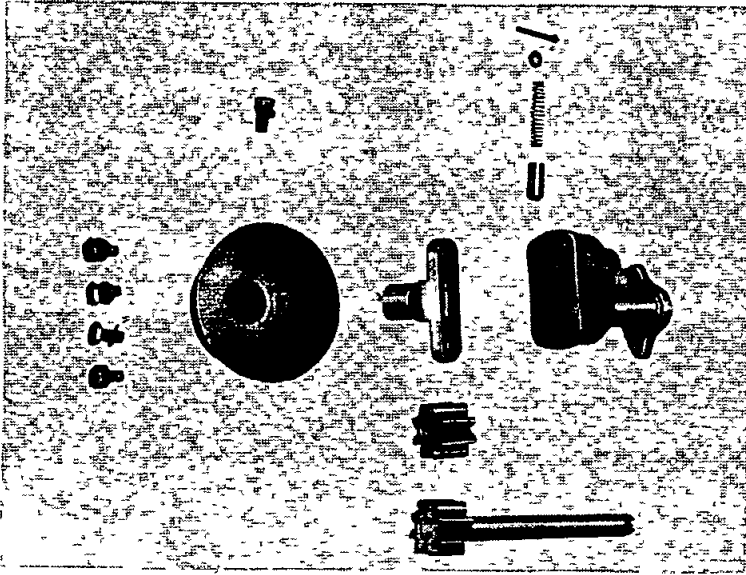


Fig. 4

## Removing the Oil Pump

Remove the oil pan and pick up strainer. The bolts securing the oil pump bottom cover are long enough to secure the pump to the crankcase. Fig 4 illustrates the pump in exploded form. Unscrew the bolts and remove the pump with its drive shaft.

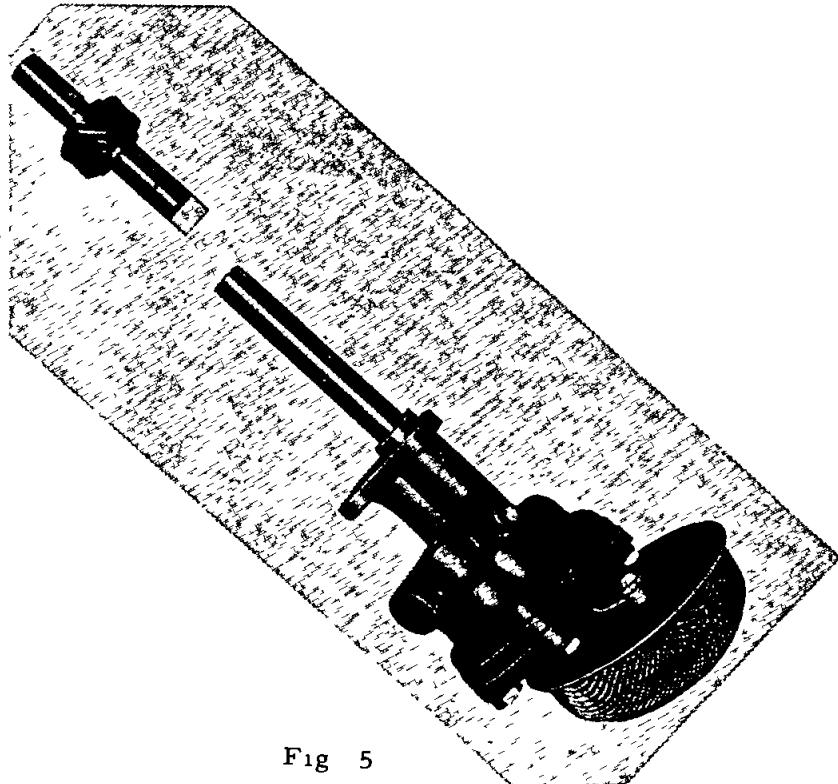


Fig 5



## Dismantling the Oil Pump

Remove the setscrews and spring washers which secure the cover to the body and take off the cover. On tilting the body upside down the drive gear and its drive shaft with a gear.

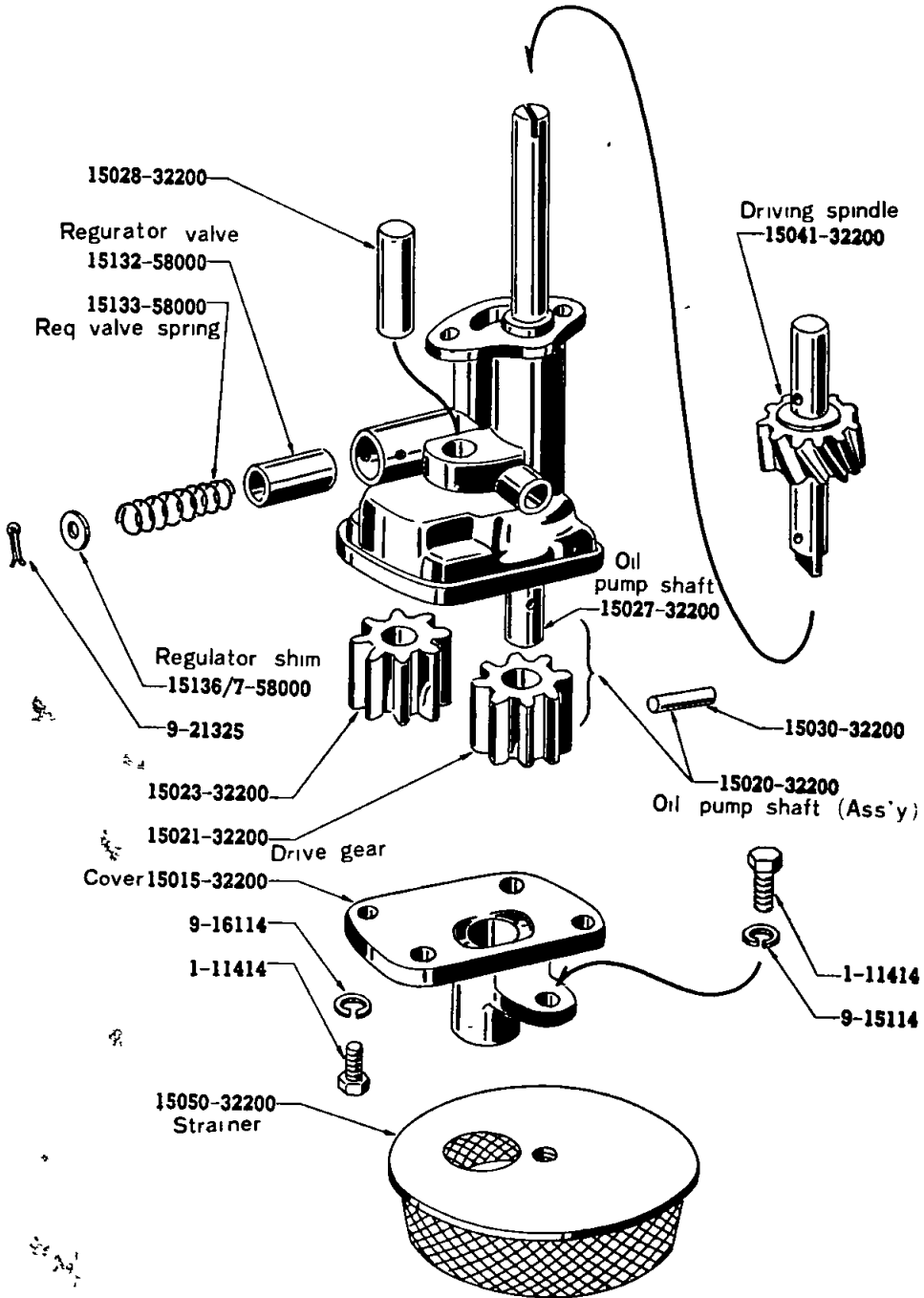
## Refitting the Oil Pan

Clean out the oil pan by washing it with gasoline, the care to remove any traces of the sediment before refitting the oil pan to the engine. Pay particular attention to the oil pan and crankcase joint faces, and remove any traces of old jointing material. Examine the joint washer and renew it if necessary. The old joint washer can be used again if it is sound, but it is advisable to fit a new one. Smear the faces of the joint with grease and fit the joint washer. Lift the oil pan into position and insert the setscrews into the flange tightening them up evenly.

## Reassembling the Oil Pump

### OIL PUMP

Performance test	22 ltr (5.8 US. Gal.) minute at 2000 rpm (pump) Pressure 4 kg/cm <sup>2</sup> (5.89 lb/in <sup>2</sup> ) Engine oil SAE 20, temperature 70°C (158°F) Regulator valve locked Vacuum 3.94 in Hg (100 mm Hg)
Gear back lash	0.25-0.3 mm (0.010-0.012 in)
Clearance between gear & cover	0.04-0.11 mm (0.0016-0.0043 in)



### Oil Pump & Strainer Assembly

(Part No 15010-32200)

# SERVICE OPERATIONS WITH ENGINE IN POSITION

## Removing Starting Nut and Pulley

Remove the radiator. Slacken the dynamo attachment bolts and remove the fan belt.

Bend back the tab on the starting bolt locking washer. Unscrew the starting nut by using heavy duty "Shock type" spanner.

A few sharp blows in an anti-clockwise direction will slacken the nut. Pull off the crankshaft pulley

## Removing the Timing Cover

The timing cover is secured by set-screw bolts, each having a shakeproof washer.

The spring washers are immediately below the bolt heads.

Take out the set-screw bolts, remove the cover and its joint washer. Care should be taken not to damage the washer when breaking the joint. If damage does occur fit a new washer, cleaning of the faces of the joint surfaces beforehand.

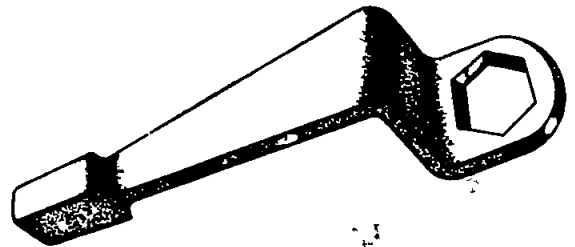


Fig. 1

Heavy duty "Shock type" Spanner

## Removing the Timing Gear

The timing chain is endless, and it is necessary to remove both the crankshaft and camshaft gears together. Before doing this, notice the timing marks on both gears and their relationship to each other.

Draw off both the gears a little at a time, first removing the crankshaft gear retaining nut.

As the gears are withdrawn care must be taken not to lose the packing washers from behind the crankshaft gear. Between the camshaft gear teeth, is a rubber ring which acts as a tensioner, and ensures silent operation of the chain drive. Examine the felt washer and renew it if oil has been lost by seepage.

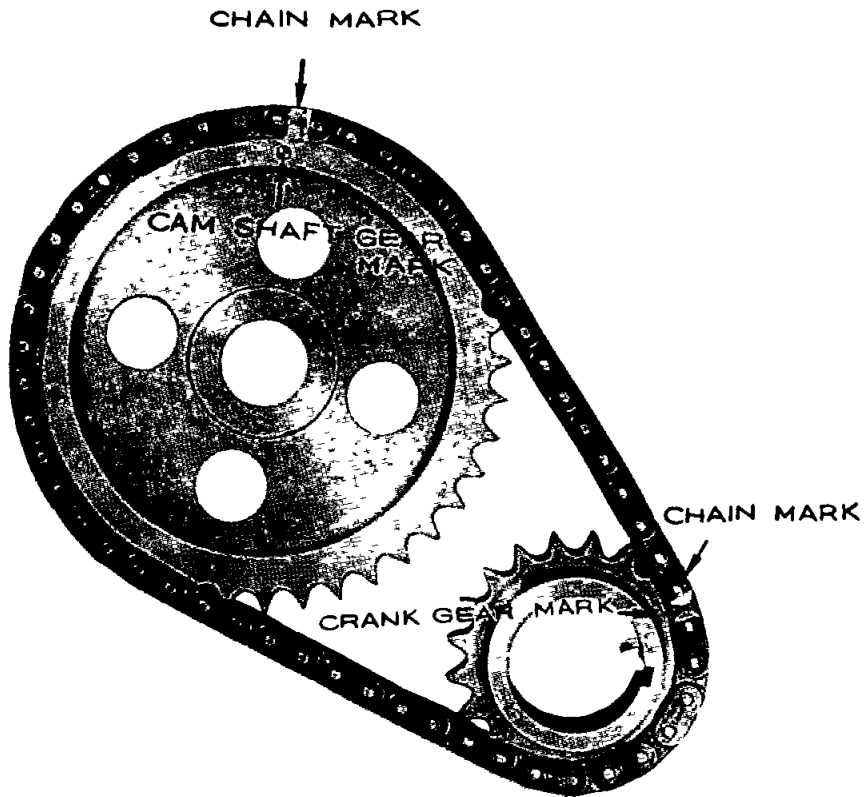


Fig. 2 Position of refitting gears with the chain

## Refitting the Timing Gear

Replacing the components of the timing gear is largely a reversal of the dismantling process, but special attention should be paid to the following points.

Turn the engine crankshaft until the keyway is at T. D. C and the camshaft with its keyway

Fit the crankshaft and camshaft gears into their respective shafts finding the key ways against each position of key as shown in Fig. 2. Ensure the timing marks are opposite along in line.

Place the gears into position, ensuring that the keys are present in keyways on the shafts. Ensure again that the timing marks on the gears are opposite to each other and in line.

The same number of shims taken from front of the crankshaft must be replaced unless a new crank or camshaft has been fitted. In this case the alignment of the gear faces and measuring the alignment with a feeler gauge. To adjust the alignment it will be necessary to vary the number of shims

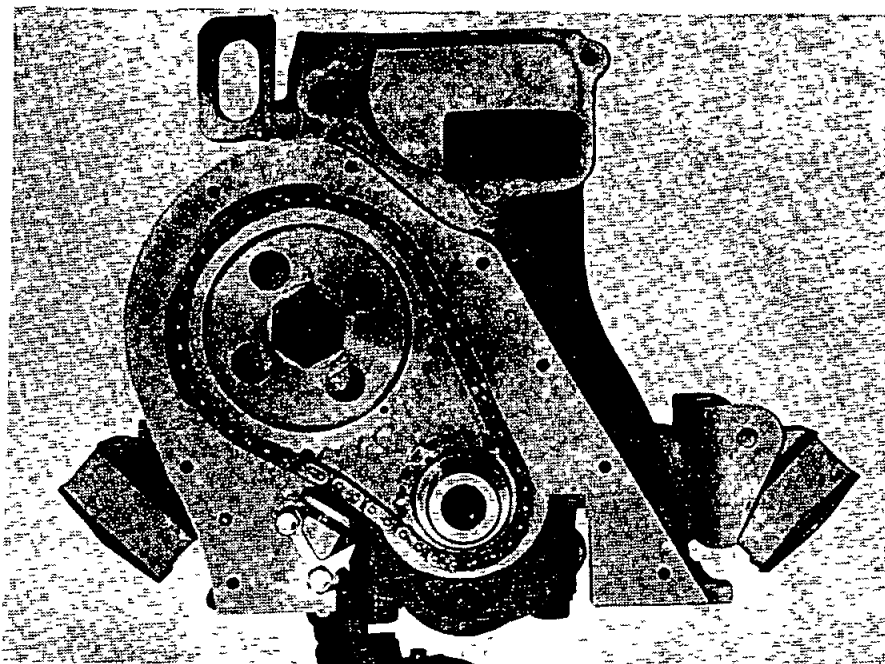


Fig. 3

## **Valve Rocker Cover Removal**

Remove the air cleaner. Unscrew the cap nuts securing the engine lifting brackets. Remove the rocker cover and the cork joint washer.

## **Removing the Rocker Assembly**

Drain the cooling system. If anti-freeze is in use, use a clean container for the fluid if it is to be used again.

It is necessary to drain the system and slacken the cylinder head bolts, because four of the rocker shaft fixing bolts also secure the cylinder head

If the cylinder head bolts are not slackened distortion may result and allow water to find its way from the cooling system into the cylinders and pump.

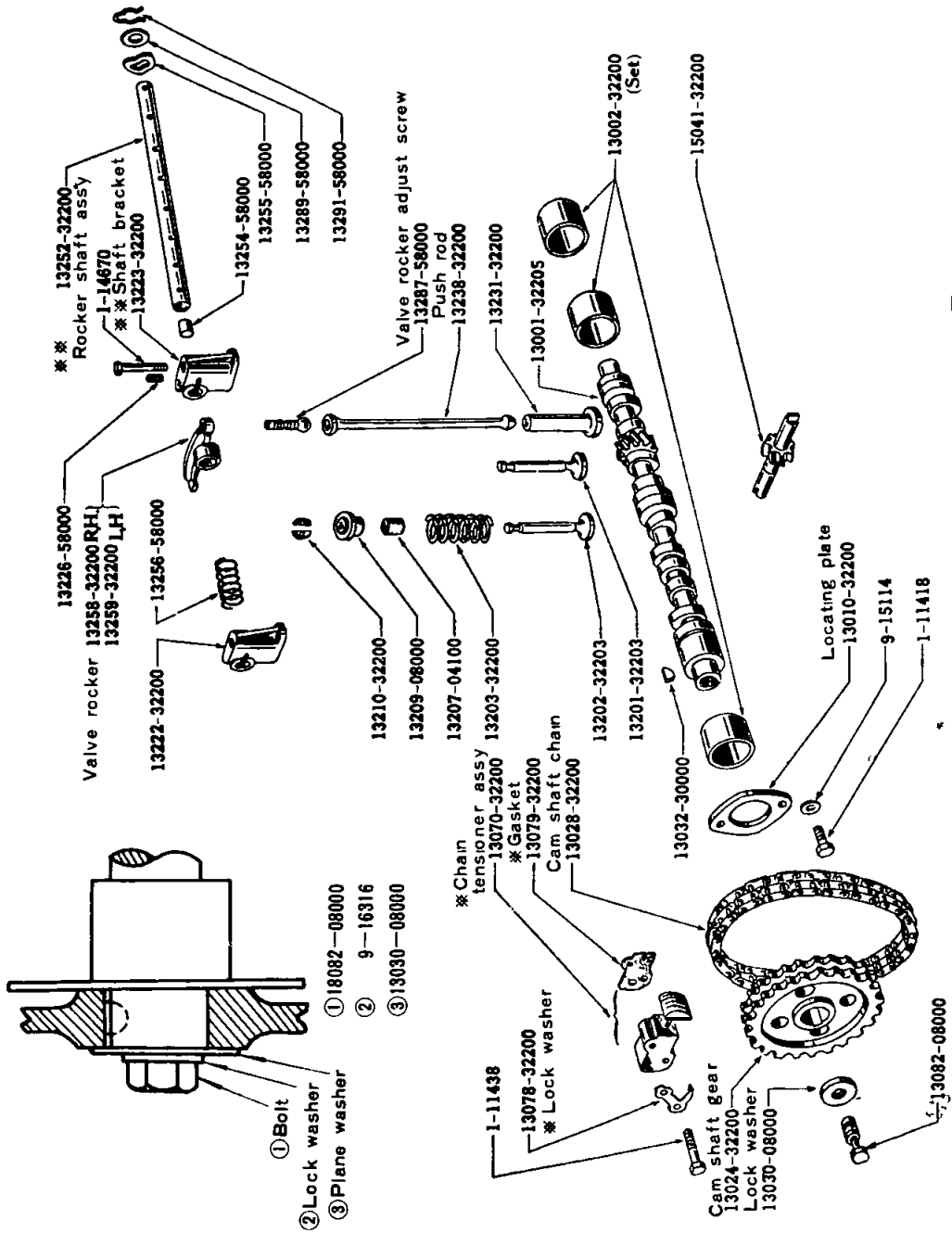
Notice that under the right-hand rear rocker stud nut is a special locking plate. Completely unscrew the rocker-shaft bracket nuts and remove the rocker assembly. Complete with brackets and rockers.

## CYLINDER

Diameter of cyld. bore					
Grade number & dimensions STD bore					
Grade No.	1	2	3	4	5
Diameter of cyld bore mm (in)	85.000	85.010	85.020	85.030	85.040
	85.009	85.019	85.029	85.039	85.049
	(3.34645) (3.34680)	(3.34684) (3.34720)	(3.34724) (3.34759)	(3.34763) (3.34799)	(3.34802) (3.34838)
Cylinder bore taper			Less than 0.02 mm (0.0008 in)		
Difference of each cylinder bore			Less than 0.02 mm (0.0008 in)		
Over size piston available			0.25 0.50 0.75 1.00 mm 0.010 0.020 0.030 0.040 in		
Cylinder head surface warpage limit			0.1 mm (0.004 in)		

## PISTON

Material	LO-EX Aluminum Alloy				
Diameter of piston skirt	Measured at right angles to the piston pin				
Standard size					
Grade No.	1	2	3	4	5
Diameter of piston mm (in)	84.975	84.985	84.995	85.005	85.015
	(3.34547)	(3.34585)	(3.34625)	(3.34665)	(3.34704)
	84.966 (3.34511)	84.976 (3.3455)	84.986 (3.34590)	84.996 (3.34629)	85.006 (3.34669)
Over size available	0.010 0.020 0.030 0.040 0.050 0.25 0.50 0.75 1.00 1.25 0.060 in 1.50 mm				
Clearance cyld. wall and piston	0.025-0.043 mm (0.001-0.0017 in)				
Checking by feeler gauge	1-2 kg. with 0.04 mm feeler gauge 2.2-4.4 lb with 0.0015 in feeler gauge				
Allowable difference of gross weight with connecting rod	Within 5 gr				
Diameter of piston pin hole	21.987-22.000 mm (0.8656-0.8661 in)				
Piston pin hole off set	1.05-0.95 mm (0.0414-0.0374 in)				
Width of ring grooves.					
Compression	2.030-2.055 mm (0.0800-0.0809 in)				
Oil control	4.015-4.040 mm (0.1580-0.1591 in)				



**Camshaft Valve & Rocker Parts**

## VALVE

Material			
Inlet	Chrome steel		
Exhaust	Unilloy 2112		
Valve timing			
Inlet opens	14°	B. T. D. C.	
Inlet closes	50°	A. B. D. C.	
Exhaust opens	52°	B. B. D. C.	
Exhaust closes	12°	A. T. D. C.	
Valve clearance Inlet & Exhaust			
	0.43 mm	(0.017 in)	Hot
	0.525 mm	(0.0207 in)	Cold
Dowel angle	50° - 54°		
Head diameter			
Inlet valve	40 mm	(1.57 in)	
Exhaust valve	32 mm	(1.26 in)	
Valve seat angle inlet & exhaust			
	45°		
Valve face angle inlet & exhaust			
	44° 30'		
Valve length (overall)	109 mm	(4.30 in)	
Lift	8.5 mm	(0.335 in)	

## Dismantling the Assembly

To dismantle the rocker shaft assembly first remove the grub screw and locking plate from the rear rocker bracket.

Remove the split pins, flat washers and spring washers from each end of the shaft. Slide the rockers, brackets and springs from the shaft. Unscrew the plug from the end of the shaft and clean out the oil way.

The two end rockers may be dismantled without the whole rocker assembly being drawn out. This may be achieved by turning the engine by hand until No. 1 push rod reaches its lowest position.

Unlock the tappet adjusting screw and screw it back as far as it will go.

Withdraw the split pin, flat and spring washers and slide the rocker off the shaft.

Sometimes the valve spring will have to be slightly compressed by levering a screwdriver under No. 2 rocker, thus allowing the end rocker to slide off the shaft easily. Repeat the procedure for No. 8 rocker.



## **Reassembling the Rocker**

On reassembly tighten the pedestal bracket securing nuts a little at a time working diagonally from nut to nut, left nut of No. 1 pedestal bracket, right nut of No. 2, left of No. 3 and so on returning from the left nut of No. 4 bracket and repeating the process until they are all tight. If the rocker assembly has been completely stripped down and rebushed, the oil holes will have to be redrilled and the bushes reamed down to size before assembly on the shaft.

The rockers and spring must be replaced in their original position on the ends of the shaft. Remember to replace the rocker shaft locating screw and lock plate

Replace the spring and flat washers with the split pins on the ends of the shaft. Replace the rocker cover and gasket. The vent pipe should be at the front of the engine. Secure the cover by means of the two cap nuts, ensuring that the rubber bushed and engine lifting plates are in position. If the rocker cover gasket or the rubber bushes are found to be faulty, they must be renewed otherwise oil leaks will result.

## **Push Rod Removal**

If the valve rocker assembly has already been removed all that remains is for the push rods to be lifted out. They may on the other hand be taken out without detaching the rocker assembly.

Remove the air cleaner and rocker cover.

Slacken all the tappet adjusting screws to their full extent, then using a screwdriver, with the rocker shaft as a fulcrum, depress the valve spring, slide the rocker side ways and lift out the push rod

All but the end push rods can be withdrawn in this way. These will have to be withdrawn after the removal of the two end rockers from the shaft. When replacing push rods ensure that the ball ends register in the tappet cups. From here onwards, reassembly is a straightforward reversal of the dismantling process.

## **Adjusting Valve Rocker Clearances**

Remove the air cleaner and rocker cover.

There should be a clearance of 0.43 mm (0.017 in.) between the face of the rocker and the base of the valve stem. Whilst checking the clearances it is important to maintain pressure with a screwdriver on the tappet adjusting screw to disperse the film of oil from the push rod cup. Failure to follow this procedure will result in a wrong reading being taken.

Turn the engine over by hand (Starting handle) until the push rod stops falling, the valve is fully closed.

To adjust (Fig. 4 ) insert a screwdriver in the adjusting screw slot and slaken the lock nut. Then insert 0.017 in. feeler gauge between the face of the rocker and the valve stem. Raise or lower the adjusting screw until the correct clearance is obtained.

Tighten the lock nut and recheck the clearance.

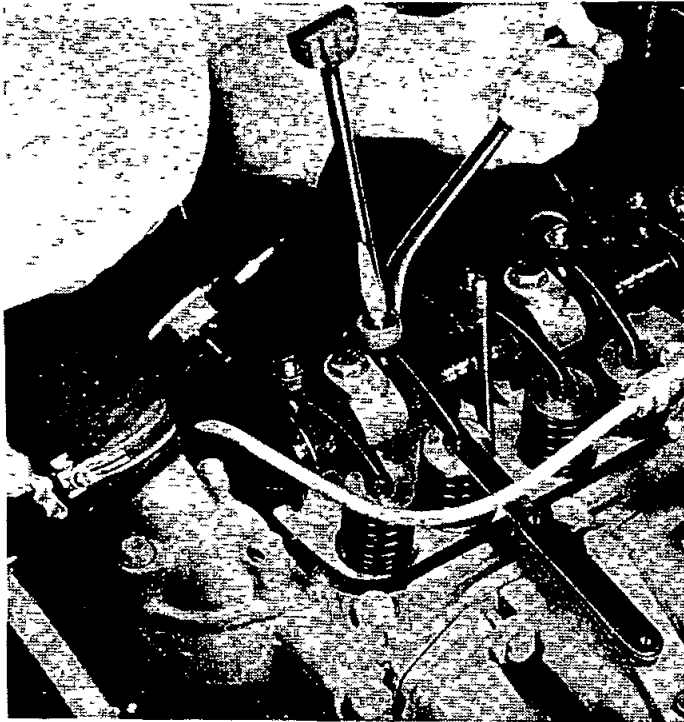


Fig. 4 Adjusting the rocker clearance

It is important to note that while the clearance is being set, the tappet of the valve being adjusted must be on the back of the cam, opposite to its peak.

# ROCKER MECHANISM

## TAPPETS

Type	Mushroom	
Diameter	12.673-12.684 mm(0.4988-0.4993 in)	
Hole diameter for tappet	12.700-12.718 mm(0.4990-0.5006 in)	
Tappet length	57 mm	(2.24 in)

## ROCKER MECHANISM

Push rod		
Overall length	196.6-197.4mm (7.74-7.77 in)	
run-out (at center of rod)	Not to exceed 0.2 mm (0.008 in)	
Diameter	6.35-5.36 mm (0.2500-0.2504 in)	
Rocker shaft length	398 mm	(15.67 in)
Rocker shaft diameter	(0.7865-0.7874 in)	
Rocker arm hole diameter	20.020-20.033mm(0.7882-0.7887 in)	
Arm & shaft clearance	0.020-0.054 mm (0.0008-0.0021 in)	
Arm lever ratio	1.46 1	

## CYLINDER HEAD

### Removing the Cylinder Head

Drain the cooling system by opening the radiator and cylinder block drain taps.

One is situated inlet tube at the backside of the radiator and other at the rear right-hand side of the engine. If anti-freeze mixture is in use it should be drained into a suitable container and retained for future use.

Disconnect the negative cable from the battery by extracting the terminal screw and removing the lug from the battery terminal post.

Slacken both the retaining clips on the hose connecting the radiator to the thermostat housing and remove the hose.

Extract the thermostat housing securing nuts and remove the housing and thermostat.

Remove the aircleaner, carburetor, rocker cover and the inlet and exhaust manifolds.

Detach the high tension cables and remove the sparking plugs, also disconnect the water temperature gauge connection from the thermostat housing.

Take off the rocker assembly not forgetting to slacken the external cylinder head bolts at the same time.

Withdraw the push rods keeping them in the order of removal.

The cylinder head can now be lifted off the cylinder block. To facilitate breaching the cylinder head joint, tap each side of the head with a hammer using a piece of wood interposed to take the blow. Do not use excessive force. When lifting the head a direct pull should be given so that the head is pulled evenly up the studs. Remove the cylinder head gasket.

## **Decarbonising**

Remove the cylinder head. With the valves still in position remove the carbon from the combustion chambers and the valve faces. Leaving the valves in position for this operation ensures that damage cannot be caused to the seats by the wire brush which should be used for the removal of carbon.

If the exhaust valve heads are coated with a very hard deposit this may be removed by using a chisel shaped piece of hardwood

Remove the valves, and using the wire brush clean out the carbon from the inlet and exhaust ports

Blow out all traces of carbon dust with compressed air or type pump, and finally clean the ports with gasoline and dry them out. The carbon should now be removed from the piston crowns. Rotate the engine until the piston to be worked on is at T.D.C. Protect the other cylinder bore from the entry of carbon particles by pushing a non-fluffy rag into them

Using a chisel shaped piece of hardwood. Carefully remove the carbon from the piston crowns. A ring of carbon should be left round the periphery of each piston, and the deposit round the top of the cylinder bore should not be touched. An indication as to when decarbonisation is required is generally given by an all round loss of power. Cars used mainly on short runs will require this attention more often than those used for long runs.

## **Removal and Replacement of a Valve**

Whilst the cylinder head is removed the valves can be taken out. To do this compress the valve spring with the special valve spring compressor

## Removal

Remove the two cap retaining collets. Release the valve spring, the valve spring cap, valve oil seals and its retainer. Withdraw the valve from the guide.

Keep the valves in their relative positions when removed from the engine, to ensure replacement in their original valve guides.

## Replacement

Note that the diameter of the exhaust valve heads are smaller than the inlet valve. To replace the valves, insert each valve into its guide and replace the spring, oil seal and retainer. Fit oil seal chamfered side downwards. The oil seals are more easily fitted if they have been soaked in engine oil for a short period before use. To replace the valve spring, compress the valve spring.

Refit the cap retainers and secure them by means of the valve cotters. Remove the Compressor.

## VALVE SPRINGS

Free length	48.7-49.3 mm	(1.917-1.931 in)
Fitted length & load	39 mm at $30 \pm 1.5$ kg	
	1.5354 in at $66 \pm 3.3$ lb	
Compressed length & load		+4
	30.4 mm at 61.1 kg	-3
	1.198 in at 134.7 lb	+8.8
		-6.6
Effective turns of Coil	7	
Diameter of coil wire	4.3 mm	(0.169 in)
Coil inside diameter	25.2 mm	(1.992 in)

## CYLINDER HEAD

Torque wrench setting	6.2 - 6.9 kgm	(45 - 50ft lb)
Cylinder head nuts	4.15 - 4.84 kgm	(30 - 35ft lb)
Connecting rod bolts	4.8 - 6.2 kgm	(35 - 45ft lb)
Main bearing cap	9.75 - 11.06 kgm	(71 - 81ft lb)

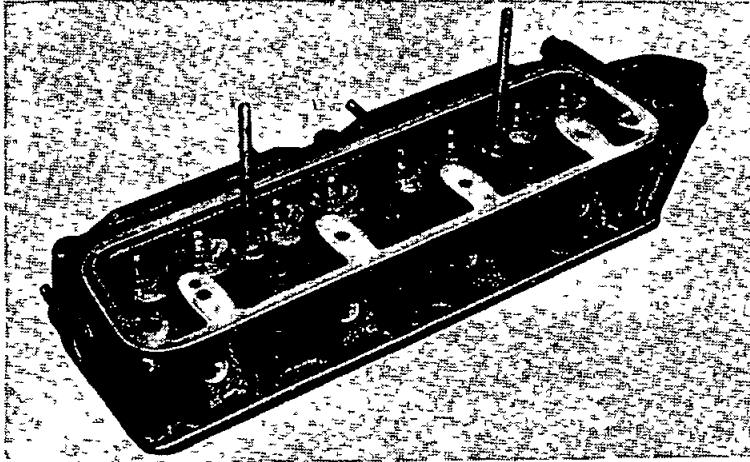


Fig. 1

## Valve Grinding

Before replacement of the cylinder head the valves and their seats should be examined for signs of pitting or burnt patches and distortion.

If these conditions are present, the valve seats must be recut before attempting to grind in the valves, whilst distorted valve heads should be trued or the valve renewed. Only the minimum amount of metal should be removed in the trueing process.

When grinding a valve onto its seating, the valve face should be smeared lightly with grinding paste and then lapped in with a suction type grinding tool. The valve must be ground to its seat with a semi rotary motion. A light coil spring interposed between the valve head and the port will assist considerably when lifting the valve in order to rotate the face to a different position. This should be done frequently to spread the grinding compound evenly.

It is necessary to continue the grinding process until an even matted surface is produced on the seating and the valve face.

On completion, the valve seats and ports should be thoroughly cleaned with gasoline soaked rag, and dried, and the subjected to a compressed air blast. The valves should be washed in gasoline and all traces of grinding compound removed.

## VALVES

Valve head diameter			
	Intake valve	40 mm	(1.57 in)
	Exhaust valve	32 mm	(1.26 in)
Valve seat angle inlet & exhaust		45°	
Valve face angle inlet & exhaust		44° 30'	
Valve length (overall)		109 mm	(4.30 in)
Lift		8.5 mm	(0.335 in)

Reset the valve clearances, and finally check them when the engine is not hot or cold. The cylinder head bolts may pull down slightly more after the engine has attained its normal working temperature, in which case the valve clearances will have to be checked again and reset if necessary.

Refit the inlet and exhaust manifolds

Fit the carburetor and reconnect the control linkage Refit the ignition advance suction pipe to the connection on the carburetter, but do not at this stage refit the air cleaner or it will have to be removed later to check the valve clearances Replace the rocker cover taking care to fit the cork gasket correctly.

Place the thermostat and its housing in position and secure with the three nuts. Reconnect the water temperature gauge wire and fit the radiator hose to the thermostat housing Connect the cables to the battery Ensure that the radiator and cylinder block drain tapes are closed, and refill the radiator

Clean and adjust the sparking plugs and refit them, clipping on the high-tension leads. The firing order of the engine is 1-3-4-2. Replace the clip which secures part of the electrical whiring harness to the side of the head

The ignition can now be switched on and the engine started When the normal operating temperature has been reached switch off and remove the rocker cover so that the valve clearances may be rechecked. Replace the rocker cover and fit the air cleaner when the final check has been made

Whilst the engine is running check that the water hose connections and fuel line unions do not leak Tighten them if necessary.

### OVER SIZE VALVES(STEM) AVAILABLE

	Intake Valve	Stem diameter	Guide hole dia
Standard	13201 32200	7.985-7.970 mm 0.3144-0.3138 in	8.018-8.000 mm 0.3157-0.3150 in
Over size 0.2mm(0.008 in)	13201 32201	8.185-9.170 mm 0.3223-0.3217 in	8.218-8.200 mm 0.3235-0.3229 in
0.4mm(0.016 in)	13202 32202	8.385-8.370 mm 0.3301-0.3295 in	8.418-8.400 mm 0.3314-0.3307 in
	Exhaust Valve	Stem diameter	Guide hole dia
Standard	13202 32200	7.960-7.945 mm 0.3134-0.3128 in	8.018-8.000 mm 0.3157-0.3150 in
Over size 0.2mm(0.008 in)	13202 32201	8.160-8.145 mm 0.3213-0.3207 in	8.218-8.200 mm 0.3235-0.3229 in
0.4mm(0.016 in)	13202 32202	8.360-8.345 mm 0.3291-0.3285 in	8.418-8.400 mm 0.3314-0.3307 in

## Refitting the Cylinder Head

Ensure that the cylinder head and cylinder block joint faces are clean.

The cylinder head gasket is marked "Top" so that it will be placed head in correctly. Place the gasket into position and lower the cylinder into place. Fit the seven cylinder head securing nuts finger tight.

Insert the push rods, replacing them in the positions from which they were taken.

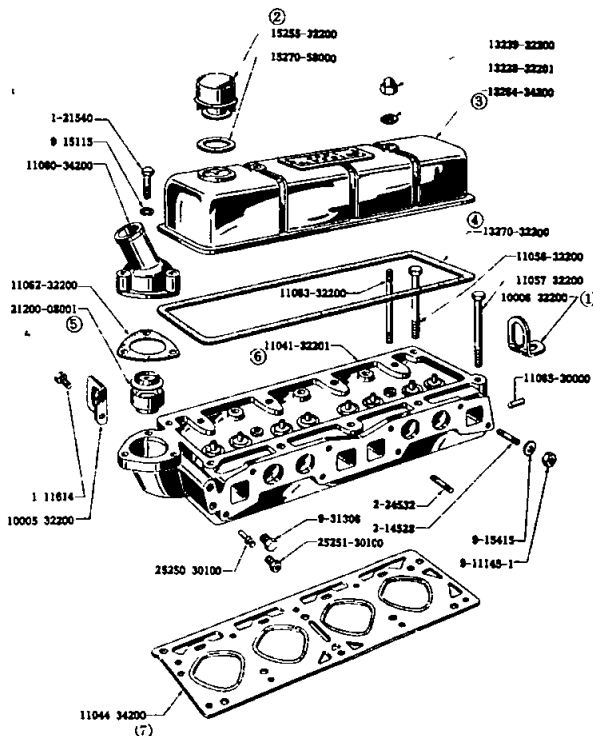
Screw back all the tappet adjusting screws. Replace the rocker assembly and screw down the securing nuts finger tight. Evenly tighten the cylinder head bolts a little at a time, finally pulling them down with a torque wrench set to 45-50 lbs./ft. (6.2-6.9 kgm).

## Removing and Replacing the Tappets

Remove the cylinder head assembly and withdraw the push rod, keeping them in their respective positions so that they will be replaced on the same tappets.

Take out the camshaft from engine block, then push out the tappet from the top of the cylinder block with one of push rods, also keeping them in same locations.

Assembly is a reversal of above procedure. It may be necessary to insert the tappets from inside of cylinder block keeping upside down or lay down.



- (1) Engine sling bracket
- (2) Oil filler cap
- (3) Valve locker cover
- (4) Washer (Cover joint)
- (5) Thermostat
- (6) Cylinder head
- (7) Cylinder head gasket

Cylinder Head



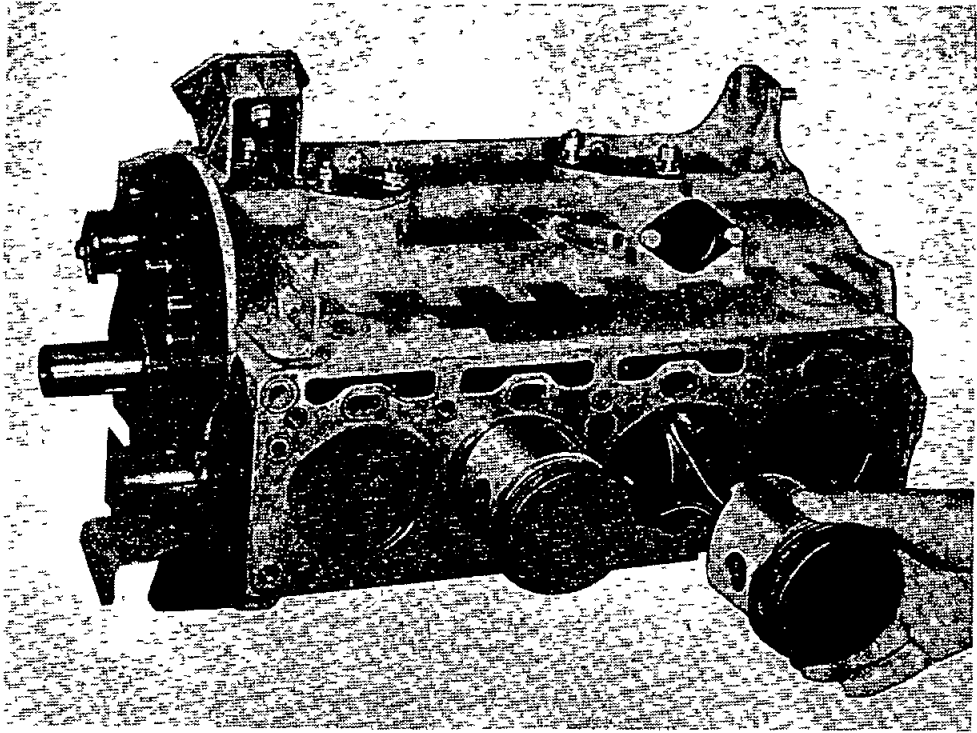


Fig 2

## ***Piston and Connecting Rod Removal***

Drain the cooling water from the engine and radiator. Drain and remove the oil pan from the engine, then disconnect and remove the oil strainer. Take out the pal nuts and cap nuts from the big ends and withdraw the caps. When used parts are replaced after dismantling, it is essential they are fitted into their original positions.

To ensure correct refitting mark the caps and connecting rods on the sides to identify them together.

The piston and connecting rods must be withdrawn upwards through the cylinder bores.

Release the connecting rod from the crankshaft side and slowly push the piston and rod upwards through the cylinder bore with the wooden bar.

**Note** It may be necessary to remove the ring of carbon or lip from the top of the cylinder bore with a hand scraper to avoid risk of piston ring breakage.

Remove the assembly from the top of the cylinder block.

Check the crankpins for ovality with a pair of micro meter calipers, and examine the bearing surface for scoring, either defect will necessitate the removal of the crankshaft for regrinding

## CONNECTING ROD

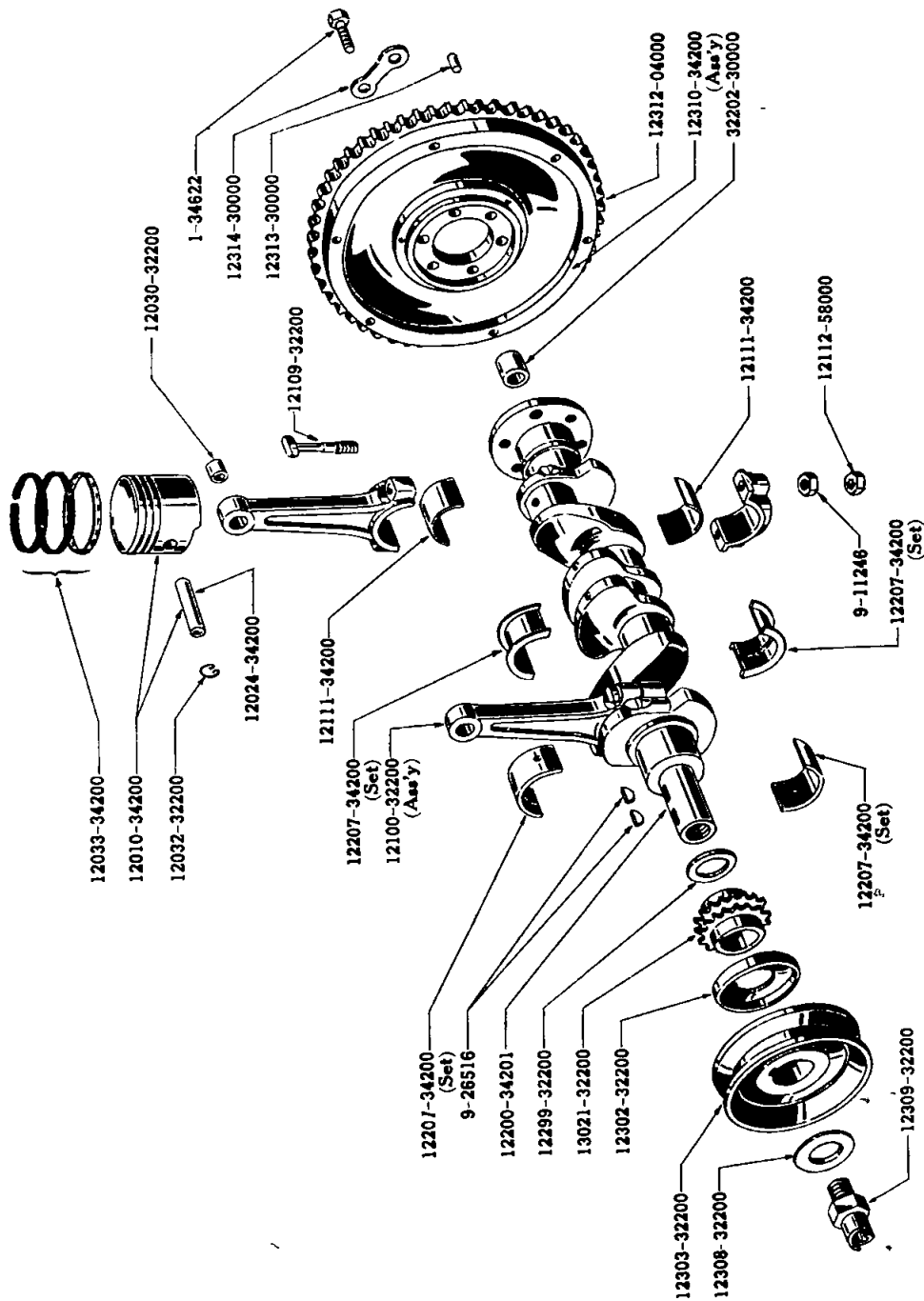
Material	Steel forging	
Length, center to center	144 mm	(5.67 in)
Big end bearing		
Material	Thinwall, steel backed white metal	
Width	24 mm	(0.945 in)
Thickness	1.5 mm	(0.059 in)
Diameter of big end housing	55.000 mm	(2.1653 in)
Big end width	28 mm	(1.1024 in)
End play	0.2-0.3 mm	(0.008-0.012 in)
Clearance crank pin and bearing	0.02-0.03 mm	(0.001 in)
Piston pin bushing (reamed in position)	22 mm	(0.8661 in)

## CRANKSHAFT

Material	Steel forging	
Diameter of journals	59.94-59.95 mm	(2.3598-2.3602 in)
Diameter of crank pin	51.96-51.97 mm	(2.0457-2.046 in)
End ply	0.05-0.15 mm	(0.002-0.006 in)
Main bearing clearance	0.03-0.07 mm	(0.001-0.0027 in)
Deflection (RUN-OUT) at intermediate journal	0.03 mm under	(0.0012 in)

## MAIN BEARINGS

Material	Thinwall, steel backed, white metal	
Number of bearings	3	
Width		
Front and rear	28 mm	(1.10 in)
Center	33.90-33.95 mm	(1.3346-1.3366 in)
Bearing thickness	1.83-1.84 mm	(0.0720-0.0724 in)



**Piston & Crank shaft**

The shell bearing are removable by hand. The bearings are require no "bedding in" it is being only necessary to ensure that the housings are scrupulously clean and dry, and to place the bearings into position with the tangs located in their corresponding slots. Always renew bearings if they are scored or damaged in any way, or following the regrinding of the crankshaft bearing surfaces. In the latter case undersize bearings will be required and the kinds of sizes available are 0.010, 0.020, 0.030 and 0.040 etc.

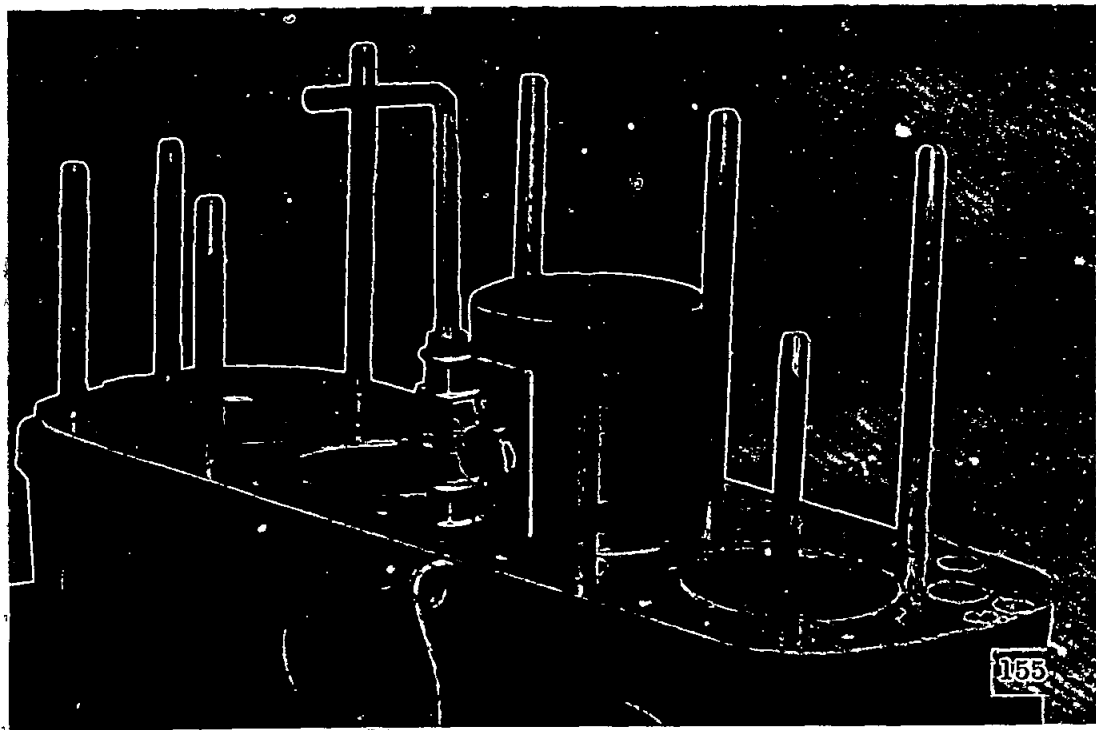


Fig 3

## PISTON

### Replacing Pistons and Connecting Rods

Insert each piston and connecting rod assembly into the cylinder from which it was taken, it is essential that the split in the skirt of the piston is positioned towards the camshaft

Compress the piston rings with inserting piston using tool (Fig. 3), and gently tap the crown of the piston with the wooden end of a hammer handle, until the piston is clear of the piston ring clamp.

Now push the piston down the cylinder block until the big end of the connecting rod just protrudes through the bottom of the cylinder bore, then position upper half bearing shells.

Note -Each upper & lower bearing has the oil holes, there by ensuring sufficient and it is of the greatest importance that the corresponding oil hole in the bearing shell registers with the oil way to provide an unobstructed passage.

Pull the connecting rod onto the crankpin taking care not to injure the bearing surface. Insert the shell into the connecting rod cap, position the cap and the locking washers. Insert the setscrews and tighten with a torque wrench to 35 - 45 lbs. /ft. (4.8-6.2 kgm).

Finally set with the pal nut.

Check the connecting rod big end for side clearance (7/1000 in.) and see that the shell bearings are not binding on the crankpin when rotating the crankshaft. If it is difficult to turn, undo the big end and examine the shell and seat for dirt or grit

Before reassembling always apply a little clean oil to the piston surfaces and into the cylinder bore. Never file the connecting rod caps or their mating surfaces as this creates ovality in the bearing.

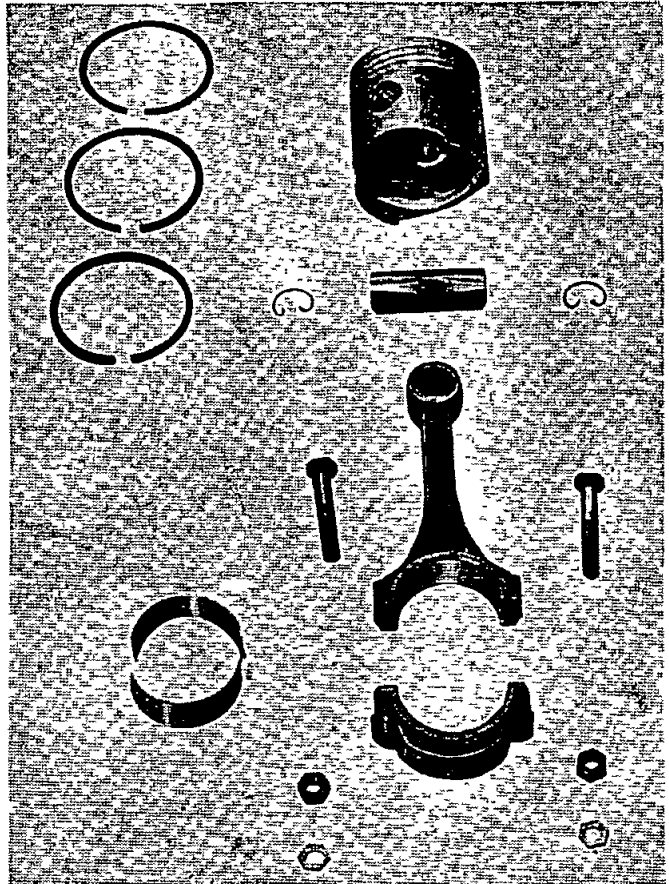


Fig. 4

## Removing a Piston

Remove the clamping bolt from the small end of the connecting rod and push out the gudgeon pin. The gudgeon pin is a push fit in piston at 30°-40°C.

When reassembling, ensure the gudgeon pin is positioned in the connecting rod so that its groove is in line with the clamp screw hole. Check that the spring washer fitted under the head of the pitch bolt is not damaged.

## PISTON PIN

Type	Full floating (Snap rings at both end of pin in piston)
Pin fit (to piston pin hole)	Thumb fit at 30° -40°C 86° -104°F
Diameter	21.99 -22.0 mm (0.8657-0.8661 in)
Length	73 mm (2.8740 in)
Fit clearance (pin and connecting rod)	TIGHT 0/01 mm (TIGHT 0.0004 in) LOOSE 0.018 mm (LOOSE 0.0007 in)

## PISTON RINGS

Type of rings	Top ring Plane type chrome plated 2nd ring Tapered type Oil control ring Slot type chrome plated
Ring width	
Compression	1.98-1.99 mm (0.0780-0.0783 in)
Oil control	3.98-3.99 mm (0.1565-0.1570 in)
Ring clearance in groove	
Compression	0.04-0.08 mm (0.0016-0.0030 in)
Oil control	0.03-0.06 mm (0.0012-0.0024 in)
Ring gap in bore	
Compression No. 1	0.25-0.40 mm (0.010-0.016 in)
"    No. 2	0.15-0.30 mm (0.006-0.012 in)
Oil control	0.15-0.30 mm (0.006-0.012 in)
Ring tension	
Compression No. 1	1.8±0.2 kg (4.00-0.44 lb)
"    No. 2	1.95±0.2 (4.33±0.44 lb)
Oil control	2.1±0.2 kg (4.67±0.44)

## PISTON AND BORES

There should be a clearance of 0.0010-0.0016 in. (0.025-0.040 mm.)

## PISTON RINGS

The top piston ring gap should be 0.010-0.016 in. (0.25-0.40 mm.) when checked in the cylinder bore. The clearance of the second and oil control compression rings in their grooves should amount to 0.006-0.012 in. (0.15-0.30 mm).

If the piston rings do not travel to the end of the cylinder bores a "lip" is eventually formed due to wear. This may be checked with a dial gauge and must be removed. If this is not done there will be a tendency to noisy operation or a fractured ring, caused by the top piston ring striking the lip. Piston and rings are available in. 0.010 in. (0.254 mm.) 0.020 in. (0.508 mm.) 0.030 in. (0.762 mm.) 0.040 in. (1.016 mm.) and 0.050 in. (1.270 mm.), oversizes.

The piston rings should always be fitted from the crown of the piston and never pushed upwards over the skirt. Before fitting the rings, remove any carbon deposit from the grooves in the piston.

When fitting, note that the second compression is tapered type and oil control ring is slot type processed by chromium plating.

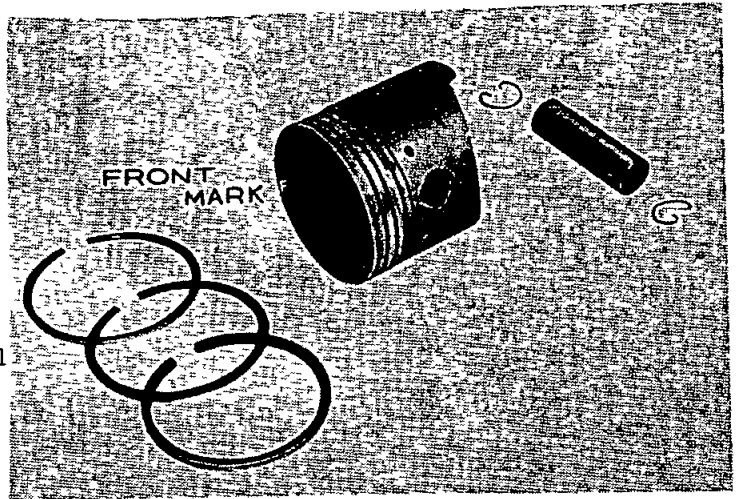


Fig 5

## Withdrawing Camshaft

The camshaft is positioned by a locating plate held by three screws and shakeproof washers. Note the position of the small lubricating oil hole in the locating plate when replacing should be to the right of the engine.

End play of 0.08-0.28 mm (0.003-0.011 in) is controlled by the thickness of the locating plate, and can be checked with a dial indicator set against the camshaft gear.

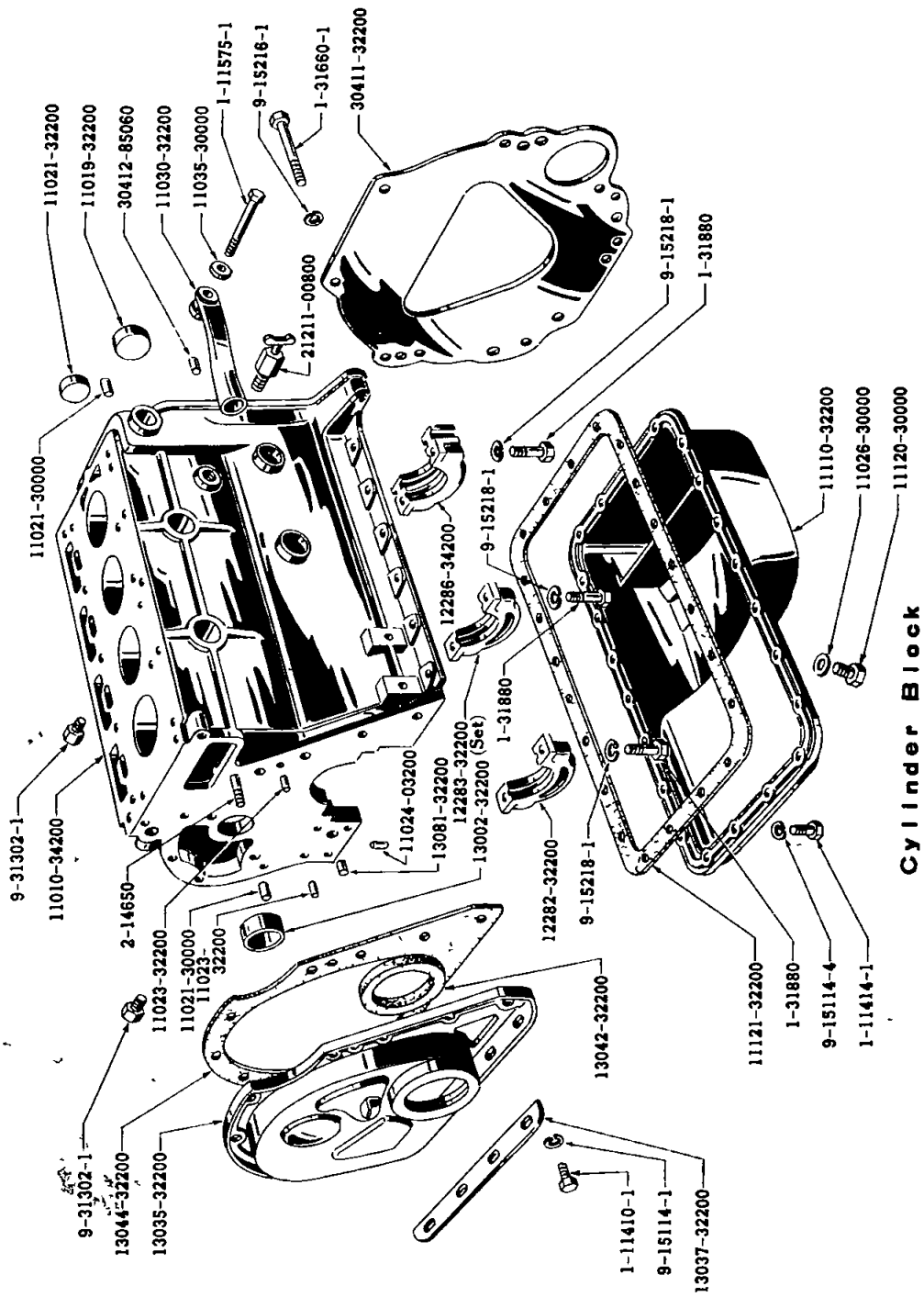
Before withdrawing the camshaft the distributor and its driving spindle push rods, will have to be removed. Remove the oil pump and its drive shaft, and take off the timing cover and gears. The engine front mounting plate is now accessible and may be removed by withdrawing the setscrew and locking plates. The dynamo swinging link must be removed.

Take out the setscrews securing the camshaft locating plate, when the camshaft can be withdrawn from the cylinder block.

## CAMSHAFT BEARINGS

White metal bearings, with steel lining are used for the camshaft. They can be taken out renewed when necessary, it being usual to do this when the cylinder block is being reconditioned.

The bearings can be removed by drifting them out of their housings.



**Cylinder Block**

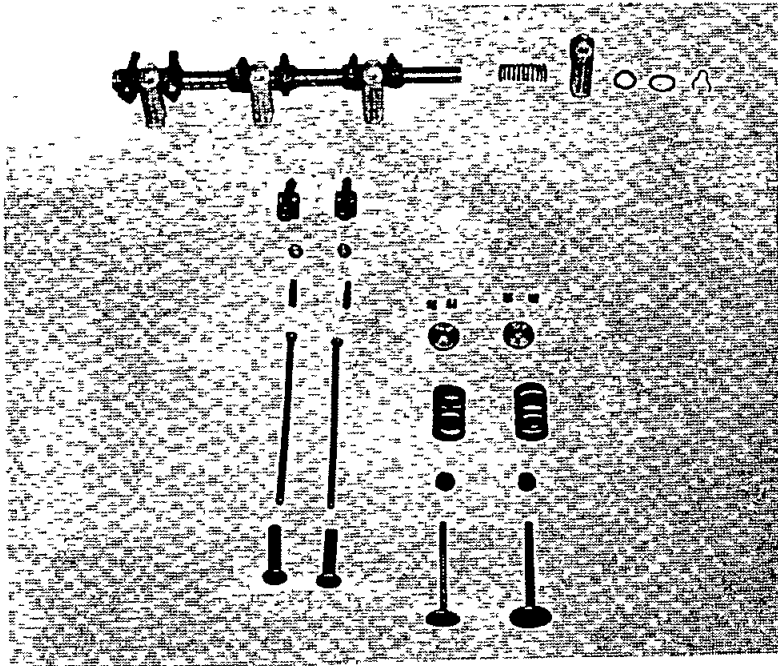


When fitting new bearings care must be taken to line up the oil holes with the corresponding holes in the cylinder block.

Tap the new bearings into position and ream them to give a running clearance of 0.001-0.002 in. (0.025-0.051 mm.)

## Refitting the Camshaft

This is a reversal of the instructions for removal. Care should be taken however, to align and engage the drive pin in the rear end of the camshaft with the slot in the oil pump drive shaft.



## Main bearing caps

Remove the flywheel and clutch.

Take off the timing chain, the oil pan and the engine rear plate. Unlock and remove the bolts securing the main bearing caps of the cylinder block, also the bolts securing the timing chain cover at front of cylinder block.

When fitting new bearings no scraping is required as they are machined to give the correct running clearance of 0.001-0.0027 in (0.03-0.07 mm.)

Handle the new bearings carefully so as not to damage the fine surface finish

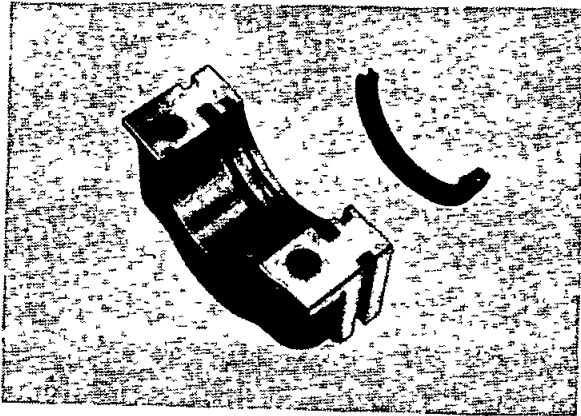


Fig. 6

Remove all traces of dirt and oil from the housings and thoroughly dry them with a non-fluffy rag. Make sure that the oil ways are clear. When fitting the bearing caps ensure that they are replaced the right-way round. Each cap is marked, and the marks should face the camshaft side of the engine.

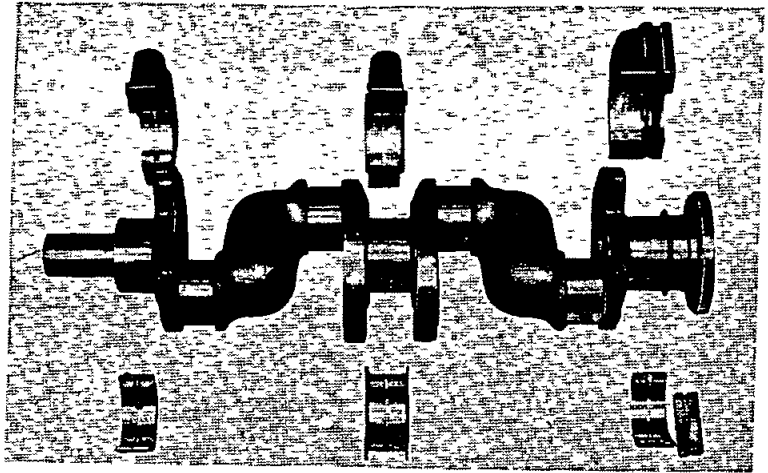


Fig. 7

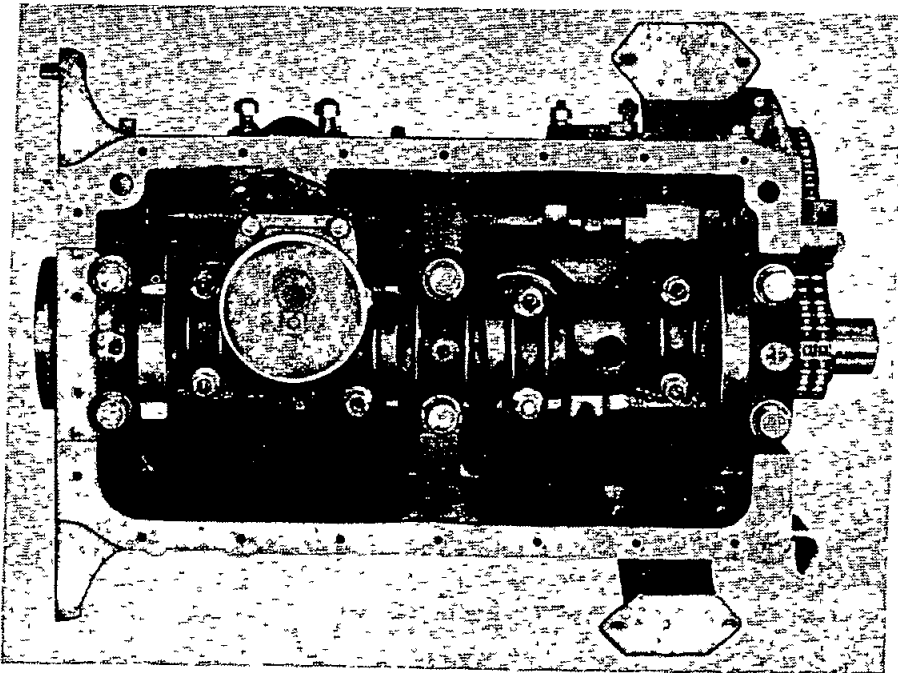


Fig. 8

## CAUTION

Never file the bearing caps to take up excessive play as this will cause ovality.

Always cover the bearing surfaces with engine oil when they are replaced.

Do not forget to refit the thrust washer. The main bearing caps are held in position by set screws and lock washers. Pull the set-screw up tight with a torque wrench set to a loading of 75-80 lbs. /ft(10.36-11.05 kgm.).

When refitting the main bearing caps tighten the center one first. After each cap is tightened rotate the crankshaft to ascertain that it revolves freely.

If it is tight remove the last cap tightened, and examine the bearing and its seating for foreign matter.

Check the crankshaft end play by means of a dial gauge. This should be 0.002 in-0.006 in(0.05 mm-0.15 mm).

If a bearing has "run", it is essential to clean out all oilways in the crankshaft and block. Wash out the engine sump and the strainer.

The oil pump should be dismantled and cleaned. Ensure that no particles of bearing, metal are left within the engine lubrication system.

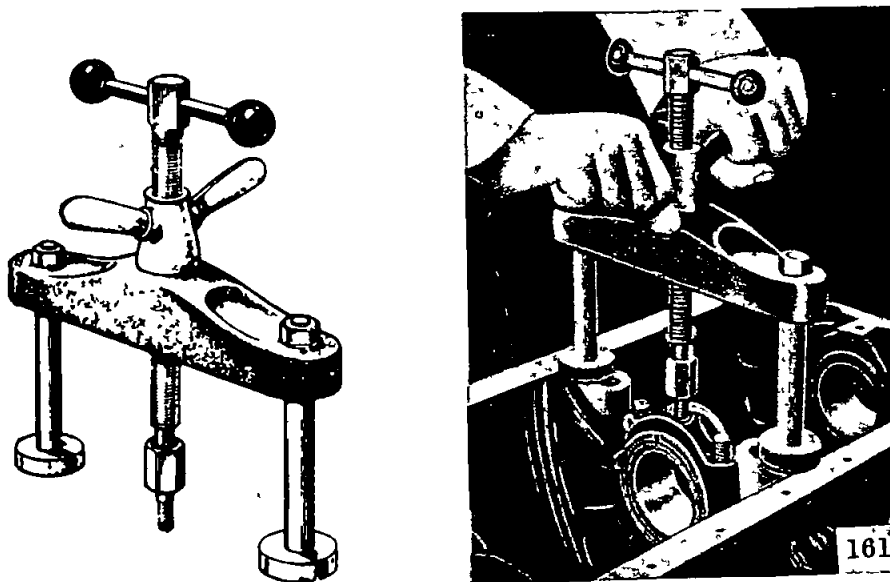


Fig. 9 Removing a Main Bearing Cap & Extractor

## Adjusting the Brake Points

To adjust the breaker points, turn the engine crankshaft with the crank handle until the breaker is fully open. / Then loosen the breaker point fixing screw. Next, by turning the adjusting screw, move the plate until a feeler gauge of 0.45 to 0.55 mm. (0.018 to 0.022 ins.) thickness slides easily between the breaker points. Then tighten the fixing screw securely.

Finally, check the gap once more, then reinstall the rotor. The interior and exterior of the cap is wiped clean with a soft, dry piece of cloth, extra attention being paid to the areas between the terminals. Clean the center electrode on the inside of the cap also.

The vacuum type timing advancer is functioning properly, can be determined by the inspection pointer located at the diaphragm if, as the engine is being run, this pointer moves when the engine speed is suddenly changed, the advancer is satisfactory.

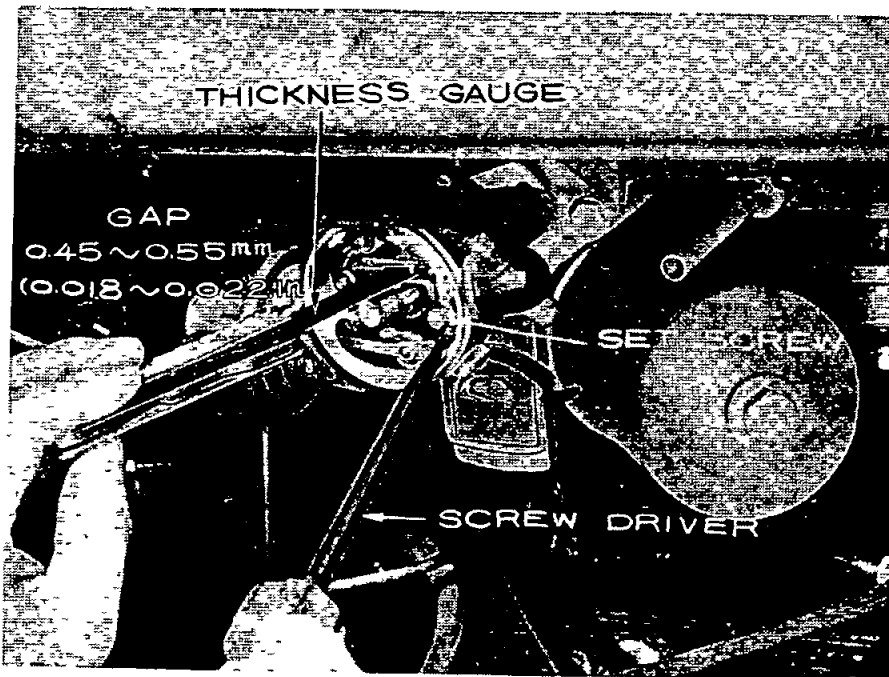


Fig. 10 Adjusting the Point Gap

# ADJUSTING THE IGNITION TIMING

The ignition timing is adjusted to 10 degrees before top dead center with the engine stopped as shown in Fig. With this adjustment, the automatic timing advancer of the distributor advances the ignition timing even further at the time the engine starts to rotate, and the timing is maintained constantly at valves suitable for the rotational speed.

With the engine stopped, adjust so that the distributor breaker point just breaks when the piston of the No. 1 cylinder is in its 10 degrees before top dead center position for compression. If a timing lamp is used, the standard ignition timing is 12 degrees before top dead center at idling (600 rpm) speed.

In the case of marks which are not evenly spaced, pointers indicate 10 deg., 15 deg. and 20 deg., positions before top dead center.

## DISTRIBUTOR

Type	D410-01	((D415-01))
Ignition timing (Idling)	B. T. D C. 12°/550 rpm((10°)) with timing light, engine 600 rpm (Adjust timing angle by the kinds of gasoline octane value.)	
Ignition timing advance	Automatic advance by the centrifugal weight and vacuum timing control. ((Automatic advance by the centrifugal weight and vacuum timing control.))	
Automatic advance	Governor start advance at 0°, 375-525 rpm ((Governor start advance at 400-550 rpm Maximum advance angle 14°-16° at 1800 rpm))	
Vacuum advance	Start advance at 90-110 mm (3.54-4.33 in) Hg. Maximum advance angle 330 mm Hg/6.5-8.5° ((Start advance at 4.7-5.5 in. (120-140 mm)Hg. Maximum advance angle at crank shaft 9-12° at 12.6 in. (320 mm) Hg.))	
Firing order	1 3 4 2	1 3 4 2
Point gap	0.45-0.55 mm 0.018-0.022 in. ((0.45-0.55 mm 0.018-0.022 in.)) 50°-54° Hitachi, 56°-61° Mitsubishi (( " " , " " ))	
Contact arm spring tension	500-650 gram	18.6-23 oz
Capacity of condenser	0.20-0.24 mfd.	0.20-0.24 mfd

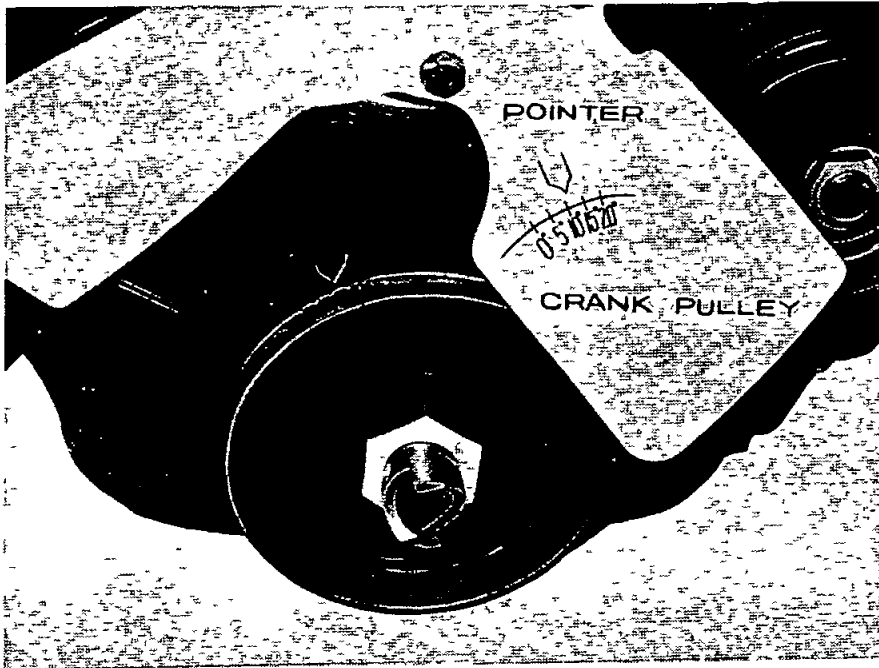


Fig. 1 Checking the Ignition Timing

Adjustment is made by the following procedure.

1. First adjust the distributor to the correct gap as described previously.
2. Turn the crankshaft gradually until the top dead center mark (Fig. 1) on the pulley periphery coincides with the mark for 12 deg before top dead center on the timing gear cover as the crankshaft approaches its position somewhat before that corresponding to the end of the compression stroke of the No. 1 piston. Stop the crankshaft in this position. The compression stroke of the No. 1 piston can be determined if the spark of the No. 1 cylinder is removed, the hole plugged with a finger, and the crankshaft turned. With the crankshaft in the previously mentioned position, the No. 1 piston is in its position of 10 deg. before top dead center of compression.
3. Next, inserting the driving shaft of the distributor at an angle to the engine, engage the gear on its lower end and with the gear on the camshaft. During this assembly place the slot of the distributor drive of the upper end of the shaft somewhat to the left. At this time, the smaller of the semi-circles is placed toward the front.
4. Adjusting the direction of the rotor so that it engages the drive shaft slot, mount the distributor to the engine. At the same time, the breaker must be in its position when it is just beginning to open. If these conditions do not coincide, they are made to do so by

slightly turning the distributor body only. To determine the position when the breaker point is just beginning to open, turn on the ignition key, hold the end of the No. 1 spark cord about 1/4 inch away from the cylinder head, and turn the body until spark jumps across the gap.

The off-set slot position of the drive shaft when the No. 1 piston is in its compression top dead center position is shown here.

5. Next put the distributor cap on and clamp it securely with the clip.
6. To the No. 1 spark plug connect the cord from the terminal to which the arm of the rotor is pointing. Thereafter connect the terminal cords to their spark plugs in the counter-clock-wise order so as to obtain a 1-3-4-2 firing order.
7. Upon completion of the wiring, cover the distributor with a rubber cap. The engine should now start properly.

Ordinarily, the pointer of the octane selector is set at its zero reading during the ignition timing adjustment. If the octane number of the fuel being used is low and the engine knocks, the pointer is adjusted to the right (R) to the optimum advance angle. Conversely, if the octane number is high the pointer is adjusted to the left (A). One unit of calibration of the selector corresponds to 2 deg. of the distributor angle and to 4 deg. of the crankshaft angle.

When a timing lamp is used, the standard setting is 12 deg. before top dead center with the engine idling (600 -620) In any case, the optimum adjustment is that in which a slight knocking is heard when, with the car running at low speed in "HIGH" (TOP) gear, acceleration is applied suddenly

# FUEL SYSTEM

The fuel tank has a capacity of 44 litres and is situated at the rear of the luggage compartment.

The fuel pump, operated off the camshaft draws fuel from the tank and forces it into the carburetor float chamber. A large and efficient air cleaner filters the air supply to the carburetor.

## FUEL SYSTEM

### GASOLINE TANK

Capacity	44 ltr	(12 US. Gal)
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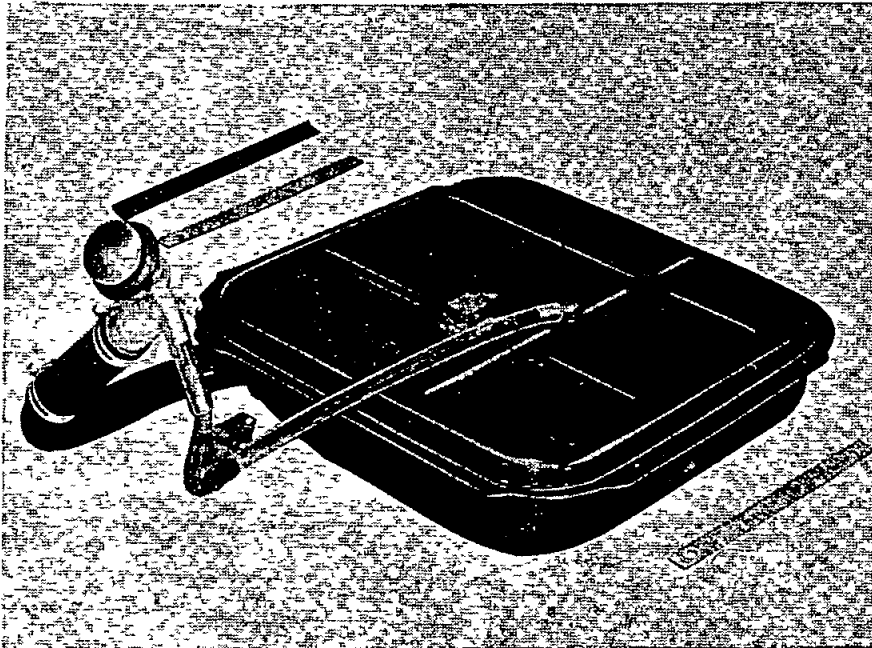


Fig. 1



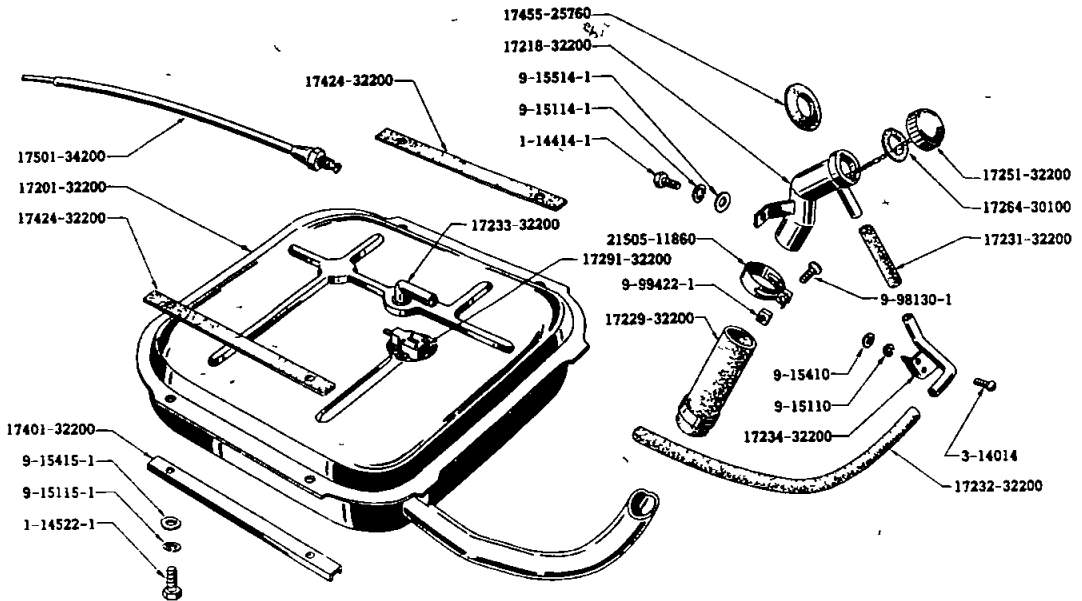


Fig. 2 Gasoline Tank Mounting

Situated on the top face of the tank is the gauge unit. To remove, withdraw the set screws which secure the unit to the tank not forgetting to disconnect the electrical lead beforehand. Care must be taken not to strain or bend the float lever as this may seriously effect subsequent gauge readings. Remember this also applies when refitting the unit

Examine the joint washer to ensure that it is in position and undamaged. This is essential as the joint between the tank and gauge unit must be fuel tight.

## TROUBLES & REPAIRS OF GASOLINE TANK

### A) When Fuel Leaks from Gasoline Tank

When a crack, distortion or damage is found in the tank, repair or replace it.

To make repairs, put marks with chalk at the leaking points and, even after the fuel in the tank has been drained out, blow with compressed air through the tank to force out stagnant gasoline vapor completely. Repairs should be done only when the tank is completely dry.

Leakage is ordinarily mended by soldering. When welding is necessary, the above precaution must be strictly observed. Otherwise, there will be danger of explosion.

## B) When gasoline Fails to Reach Gasoline Strainer

If the fuel fails to reach the gasoline strainer when there is some fuel left in the gasoline tank and the operation of fuel pump is known to be satisfactory, check the following points.

(When it is difficult to confirm the delivery of fuel at the strainer, loosen the connector at the fuel intake of the carburetor.)

(1) Check to see if gasoline pipe is clogged with dust and dirt. This can be easily checked by disconnecting the connector of the pipe and blowing with compressed air toward the direction of the tank. Then from the tank end blow the pipe again and clean the pipe.

In many cases the tip of gasoline intake pipe of tank unit is clogged with dust and water.

Therefore, together with cleaning of the pipe, the interior of the tank should be cleaned by removing the drain plug at the bottom of the tank.

Check to see if the gasoline pipe of the tank unit is so bent as to fail to reach the fuel surface.

The standard position of the bottom end of the pipe is about  $\frac{3}{4}$  in. apart from the bottom in order to prevent its sucking up sediments on the tank bottom.

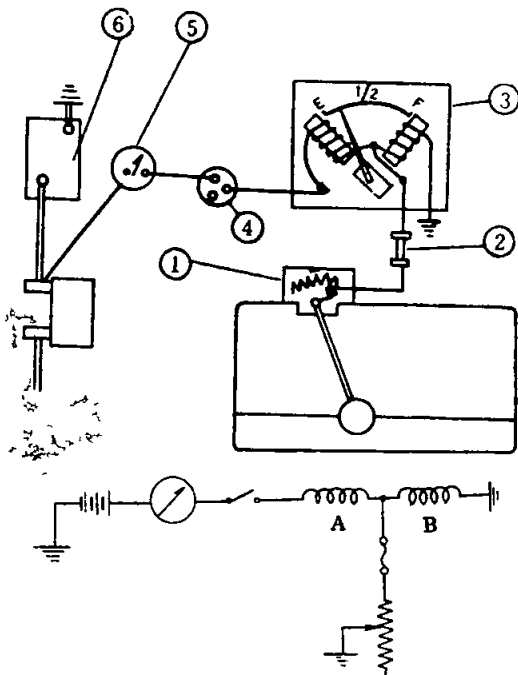


Fig. 3 Wiring of Fuel Gauge

- (1) Unit gauge
- (2) Fuse
- (3) Fuel gauge
- (4) Ignition switch
- (5) Ammeter
- (6) Battery

If not normal, remove tank unit and adjust the bend of the pipe.

Check to see if the vent hole of the filler cap is clogged with dust and dirt, not supplying air to the tank.

According to the degree of vacuum within the tank, fuel cannot be drawn up even by the operation of fuel pump.

So be sure to clean the air vent of the cap.

If you should lose the cap and substitute a wooden plug for it, a measure which is sometimes witnessed, the condition inside of the tank becomes the same as though it were sealed up. Always use only the standard cap.

## Operation and Repairs of Fuel Gauge

As shown in Fig. 3, the fuel gauge consists of the dash unit and tank unit.

The dash unit, which is installed on the instrument panel, has two coils that cross each other at right angles, whose magnetic forces control the movement of a keeper (iron piece) with a hand (indicator).

On the tank unit, a contact arm slides over a resistance in response to the float level.

As shown in Fig. 3 if the ignition switch is turned on when the tank is empty, electric current will flow from the battery through the ammeter into coil A, and then through the contact arm to the ground.

Coil A is then magnetized, attracts the iron piece, and the indicator points to E.

As the float is raised and the contact arm moves, tank unit increases resistance in the circuit and thus the current which traveled through coil A then flows, this time, both contact arm and coil B, and finally to the ground.

As both A and B coils are so wound as to have their magnetic poles in the same direction, the iron piece will rotate to the direction where the magnetic power of the two coils can be balanced, with the indicator deflecting in the direction of F.

That is, this is a gauge of electric resistance control type, E signifies Empty level and F, Full level.

## Troubles with Fuel Gauge and their Remedies

When something is wrong with the readings of the fuel gauge, first disconnect the wiring at the unit and, turning on the ignition switch, ground and unground the terminal end of the said wiring to the body of the car.

If the indicator of the dash unit swings actively between E and F, the wiring between the dash unit and the said terminal end is in good condition, with the defect existing either in tank unit itself or in poor ground of this unit.

In the test mentioned in the preceding section, if the indicator does not swing but it moves (moves to E) when the dash unit end of the wiring from the tank unit is grounded, the wiring between the dash unit and tank unit is defective.

Therefore rewiring or repairing is required.

If, when indicator fails to swing but sparking is observed when the wiring connecting the battery with the terminal on the dash unit is disconnected at the dash unit end and grounded, it proves the wiring is satisfactory, and the trouble is in the dash unit itself.

If sparking does not occur, the wiring, which is thus indicated to be out of order, should be repaired or replaced.

Incorrect readings of the indicator probably means that the height of the float of the tank unit is in error.

In this case, adjust the height of the float by bending the rod.

Trouble with the unit are difficult to repair so it should be replaced by a new unit

In checking the tank unit, be sure to insert a fuel gauge in the circuit between the battery and the unit.

# FUEL SYSTEM

Specification of carburetor used for G type engine (D3032A-1A)

	Primary	Secondary
Bore dia. mm	30	32
Venturi dia. mm	21-8.8	27-8.8
Main jet	100	170
Main air bleed	60	60
Power jet		40
Slow jet	48	80
Slow air bleed		
First	140	—
Second	140	150
Slow economizer		160
Inlet dia. mm	Inner dia.	75
	Outer dia.	80

Used for H type engine (D3234A-1A)

	Primary	Secondary
Bore dia. mm	32	34
Venturi dia. mm	24-8.8	30-16-8
Main jet	110	180
Main air bleed	60	60
Power jet		70
Slow jet	58	80
Slow air bleed		
First	160	—
Second	150	100
Slow economizer		180
Inlet dia. mm	Inner dia.	75
	Outer dia.	80

# Construction and Function

## CARBURETOR

A dual type carburetor with new mechanism is adopted diagram type operated by negative pressure accordingly high power can be obtained with suction resistance.

Accelerating system is separated from power system to get more sufficient operation of accelerating pump, simultaneously power system is automatically operation by negative pressure responding to the engine load so that the economical fuel consumption will be obtained in high speed or accelerating. The needle valve is located vertically but horizontally for the reliable operation.

### a. Float Chamber

Needle valve is located vertically as mentioned above, accordingly over-flow caused by partial wearing will be prevented.

### b. Choke System

Semi-automatic eccentric choke valve is adopted for only primary barrel and combined with the throttle valve accordingly in case of fully closing of choke valve the throttle valve is little opened for the easy starting.

### c. Slow System

Slow system is almost same with former one, i.e. after passing through the main jet, proper fuel will be ready by slow jet and vaporized with mixing the air coming from 1st slow air-bleed, and the above mixture is properly ready by 2nd jet which is so called slow-economizer, then this mixed fuel will be re-mixed with the air taken in by 2nd slow-air-bleed thus the more sufficient vapour will be gain and injected into slow-port.

### d. Main System

The mixture used in normal condition is mainly provided from primary barrel thus system is just same with former type of dual barrel, i.e. the fuel will be properly prepared by main-jet and mixed with air coming from main-air-bleed. This vaporizable

mixture is inhaled into double venturi by negative pressure and more perfectly vaporized to be led it into the cylinder. But diameter of jet is differed from former one to be matched with performance of engine.

#### e. Accelerating System

Due to adoption of separate type of accelerating system and power valve system instead of unit type, reasonable accelerating system will be given.

The dumper spring is set in the accelerating pump piston which is double unit type. In case that the piston reaches to lower end of cylinder, when pump rod is pushed by pump arm dumper spring is pressed then pump piston will operate up to fully opening of throttle valve. 0.6 mm $\phi$  hole is provided at the top of accelerating nozzle the pump arm have three holes to be get correct amount of gasoline-air mixture caused by engine condition, i.e. the connecting rod should be inserted to inside hole in winter and to outside hole in summer.

#### f. Secondary Barrel

##### Changing to Secondary Side

The throttle valve of secondary barrel will be opened by diaphragm which is operated by negative pressure of venturi. At the most narrow part of venturi placed in lower side of both carburetor (primary & secondary). 1.3 mm $\phi$  intake hole of negative pressure is prepared and from which the passage of negative pressure is led to outside of diaphragm.

The diaphragm is made from rubber being added oil-proof-nylon and fixed to diaphragm rod, other end of the rod is connected to throttle valve of secondary barrel.

On the secondary barrel throttle shaft is eccentrically fixed against the bore so that the throttle valve will be tend to close when negative pressure occurs beneath the valve then the throttle valve entirely closed and results no operation.

After opening the throttle valve on primary barrel and air suction is increased, the negative pressure of venturi is accordingly increased, but no air ventilation to secondary barrel is made and negative pressure at the port of secondary barrel is not down.

Both negative pressure, primary and secondary, should be operated to the diaphragm, accordingly the negative pressure of venturi at primary barrel is not increased until throttle valve of

secondary barrel is operated because the secondary barrel negative pressure port will operate as air bleed. On the other hand the diaphragm will not operate unless regular pressure will be given out to operation of spring at negative pressure side.

The throttle valve on the primary side is largely opened and more air is supplied. Accordingly negative pressure to be effected to the diaphragm will attain beyond the tension of spring and the power against opening the throttle valve, and it results that the diaphragm is pulled to outside, then the throttle valve is open.

When the air flow in the secondary barrel, the air bleed efficiency at the port in most narrow part of venturi tend downward, then the higher negative pressure to the diaphragm is given, accordingly the diaphragm is more pulled to outside and secondary throttle valve is largely opened, finally opened perfectly.

Generally, primary barrel have no resistance up to 50° of valve opening angle and no necessity operate secondary barrel so that the secondary throttle valve will not open due to cam mechanism.

This cam mechanism is explained that the throttle valve arm pin fixed to throttle valve shaft in secondary barrel will be prevented by cam installed at primary throttle valve arm until 50° opening of primary throttle valve is obtained so that the secondary throttle valve cannot open.

The primary throttle valve is more opened, then secondary throttle valve will become free by putting cam off from the pin, accordingly secondary throttle valve will operate freely by diaphragm and fully opening of primary throttle valve will result fully opening of secondary throttle valve.

In this condition, closing the primary throttle valve, the secondary throttle valve is closed by the operation of cam, then negative pressure in manifold is increased and secondary throttle valve is entirely closed, therefore rotation of engine will smoothly reduced.

#### g. Secondary Fuel System

There is a head between the top of nozzle and float chamber, therefore to spout the fuel from the main nozzle secondary throttle valve is, remarkably opened. To adjust this discrepancy of gasoline-air mixture a step port is ready at the top of secondary throttle valve.

This kind of step port was prepared in former type carburetor which is utilized such as choke valve and main nozzle, but this new type carburetor have no auxiliary valve so that the unique step port is necessary.



The fuel in this step system is separated from main system after passing the secondary main jet, properly ready at step jet, vaporized with air from the step air bleed, and reaches to the step port.

The main system is almost same with the system of primary side, and main jet is prepared on the wall of float chamber, it is to say that in case of high speed primary side system is utilized so that the severe operation or bad effect by inclination in sharp turning are out of consideration.

Diameter of bore and venturi are rather enlarged to take in plenty of air because of power barrel.

#### h. Power System

The power valve is in the center of float chamber and the push-spindle connected with piston is just on the power valve.

At the upper side of piston the negative pressure in manifold side is led from the throttle valve.

When the negative pressure attains more than 110 mm of mercury thermometer the push-spindle is lifted by piston beyond the tension of piston spring located between push-spindle and air-horn, accordingly power valve is lifted up by valve spring and the valve comes in contact with valve seat then fuel path is cut off.

When the negative pressure is down to 110 mm, a head of boost valve is pressed by push-spindle which is operated from exceeding spring tension, then the fuel passed between valve and valve seat is properly ready at power jet placed at side wall of valve and meet with fuel in primary main system.

### Idle Adjustment

Idle adjustment is carried out with the throttle adjust screw and the idle adjust screw. The throttle adjust screw adjusts the slow running speed. Screw in to increase speed or turn out to reduce speed. The idle adjust screw adjusts the density of air fuel mixture. Screw in for lean mixture and screw out for rich mixture. Therefore, the idle adjustment is to be done with these two screws in correlation. Too much screw in of idle adjust screw will damage the point of it and cause disorder in idle running. If there is no effect on the engine however screw-in the screw, that is not a normal condition, when it is necessary to check whether or not the slow air bleed is clogged, the slow jet slackens or the fuel level is abnormally high. Do the idle adjustment after the engine warmed up. Adjust the idle running to 600 r. p. m..

## Adjustment of Fuel Level in Carburetor

On the transparent cover of the float chamber drawn is a line marked "LEVEL" which stands for the standard fuel level. The fuel level should agree with this line. The fuel level is adjusted with the adjust shims. That is, remove the float needle valve carrier from outside and adjust the shims at the root of it. Increase or decrease of two shims makes the fuel level up or down about 0.39 inch (1 mm). When the fuel level is wrong, density of the mixture gas will become improper and the engine will get in disorder.

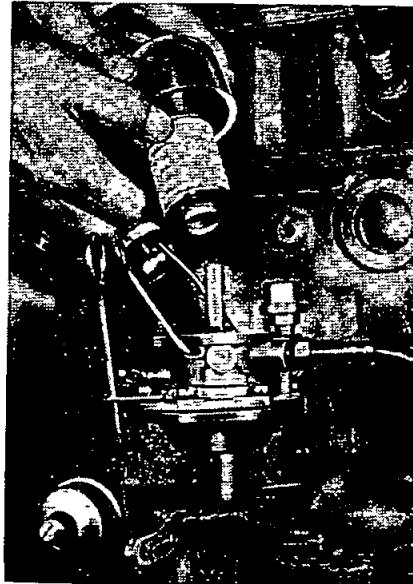
## FUEL STRAINER AND FUEL PUMP

Newly designed, unitizing with the strainer. Remove the glass bowl by slackening the nut on the top to clean the interior. Remove the drain cock to eliminate deposits at the bottom.

Fuel pump	
Type	Diaphragm
Method driven	Driven by camshaft
Performance	
Out put	Min. 1.5 per minute at cam 1,000 r.p.m.
Max. out let pressure	0.3 kg/cm <sup>2</sup> (4.3 lb/in <sup>2</sup> )

The fuel pump, which is of the diaphragm type, is mechanically driven by the eccentric part of the camshaft of the engine.

It draws gasoline from the tank and delivers it under pressure to the carburetor.



Fuel pump & fuel  
strainer ass'y

The fuel pump, which is of the diaphragm type, is mechanically driven by the eccentric part of the camshaft of the engine.

It draws gasoline from the tank and delivers it under pressure to the carburetor.

Even when the engine is not running, fuel can be delivered under pressure by moving the hand primer up and down.

By the rotation of camshaft, rocker arm is pushed and pull rod of diaphragm is pulled down.

At the same time, diaphragm goes down against diaphragm spring and then is pushed up again by its spring.

By the movements of the diaphragm and functioning of the valves at the inlet and outlet of the pump chamber, gasoline is drawn up from the tank to the carburetor.

If the float chamber of the carburetor contains enough gasoline and the needle valve is closed, gasoline is not allowed into the carburetor.

Thus gasoline is stored in the pump chamber and due to its pressure, the diaphragm is kept down and cannot return.

Under this condition, the rocker arm works in vain, as the rod remains low.

The rocker arm spring serves to prevent noise, keeping the rocker arm pushed against the eccentric of the camshaft.

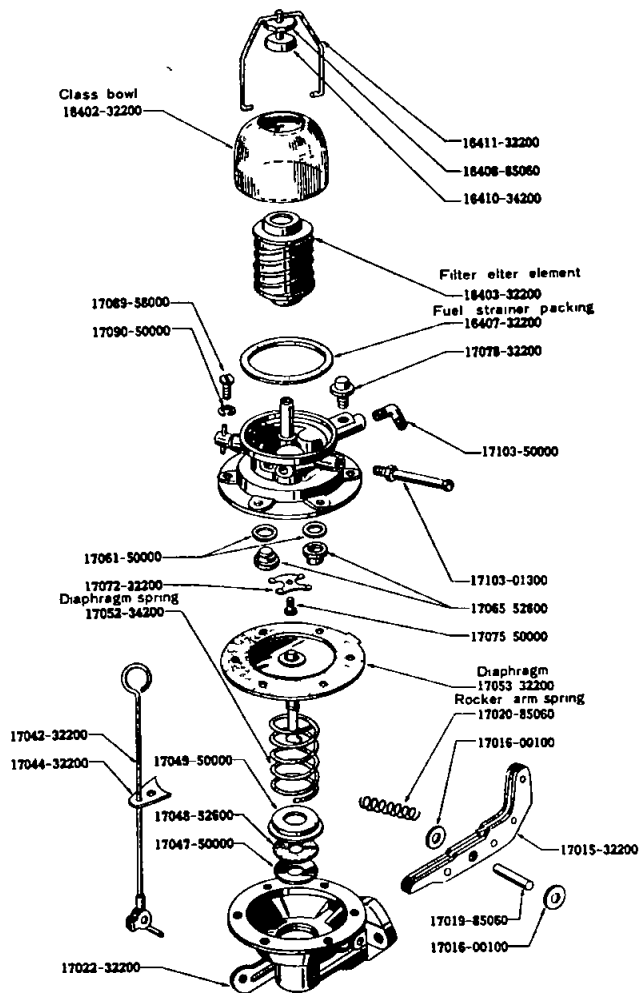


Fig. 3 Components of fuel pump

## Disassembling & Inspection

Checking with fuel pump installed on engine:

Switch off and stop the engine. Disconnect the fuel pipe at the inlet union of the carburetor, and then turn the engine with the crank handle.

Now the gasoline should be ejected vigorously from the tip of the pipe once every two rotations of the crankshaft.

To test the function of the pump alone, operation of the hand primer and checking the fuel ejection is enough.

Removal from engine:

Fuel pump can be easily removed by disconnecting the inlet and outlet unions and loosening the 2 attachment nuts.

Inspection prior to disassembling.

Prior to disassembling of the removed pump, measure the distance between the rocker arm and flange of the lower body by means of a scale and see if the rocker arm, rocker link and pins are worn.

Method of disassembling.

First wipe dirt off the outer surface of the pump and put marks on both the upper and lower bodies, to make their reassembling easy.

It is easily separated into two when the six screws around the upper body are loosened.

Take great care not to damage the diaphragm during this disassembly.

## Checking & Repairs of Parts

Wash the disassembled parts well in gasoline then inspect them.

Replace the diaphragm if any damage, impregnation by gasoline.

Replace a valve assembly if any wear or faulty operations is detected.

Even if repairs are unavoidable required, the limit for repairs of warp or wear of the valve is 0.001 in.

When the surface of the valve seat or valve is found irregular, remove the valve seat of the outlet and dress the surface with a fine oilstone.

In case of irregularity to the seat surface of the inlet valve, which cannot be taken off from the body, recondition it with a cutter and grinding tool.

When the surface of the valve is faulty, place some very fine grinding compound on the surface of a flat piece of glass plate and grind it lightly with the tip of a finger.

The hole of the joint parts of diaphragm shaft and link may be worn to some extent. This is not serious, but when serious eccentric wear, crack, or breakage is found, the part must be replaced.

As a remedial measure, such wear can be compensated for at the time of dismantling and reassembling of the body, by inserting a packing made of thick paper between the lower body and diaphragm to raise the relative position of diaphragm shaft with respect to the lower body.

The rocker arm should be replaced when its contact face with the cam and that with the link and its pin hole are seriously worn.

When its reemployment by reconditioning is unavoidable, add material to the rocker arm and link by welding and finish them with a file, but this cannot last long and is no more than a temporary measure.

Renew the arm pin when it is found worn excessively.

The diaphragm spring, arm spring seldom become faulty, but when weakened, replace them always with standard ones.

If the diaphragm spring is too strong, it results in overflow of the float chamber of the carburetor.

The tension of the spring must not be strengthened or weakened arbitrarily by hand.

Check to see if there is any warp on the joint surfaces of the cap and body, and, after disassembling is over, renew the gasket to keep its airtightness.

## Reassembling & Installing

Employ standard springs for the various uses as stated before.

Install valves precisely for close contact with their respective seats.

In screwing in of upper and lower bodies and diaphragm, fit them together according to the marks which were put before the disassembling and align one screwing hole to its mate, and then screw in at the position where the diaphragm is fully pulled down with the rocker arm pushed towards the side of the body by hand pressure.

Do not screw in tight one by one since it causes warping. Instead, clamp all the screws round loosely and uniformly.

Then tighten them diagonally and lastly retighten all of them in order to make sure.

As a general rule, gaskets should be replaced by new ones.

Installation on the engine is done in the reverse order to that for disassembly

Be sure to set the rocker arm so that it is contacting the eccentric of camshaft properly, not the rear side or to one side. Replace the gasket between the cylinder block and pump with a new, standard one.

## Checking Function

When repairs of the pump is over, or before it is installed on the engine, make a check to see

When a vacuum gauge is connected to the pump inlet port and the pump is mounted on a tester, the rocker arm is activated by the eccentric of the camshaft, Min. 1.2 l per minute at 1,000 rpm. Then the gauge pressure should be 0.22 kg/cm<sup>2</sup> (3.150 lb/in<sup>2</sup>) - 4.50 mm Hg Max. vacuum and even if operation is discontinued, this condition should remain for more than 3 seconds.

When a gauge or tester is not available, test in the following way

Close the inlet port and outlet port with finger tips. Then, after operating the rocker arm several times, suddenly release the fingers. The pump is in good conditions if, 3 to 5 seconds thence, there can be heard strong inlet and outlet noise respectively.

The pump is mechanically fit for use when, by connecting a hose to the inlet port, it is able to draw up gasoline from a height of more than 0.5 m. After installing the pump, test its functions during operation.

(A) Connect the gasoline pipe on the inlet post side only. Leave that on the outlet port side as it is, and turn the engine 6 to 7 rotations by means of the crank handle and make sure that there is sure outflow of gasoline from the outlet port.

(B) Connect the gasoline pipe to the outlet port side and tighten all the piping joints. Then turn the engine again several times to see if there is any leakage of air or gasoline from each connection.

# ADJUSTMENT AND INSPECTION OF ENGINE

The engine must always be operated in the best possible condition, and for this purpose, periodic inspection and adjustment must be maintained in a certain order while in use as well as after overhaul.

## Order of Inspection and Adjustmet of Engine

- (1) Check the cooling water water level and extent of filthiness.
- (2) Inspect the battery all connections, level of electrolyte, specific gravity of electrolyte and voltage.
- (3) Inspect the oil amount, filthiness, classification and viscosity.
- (4) Cleaning of spark plugs and adjustment of their gaps.
- (5) Measurement of compression pressure of cylinders.

The standard compression pressure of the engine is approx. 172 lbs. per. sq. in. ( $12.0 \text{ kg/cm}^2$ ) at 350 r. p. m.

Measurement of pressure is made in the following manner (see Fig. 1 ) First, warm up the engine (temperature of cooling water,  $70-80^{\circ}\text{C}$ ) then remove all spark plungs and pull out the throttle knob all the way (that is in the carburetor, the throttle valve and choke valve are fully opened), press a compression gauge against each spark plug hole, and run-

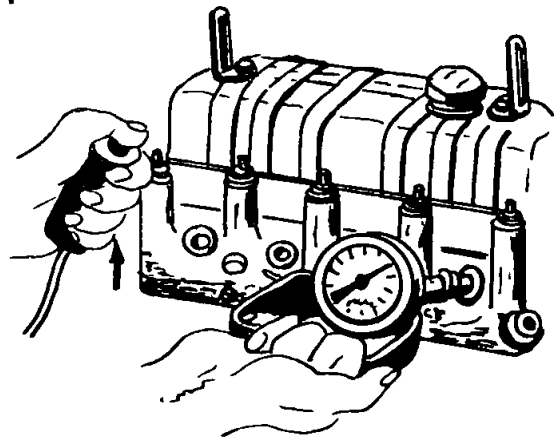


Fig. 1  
Measuring Compression Pressure by Means of a Compression Gauge

ning the starter motor with a fully charged battery, read the maximum pressure obtained within 5-8 rotations of the motor. This measurement must be made as quickly as possible. If the compression pressure of any one cylinder differs by 10 lb./sq. in. or more from that of another, the cause must be investigated.

- (6) Check and adjust the distributor  
If the breaker contact points have defective contact surfaces, dress them and adjust the gap to 0.45-0.55 mm.

Also turn the cam of the distributor clockwise and check to see if the governor can carry out advancing function.

(7) Adjust ignition timing correctly.

By utilizing a power timing light, the function of the governor can be checked together with the ignition timing (illumination of crank pulley will enable to inspect the conditions of running and advancing of the timing.)

(B. T. D C.  $12^{\circ}$  /550 rpm)

(8) Inspection of fuel pump and gasoline strainer.

(9) Adjust the slow setting of carburetor

(10) Checking operation of generator.

Check the generating condition and functioning of the cutout relay by means of indications of the ammeter.

(11) Adjustment of slack in fan belt.

(12) Adjustment of valve tappet clearance

## Diagnosing of Engine by means of Vacuum Gauge and Combustion Tester

In diagnosing the engine, the condition of each cylinder can be assumed by measuring its compression.

For employment of a vacuum gauge, connect it to the engine intake manifold and refer to Fig. 2.

The use of a master motor tester as showing in Fig. 1 is convenient.

When a combustion tester is used, install a special intake (pick-up) in the exhaust tube, and after the engine has been started, analyze by means of a special gauge, the combustion gas which flows through the connecting hose into the tester, and judge the combustion condition according to the mixture ratio of fuel and air. When measurement is to be made in rainy or cold weather, use an auxiliary condenser between the pick up and the meter, otherwise, the excessive moisture in the exhaust gas will damage the functioning of the meter if permitted to enter it.

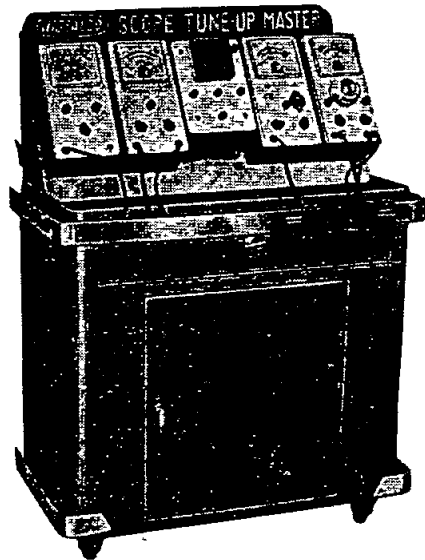


Fig. 2  
Motor Master Tester Available  
for 4, 6 and 8 Cylinder Engine

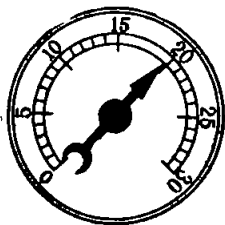


When a tester is to be used, make adjustments according to the following table.

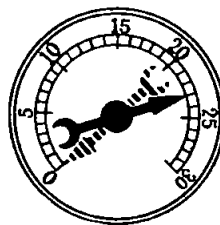
Conditions (Without load)	Suitable Weight Ratio of Mixture
Low Speed Running (600 r. p. m. )	$70 \pm 2\%$
High Speed Running (2,000 r. p. m )	$85 \begin{matrix} + 5 \\ - 2 \end{matrix} \%$

## Engine Trouble Shooting

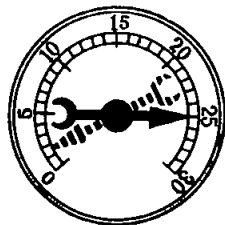
Fig. 3 is intended to be of assistance in the systematic analysis and isolation of symptoms of engine troubles so that the defective points may be accurately traced and economically repaired.



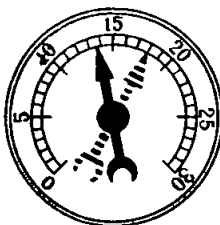
- (1)  
Normal condition  
Settles between 18~20 in



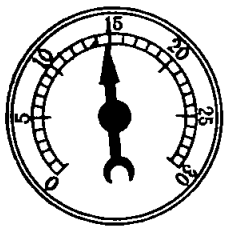
- (4)  
When above (3) condition exists, indicator will swing to 0 in if engine is raced



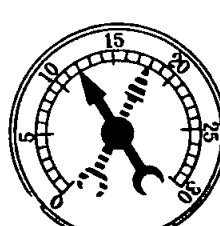
- (2)  
Normal condition  
When indicator fluctuates between a range of 0~25 in as engine is raced, rings and valves are in good conditions



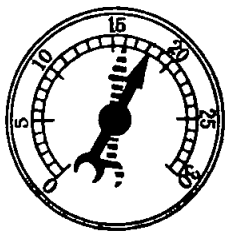
- (5)  
When indicator sometimes drops by 4 in, or so, valve sticking exists



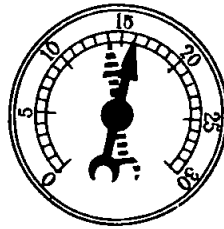
- (3)  
Even if indicator settles, if reading is low rings or oil are in faulty condition.



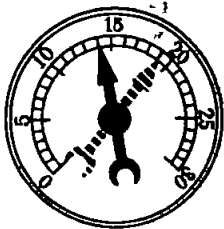
- (6)  
When indicator drops by several inches at certain time valves are burnt



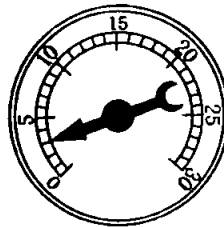
(7)  
When indicator drops by about 2 in., valves leak (Faulty seating of valves.)



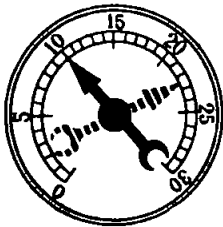
(12)  
When indicator moves slowly between 14~16 in., it is because either electrode gaps of plugs are too narrow, or breaker point is defective



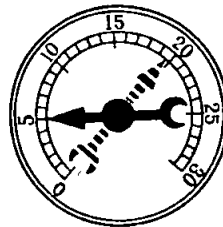
(8)  
When indicator oscillates actively between 14 and 18 in., valve stem guide is worn out



(13)  
When indicator points to 5 in or below, there is leakage at intake-manifold or gasket of carburetor (Faulty clamping of gasket)



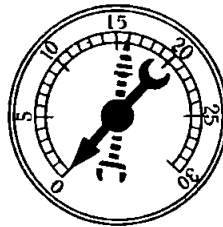
(9)  
When, with a slight speeding up, indicator moves between 10~22 in., and with increase of speed, the range becomes larger, valve springs are weak



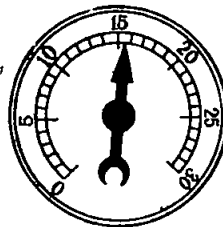
(14)  
When indicator oscillates regularly between 5~19 in., there is leakage at cylinder head gasket (Faulty clamping of gasket)



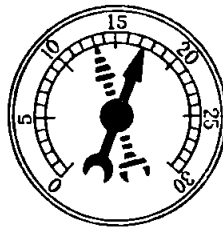
(10)  
When indicator remains still between 8~15 in., it is because either valve timing is retarded or valve clearances are not correct



(15)  
When indicator first rises high, drops down to zero, and then returns to 16 in., muffler is clogged



(11)  
When indicator settles between 14~17 in., ignition timing is retarded



(16)  
When indicator moves slowly between 13~17 in., carburetor is poorly adjusted

Fig 3 Diagnosing engine by means of a vacuum gauge.

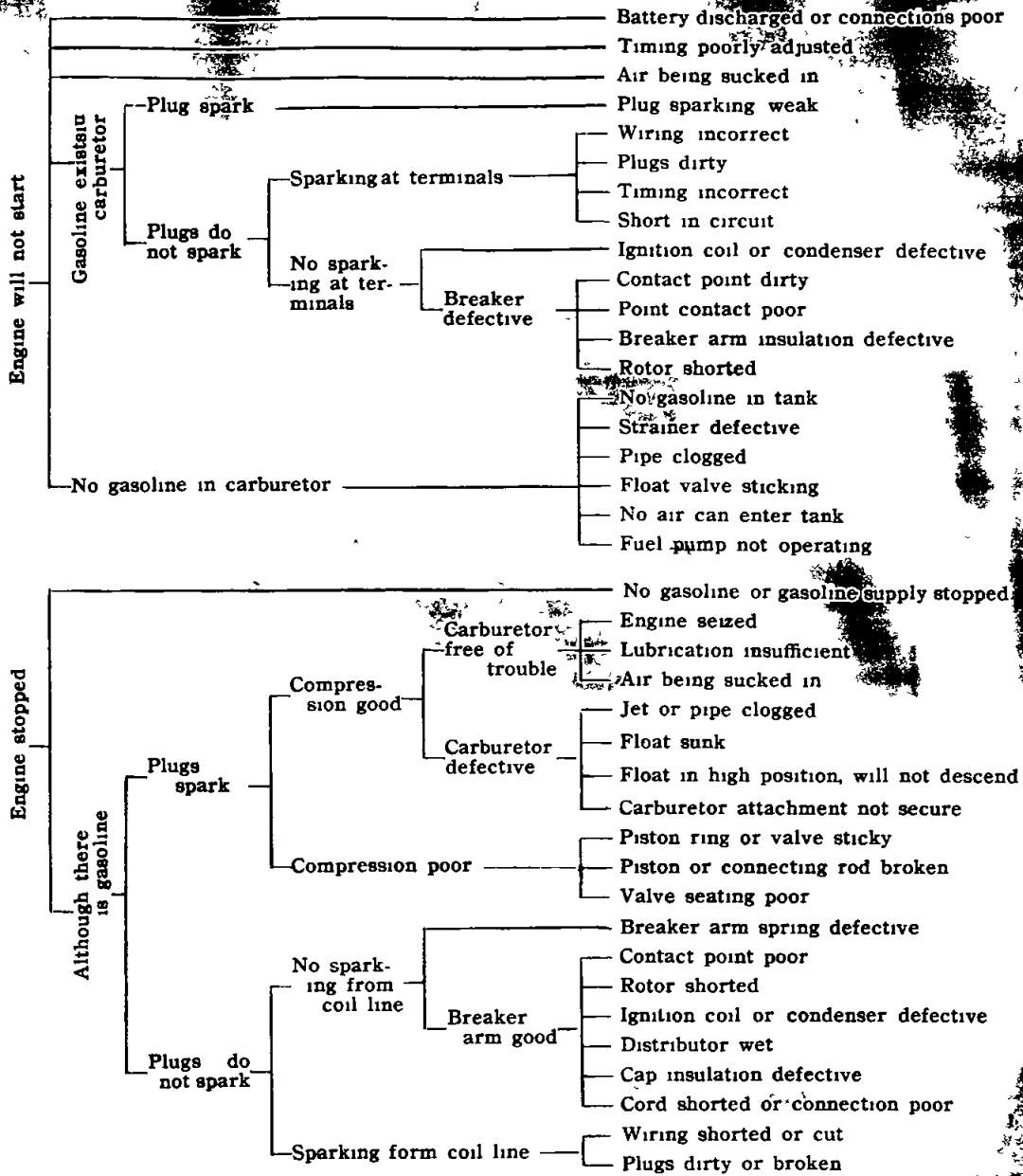


Fig. 4 (A) Trouble shooting chart

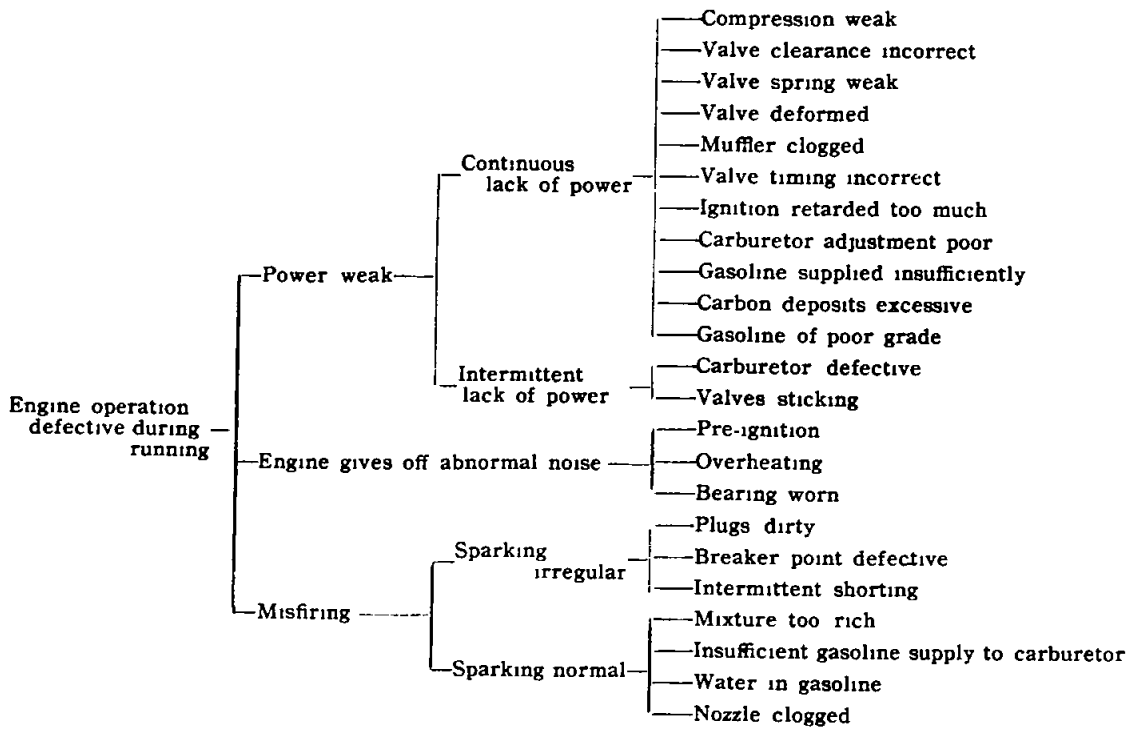


Fig. 4 (B) Trouble shooting chart

# REMOVING & REFITTING OF ENGINE ASSEMBLY

## Operations with the Engine Removed

The following operations are best performed with the engine removed from the car.

Although it may be found possible to carry out certain attentions with the engine in position, it is more convenient to do the work on the bench.

Experience has shown that it is much easier to remove the engine and transmission as a single unit than to detach the engine by itself

To remove the engine and transmission upwards, proceed as follows, Completely drain the cooling system and the transmission, disconnect and remove the battery and its supporting tray.

Remove the upper and lower radiator hoses by undoing the retaining clips.

Disconnect the capacitor lead at the distributor, also the high tension and switch wires at the coil.

Take off the dynamo lead and disconnect the starter motor cable at the motor end

Remove the oil gauge and water, temperature gauge leads from their terminals on the engine.

The throttle and choke controls must be disconnected from the carburetor. Disconnect the fuel pipe from the fuel pump.

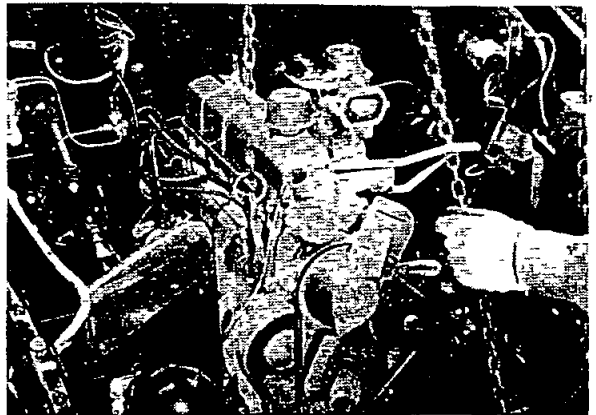
Next, remove the exhaust pipe from the manifold.

From below the vehicle, remove the gear change selector rod from the lever on the transmission casing.

Disconnect the earth strap from the starter motor. Remove the hand brake control rod supporting from transmission.

Disconnect the speedometer cable from the transmission. Uncouple the propeller shaft pinion franges at rear axle and draw the shaft out of the transmission.

To allow the engine and transmission to be drawn forward, the radiator must be removed by undoing the four securing bolts



Engine & Transmission  
assembly being lifted from  
chassis.

# COOLING SYSTEM

## RADIATOR

Type	Maccord closed type
Pressurised	0.3-0.4 kg/cm <sup>2</sup> 0.4-0.6 lb/in <sup>2</sup>
Total capacity of cooling water	8.4 ltr (2.2) US. Gal

## THERMOSTAT

Type	Bellows type
Start to open temperature	72±1.5°C 161.6±3°F
Fully open temperature	80±1.5°C 176±3°F
Valve lift	9.5 mm 0.374 in

An efficient cooling system is of major importance to ensure the satisfactory running of the engine and it is therefore necessary to pay particular attention to its maintenance. Attention is especially drawn to the procedure for winter months, if damage is to be avoided.

## Description

The cooling system is maintained by water pump circulation, combined with an efficient fan cooled radiator and thermostat.

The system is pressurised and the relief valve, incorporated in the radiator filler cap, controls the pressure at approximately 0.4 kg per sq. cm. Do not remove the filler cap if the temperature of the coolant is above boiling point or if the engine is running. Topping-up should only be required occasionally to replace water lost through the overflow pipe. Top-up when the engine is cold, and if possible use clean soft water.

Fill to within 1/2" of the bottom of the filler plug well. Overfilling when the engine is cold may cause water to flow through the overflow pipe. The capacity of the system is approximately 8.4 litres.

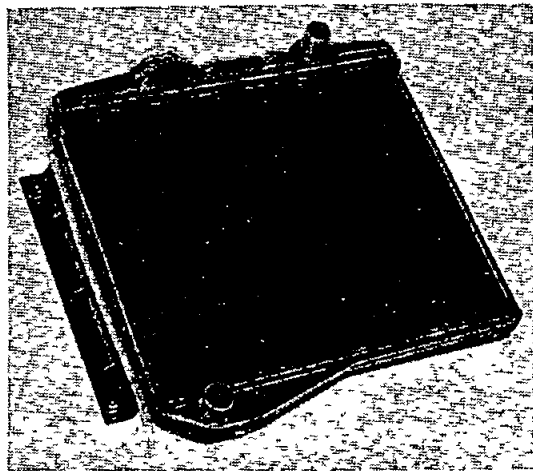


Fig 1 Radiator

## Thermostat

In order to ensure maximum efficiency, it is essential to keep the engine operating temperatures within certain limits. To assist this a bellows type thermostat is fitted, being located in the water outlet at the front of the cylinderhead. The device consists of metallic bellows, filled with a volatile liquid, which controls a mushroom valve. When the engine is cold this valve is closed and on starting the engine the flow of water to the radiator is temporarily restricted.

Due to this, the temperature of the water in the cylinder head and cylinder jackets will quickly rise, thus ensuring rapid warming up. The heat so generated will gradually expand the bellows so opening the valve, and ultimately permitting a full flow of water to the radiator.

The thermostat itself is detachable, therefore, should the occasion arise, it can be removed from its housing and the hose reconnected to avoid laying up the car. Should the thermostat be tight, there are two tapped holes on the top which may be utilized to ease it from casting. When the system has been completely emptied, it is essential to allow air to escape through the thermostat valve and then finally top-up. The thermostat opening is set by the manufacturer and cannot be altered. It opens at a temperature of  $72 \pm 1.5^\circ\text{C}$ . During decarbonising it is policy to test this opening by immersing the thermostat in water raised to the requisite temperature. The valve should open under these conditions, but if it fails to open a new unit should be fitted.

## Overheating

Overheating may be caused by a slack fan belt, excessive carbon deposit in the cylinders, running with the ignition too far retarded, incorrect carburetor adjustment, failure of the water to circulate or loss of water.

## Fan Belt Adjustment

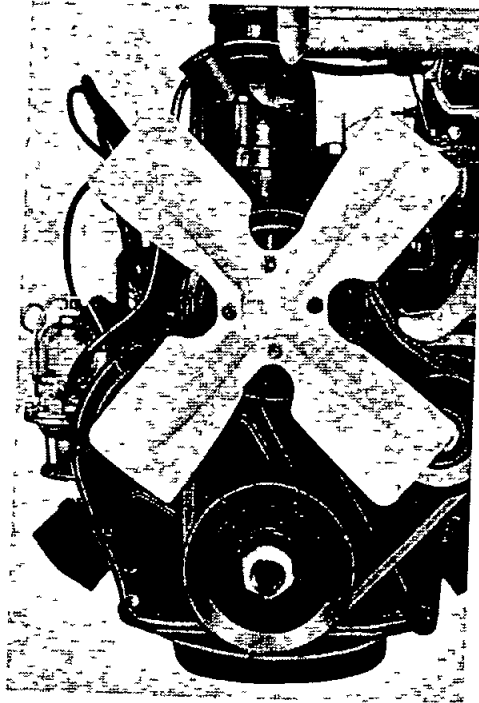
The fan is driven from the crankshaft by a "V" belt, this also driving the dynamo.

A new belt can be fitted by first loosening the clamp bolts (Fig. 2), which hold the dynamo in position, and moving the dynamo towards the engine. Slide the belt over the fan and onto the fan pulley.

Adjustment is then made by bringing the dynamo away from the engine. The belt should be sufficiently tight to prevent slip, yet the belt should have 15 to 20 mm.  $5/8'' - 3/4''$  space between the generator and crankshaft pulley when the midspan is pushed firmly.

As the drive is taken on the "V" of the pulleys it is not necessary to have the fan belt tight, to do so may cause excessive wear to the dynamo and water pump bearings. After the correct tension has been obtained, securely lock the dynamo in position again.

Fig. 2  
Fan belt adjustment

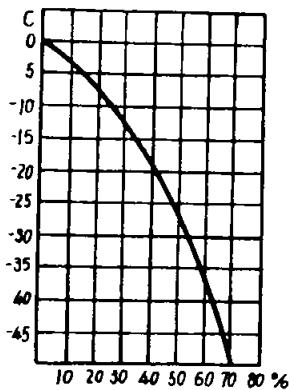


## Frost Precautions

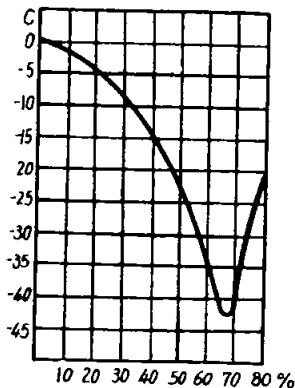
Freezing may occur first at the bottom of the radiator or in the lower hose connections.

Ice in the hose will stop water circulation and may cause boiling. A muff can be used to advantage, but care must be taken not to run with the muff fully closed, or boiling will result. When frost is expected or when the car is to be used in a very low temperature, make sure that the strength of the solution is, in fact, up to the strength advised by the manufacturers. The strength of the solution must be maintained by topping-up with antifreeze solution as necessary. Excessive topping-up with water reduces the degree of protection afforded. Solution must be made up in accordance with instructions applied with the container.

Relations of freezing temperatures of alcohol-water and glycerine mixtures ratio



Alcohol-water (%)



Glycerine-water mixture (%)



Top-up when the system is cold

If the cooling system has to be drained, run the mixture into a clear container and use again

## **Protection by Draining**

On cars where antifreeze is not used the following precautions must be taken during frosty water to obviate any damage due to freezing of the cooling system

When heavy frost is imminent, the cooling system must be completely drained. It is not sufficient merely to cover the radiator and engine with rugs and musfs. There are two drain cocks one on the left hand side of the cylinder block and the other at the base of the radiator block. Both taps must be opened to drain the system and the car must be on level ground while draining.

The drain taps should be tested at frequent intervals by inserting a piece of wire to ensure that they are clear. This should be done immediately the taps are opened, so that any obstruction freed by the wire may be flushed out by the water. The draining should be carried out when the engine is hot.

When completely drained the engine should be run for a timed minute to ensure that all water has been cleaned from the system.

A suitable notice should be then affixed to the radiator, indicating that the water has been drained.

## **Flushing the Radiator**

To ensure efficient circulation of the coolant and to reduce the formation of scale and sediment in the radiator, the system should be periodically flushed with clear running water, preferably before putting in anti-freeze in the winter and again when taking it out in the spring. The water should be allowed to run through until it comes out clear from the drain taps. At intervals a stiff piece of wire should be inserted into the taps during draining to ensure that they are not becoming clogged with sediment.

This method of radiator flushing may serve well, but in cases where the "furring" up is excessive the operator will find it more efficient practice to remove the radiator completely and flush in the reverse way to the flow, turn the radiator upside down and let the water flow in through the bottom hose connection and out of the top connection.

## **WATER PUMP**

After draining the water from the radiator, remove the pump unit from the cylinder block by taking off the fan belt and releasing the setbolts with spring washers and hinge bolts to dynamo.

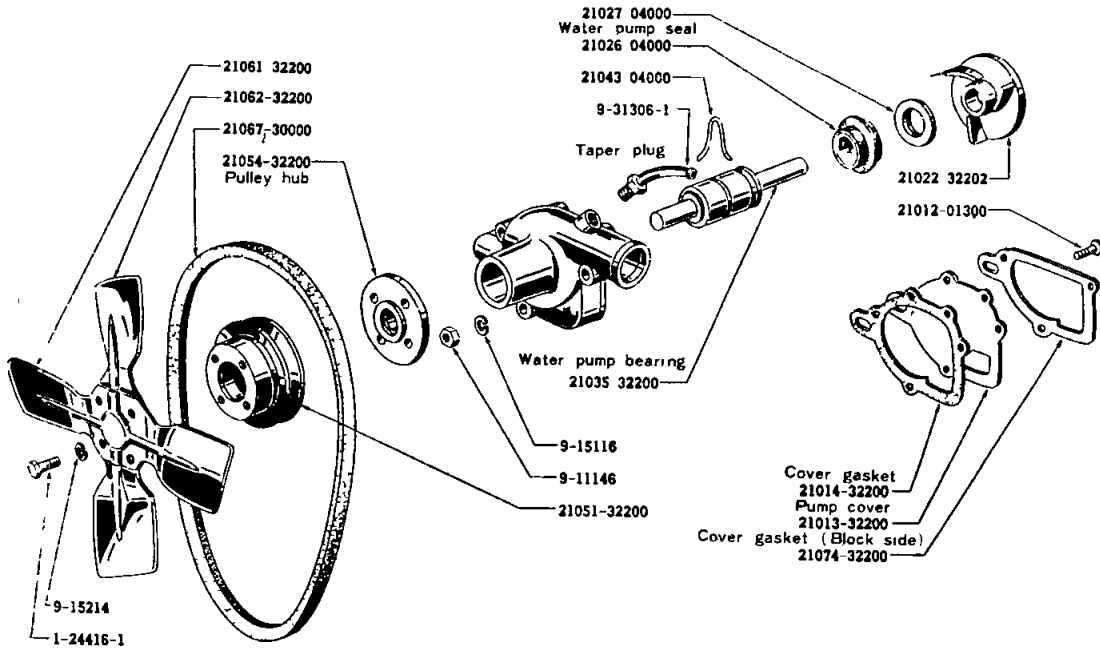


Fig. 3 Water pump

## Removing the pump Shaft Assembly

Disconnect the fan blades, pulley and cover

The shaft and ball bearings is combined with one unit.

Put the pulley hub on the bench.

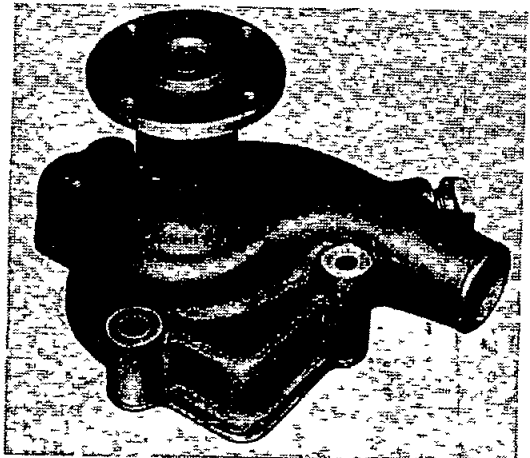
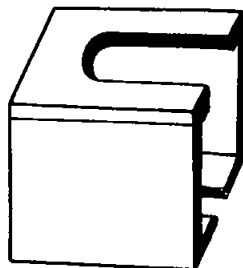
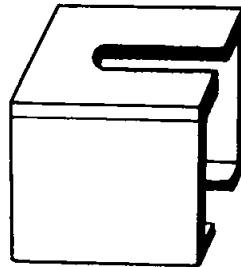
First, press or knock the shaft end with a drift (hard bar) and draw out the pulley hub on the U type bench.

Take out the set pin from the slit which locked the shaft assembly to the pump body (See Fig.)

Next, turn the body upside down and press out the shaft assembly from the vane side on the U type bench.

The shaft and ball bearing assembly can be drew out from the body.

Thus take out the vane, floating seal and seal which remained in the pump body



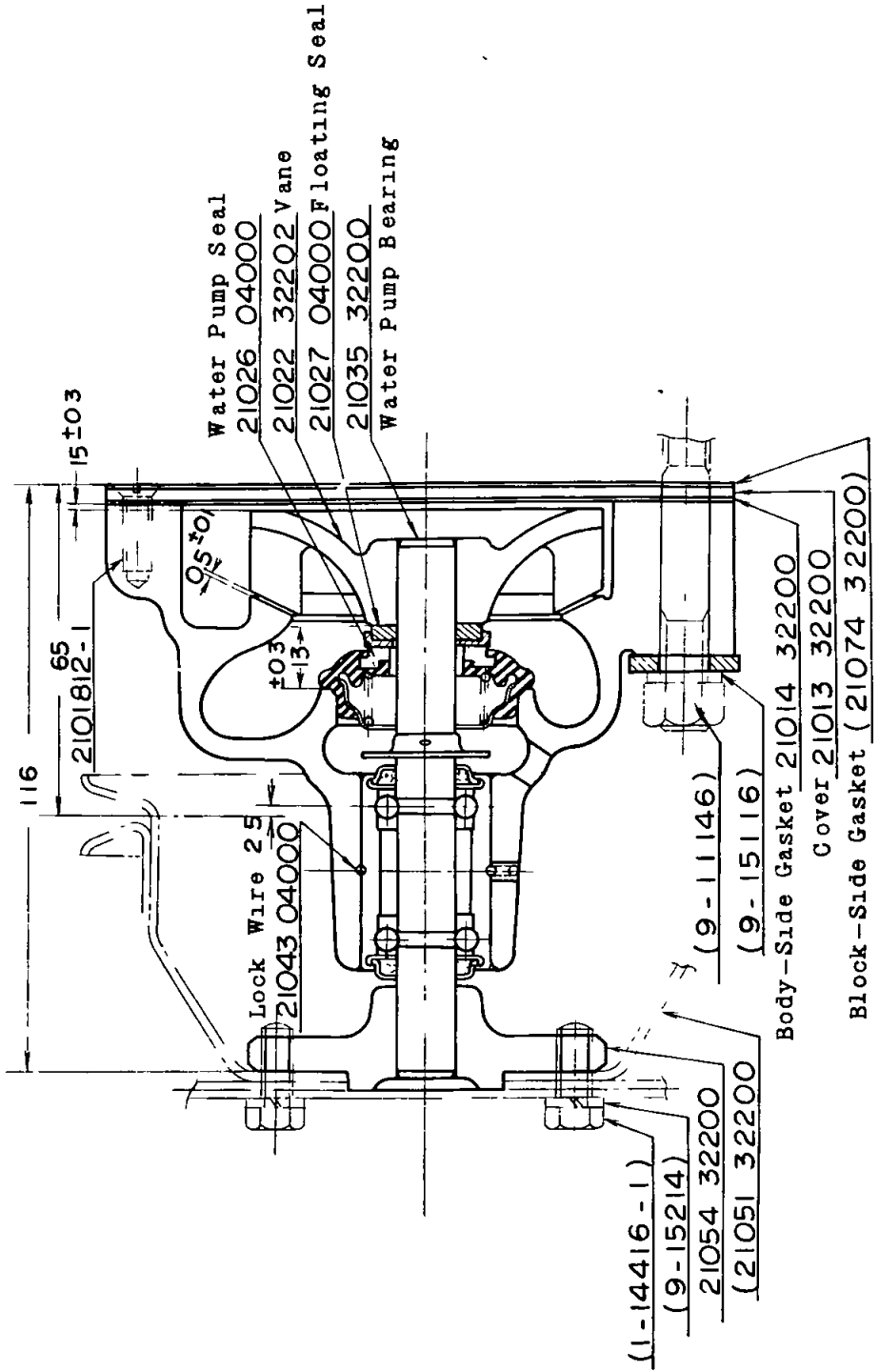


Fig. 5 Sectional View of the Water Pump

## Reassembly

The reassembling of the pump is a reversal of the disassembly procedure, but a care should be taken to ensure that the shaft assembly is fitted correctly for a slit (a hole of set ring) with a groove of shaft so as to insert and set the said ring correctly.

### Adjusting the Clearance the Vane End and Body

First, press down the shaft fitting with a groove line to insert the set pin.

Inserting thickness gauge

(Thickness 0.4-0.5 mm) between the vane edge and inside of the body (See Fig. 5) press down the vane end on the U block bench.

Take out the thickness gauge and find out good condition

Screw up with the cover and cork washer.

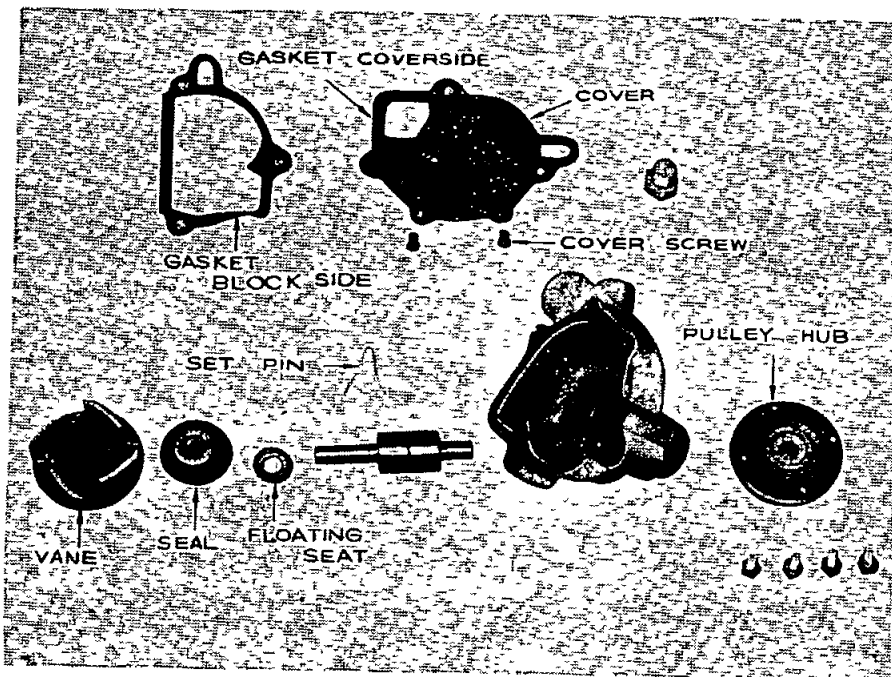


Fig 6

# IGNITION SYSTEM

The ignition system is a system which is necessary for igniting the compressed fuel-air mixture within the engine cylinders.

The electric current from the electric power source (battery and generator) as shown in Fig 1, flows through ammeter (5) and ignition switch (6), into ignition coil (7)

The low-voltage current through the primary coil (14) is interrupted by contact breaker (9) of the distributor. This charges the magnetic field within the ignition coil intermittently, thus inducing high voltage

The high voltage current is distributed by the distributor (10) through the high tension cord (16) to the spark plugs installed in the combustion chambers of the cylinder head. The spark plugs are made to spark to ignite the fuel-air mixture in the cylinders.

To diagnose defects of the ignition system, always have this distribution principle in mind and check the low and high voltage circuits separately.

As shown in Fig. 2 The ignition coil has two coils with primary current which is sent through the primary cord is sent and cut, the magnetic field within the primary coil changes and, by mutual induction, a voltage of 10,000 volts or more is created in the secondary coil

At this moment, self-induction voltage in the primary coil causes sparking at the contact points of the distributor contact breaker resulting in a decrease in the induced voltage of the secondary coil and pitting of the contact points.

Therefore, the primary circuit is provided with condenser to prevent drop of secondary voltage and absorb the sparks at make-and-break contacts.

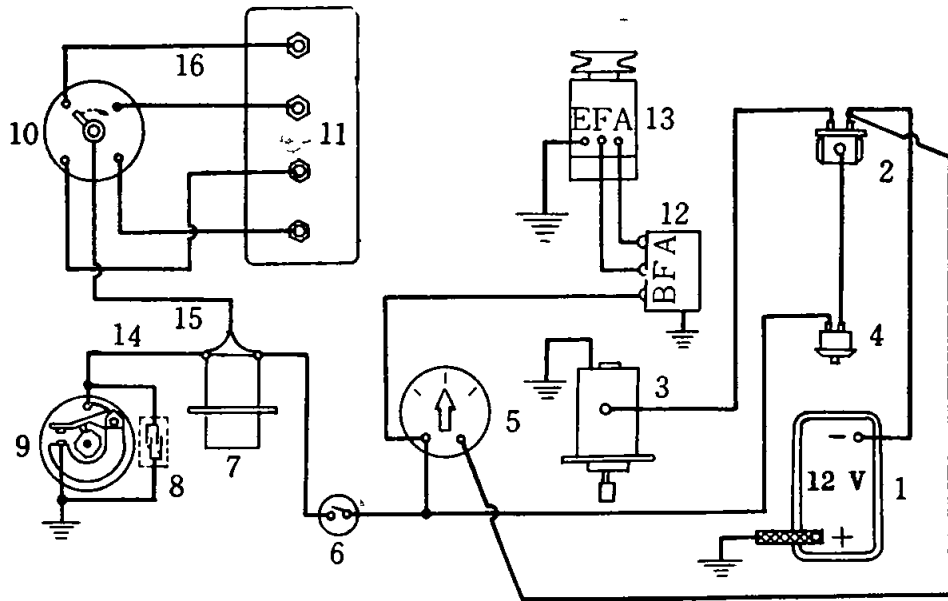
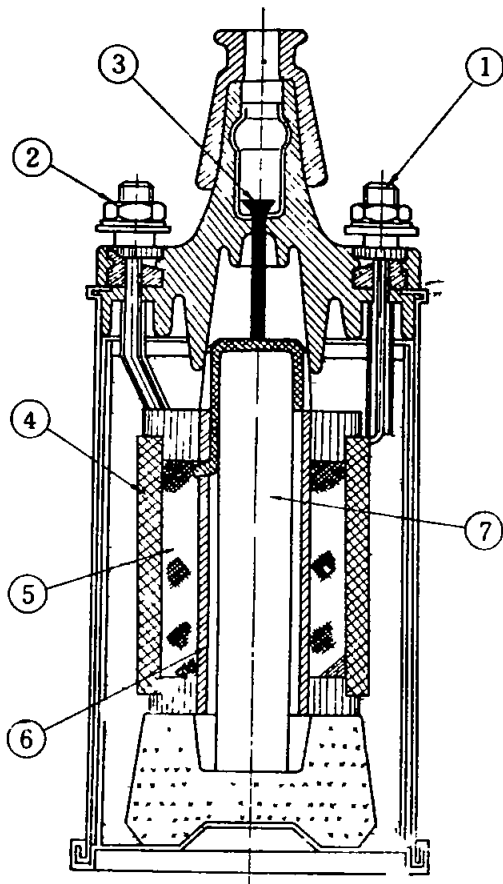


Fig. 1 Wiring diagram of ignition system

- |                     |                        |
|---------------------|------------------------|
| (1) Battery         | (9) Contact point      |
| (2) Magnetic switch | (10) Distributor       |
| (3) Starter motor   | (11) Cylinder head     |
| (4) Starter button  | (12) Voltage regulator |
| (5) Ammeter         | (13) Generator.        |
| (6) Ignition switch | (14) Primary cord      |
| (7) Ignition coil   | (15) Secondary cord    |
| (8) Condenser       | (16) High-tension cord |

## IGNITION COIL

Type	Hitachi CIZ-01 Hanshin HU-13C
Primary voltage	12 volts
Primary current	1.8 amperes Check cause if current is less than one ampere or more than three amperes.
Gap test	7 mm (0.275 in) or more at 1800 rpm 80°C temperature of coil.



- (1) Primary cord terminal
- (2) Primary cord terminal
- (3) Secondary cord terminal
- (4) Primary coil
- (5) Secondary coil
- (6) Core (iron)
- (7)

Fig 2 Section of ignition coil

## Inspection

Most troubles with the ignition coil can be attributed to short-circuit of primary or secondary coils caused by their defective insulation, overheating, or interior damage

With such a faulty ignition coil, it does not generate sufficient secondary voltage, and the engine will misfire.

But as repairs of troubles are very difficult, except in cleaning terminal connection, replace a defective ignition coil.

Check of functioning of coil

Remove the cap of the distributor and turn the crankshaft until the contact point of the contact arm closes

Then switch on the ignition switch, draw out the secondary cord from the central electrode on the distributor cap and, holding its tip about 6 mm away from a metal portion, of the engine, open and close the point by moving the contact arm by hand.

If bluish white and strong sparks are created between the tip of the cord and the metal portion, the coil may be considered to be all right.

When the sparks are feeble and reddish, or when sparking does not take place unless the gap with the metal portion is extremely reduced, the coil must be defective.

Since these are cases when the condenser and ignition switch are all right, to be exact, employ a coil tester.

To check by means of an ammeter connect the primary coil and battery then measure the current.

If there is no current at all, this signifies a break in the circuit.

In such cases the coil must be renewed.

For thorough inspection, a coil tester should be employed





# GENERATOR & REGURATOR

## Trouble Shooting Generator Equipped with Voltage Regulator

Condition	Location of troubles	Cause of trouble		Remedy	
		Hitachi (ICK-SCRD) (CCA)	Mitsubishi (DF-N) (RH)	Hitachi (ICA-SCRD) (CCA)	Mitsubishi (DF-N) (RH)
Insufficient charging	Wiring	1. Wiring almost broken or grounded. 2. Loose terminal, defective ground	Same as at left	1. Replace wiring or repair grounded part 2. Tighten terminal securely, or correct ground	Same as at left
	Regulator	1. Voltage regulator voltage too low 2. Resistance in voltage regulator shorted	1. Constant voltage relay operates at low voltage	1. Adjust by turning "P" screw 2. Replace resistance (Temperature stabilizer 7 ohms, stabilizer 25 ohms)	1. Re-adjust
	Cut-out relay	1. Cut-out relay points dirty or damaged	Same as at left	1. Dress point with sandpaper	Same as at left
	Generator	1. Commutator surface dirty or damaged 2. Poor brush contact 3. Armature field coil shorted, broken wire	Same as at left	1. Dress with sandpaper and clean off oil 2. Reseat or replace brush 3. Repair or replace	Same as at left
Not charging or unstable charging	Wiring	1. Wiring terminal loose or disconnected 2. Wiring broken or shorted	Same as at left	1. Re-tighten 2. Replace wiring	Same as at left
	Regulator	1. Coil, lead wires shorted or broken 2. Carbon disc damaged	1. Constant voltage relay operates at low voltage	1. Repair or replace 2. Replace carbon disc	1. Re-adjust
	Cut-out relay	1. Cut-out relay will not close or points vibrate	1. Charging switch relay cuts in at high voltage 2. Voltage coil of charging current switch relay is broken	1. Adjust cut-in voltage or replace the cut-out relay	1. Re-adjust 2. Replace charging current switch relay.
	Generator	1. Short or broken wire in armature field coil 2. Poor brush contact	Same as at left	1. Repair or replace 2. Repair commutator, reseat, replace brush and brush holder	Same as at left
Overcharging	Wiring	1. Poor grounding	Same as at left	1. Check and correct grounding	Same as at left
	Regulator	1. Voltage regulator voltage too high 2. Broken wire in coil 3. "A" and "B" terminals contacting	1. Constant voltage relay adjusted to operated at too high voltage 2. Broken wire in voltage coil of constant voltage relay 3. "A" and "B" terminals contacting	1. Adjust by loosening "P" screw 2. Replace 3. Repair insulation	1. Re adjust 2. Replace constant voltage relay 3. Repair insulation

Note When charging insufficiently it is necessary to check not only the charging circuit but also to see if the ammeter needle is stuck and to check for broken wire in coil, low fluid level in battery difference in specific gravities, internal short circuit or damaged plates in battery and other causes

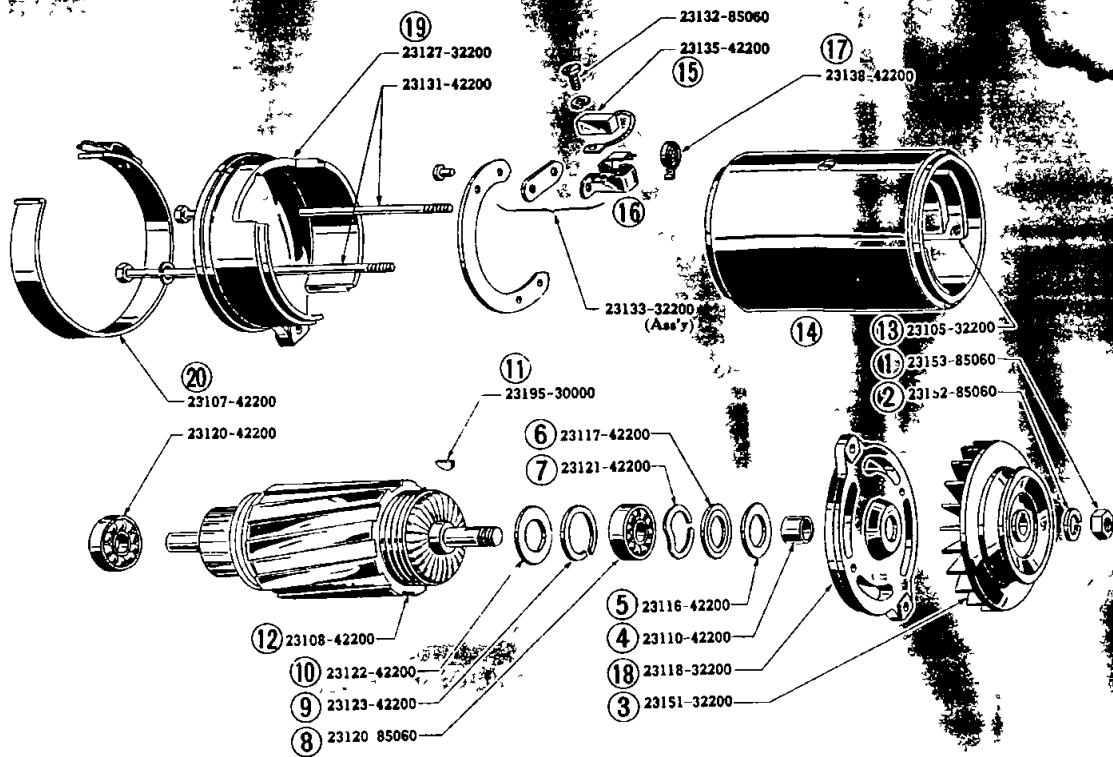


Fig 1 Generator

- |              |                  |                   |
|--------------|------------------|-------------------|
| (1) Nut      | (7) Spring       | (15) Brush        |
| (2) Washer   | (8) Ball bearing | (16) Brush holder |
| (3) Pulley   | (9) Clip         | (17) Brush spring |
| (4) Spacer   | (10) Oil cover   | (18) Front cover  |
| (5) Packing  | (11) Key         | (19) Rear cover   |
| (6) Retainer | (12) Armature    | (20) Brush cover  |
|              | (13) Filed coil  |                   |
|              | (14) Yoke ass'y  |                   |

# GENERATOR

Type	G123-03
Voltage	12 volts
Out put	300 watt (2500 rpm)
Length of brush	20 mm (0.78 in)
Outer diameter of commutator	45 mm (1.77 in)
Rotation ratio to crankshaft pully	1.46 : 1

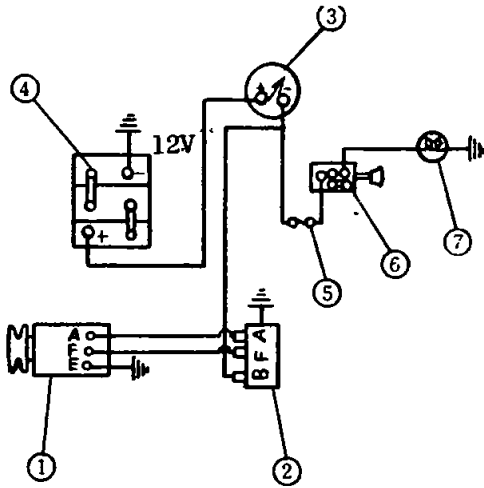


Fig. 2 Diagram of generating system

- (1) Generator
- (2) Voltage regulator
- (3) Ammeter
- (4) Battery
- (5) Fuse
- (6) Lighting switch
- (7) Lamp

produces an output conforming to the load. In other words, conforming to the state of battery charge, the charging current is automatically regulated, preventing excessive charging or discharging. When the load is increased suddenly, the output will increase correspondingly so that the life of the battery will be prolonged.

The generator is mounted on the front left side of the engine and is driven by a fan belt at 1.46 times the speed of the crankshaft. As shown in the diagram of the generating system Fig. 2 the generator (-) terminal is grounded to the car body, and the (+) circuit line goes through the voltage regulator and ammeter to charge the battery. The generator is a constant-voltage type equipped with a carbon pile type

The constant-voltage type generator, when charging, maintains a fixed voltage at the generator terminals regardless of the vehicle speed, that is, over a wide range of engine speeds and also

## Generator Construction

As shown in Fig. 3 the generator is flange mounted, pulley driven type, shunt wound, and ventilated by a fan integral with the pulley. It is a so-called enclosed, ventilated type with the brush part covered with an easily removable band to facilitate inspection and cleaning.

## Servicing Generator

Care should be taken to see that the exterior and the interior of the generator always kept clean.

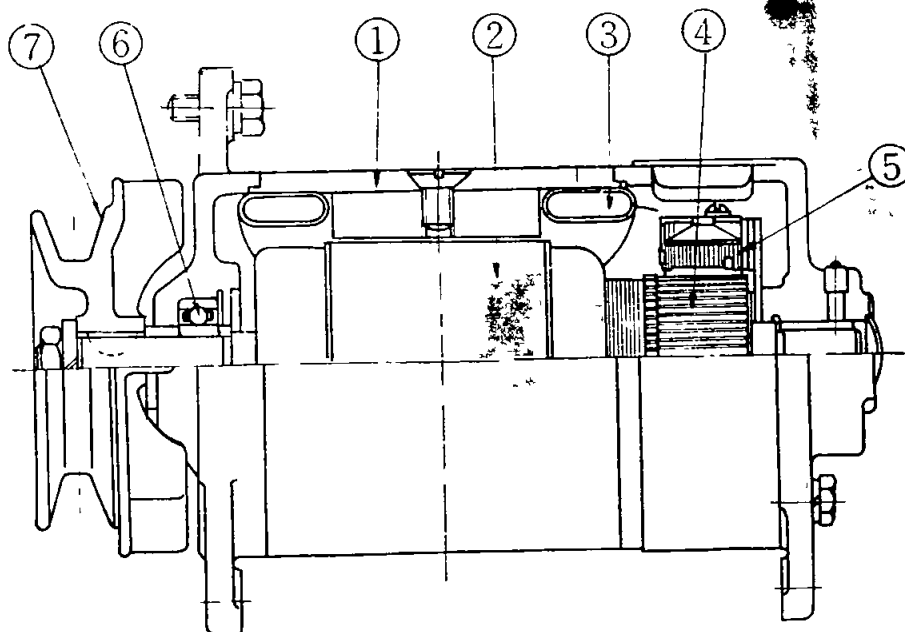


Fig. 3 Generator sectional view

- |                |                   |
|----------------|-------------------|
| (1) Frame      | (5) Brush spring  |
| (2) Armature   | (6) Ball bearings |
| (3) Field coil | (7) Fan pulley    |
| (4) Commutator |                   |

To disassemble, first remove the drive pulley. Then after removing the band cover, press the brush spring back and pull out the brush from the holder. Then by unscrewing the two through-bolts connecting the end covers, the generator can be disassembled as shown in Fig. 3.

All disassembled parts with the exception of the field coil and the armature coil are washed with gasoline before being inspected and reassembled.

When reassembling, the front bearing, being of the ball bearing type, is filled with magneto grease while the rear bearing is lubricated with a few drops of light engine oil.

When installing the generator on to the engine, care should be taken to see that the fan belt is properly tensioned.

After installing, all electrical connections are securely tightened and cleaned.

## Trouble Shooting

Diagnosis through motoring test, before disassembling the generator for inspection, an overall check-up can be made through the motoring test. The constant voltage generator operates together with the voltage regulator, which being a complicated unit, makes it difficult to discover troubles in the generator. Thus, by checking the performance of the generator alone through motoring test makes this an efficient repair operation. For the motoring test, a fully charged battery (12 volts) and about 50 ampere capacity ammeter are required.

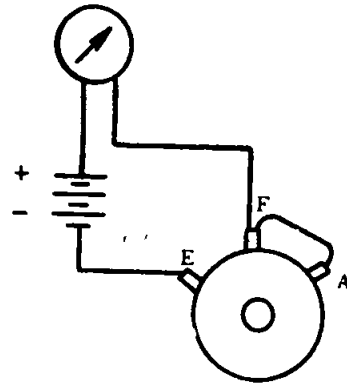


Fig. 4

With the units connected for the tester. The generator is turned as a motor and from the condition of the current and speed, troubles occurring in the generator can be checked.

(A) The generator is in normal condition if the ammeter indicates from 5 to 7 amperes and the generator rotates smoothly with only a faint hum. If the generator fails to rotate, there is trouble in the electrical circuit. The rated currents are 8 amperes at 750 r. p. m.

(B) If the ammeter indicates higher than the rated values, there is a short or grounded connection provided there are no mechanical defects. It should be noted that a fairly large current will flow if the frictional resistance of the rotating parts is great.

If the rotation is irregular, there is a short or ground in the armature,

and if the rotation is slow, the trouble may be due to short or ground in the field coils. Furthermore, if the rotation is normal but the ammeter pointer vibrates exceedingly, the trouble will also be due to short or ground in the interior parts.

(C) If the ammeter indicated below the rated values or if the rotation is uneven or slow, there is a defective connection in the interior parts or a high frictional part. In this case, repairs or replacement of defective parts are made.

Diagnosing troubles with a tester. With the above motoring test, the generator can be checked to see if it is faulty and the troubles approximately located but it would be more advantageous to use a multitype tester shown in Fig 5.

Furthermore, by using a portable dynamo tester, test can easily be made without removing the generator from the car. In making these tests, the A and F terminals of the generator are connected together, the voltmeter is connected between generator A terminal and the ground, and the ammeter is connected between regulator B terminal and the battery. The engine is turned over at medium speed (generator speed about 2,000 rpm). If the ammeter pointer fails to move, or if current is being generated but when the load is increased to 20 amperes, the voltmeter indicated below 13 volts, the generator is defective and requires repairing.

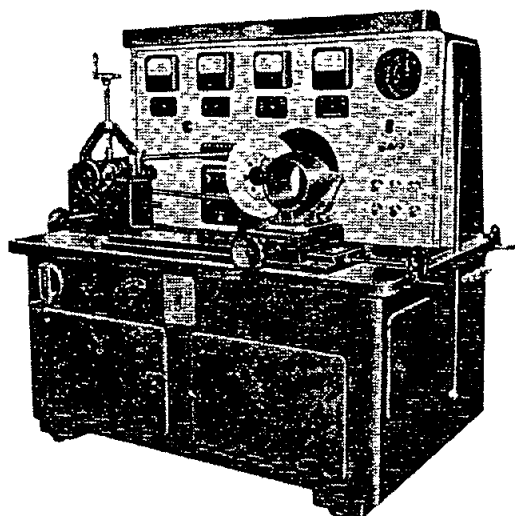


Fig 5  
Generator and Regulator tester

When the generator is disassembled and the parts are to be inspected, the armature growler is used for this purpose in the following manner:

## Testing for Grounding in Field Coil

The ground terminal of the field coil is removed one lead from the growler is grounded while the other lead is contracted with the other field coil terminal.

If the test lamp on the growler lights, the field coil is grounded so that it should be replaced with new coil. If the test lamp fails to light, the field coil is free from grounding.

## **Testing for Shorts in Field Coil**

The field coil is placed in series with an ammeter between the positive and negative terminals of a 12 volt electrical source. If the ammeter shows an exceedingly high reading, the field coil is shorted and should be replaced.

Rated currents are Hitachi 10.5 amperes.

## **Lead Wire Test (Circuit Test)**

To test the lead wire, that is, the wiring from the plus brush holder to the generator A terminal, the two leads from the growler are contacted with both ends of the lead wire. If the test lamp lights, there are no defects but if it fails to light there is a break in the lead wire, which should be replaced. If one test lead is contacted with one end of the lead wire and the other test lead contacted to the body and the test lamp lights, the lead wire is grounded.

## **Plus Brush Test**

One lead from the growler is grounded and the other lead is contacted with the plus brush holder. If the test lamp lights, the brush holder is grounded and should be replaced.

## **Testing for Grounding in Armature**

To test if the armature is grounded or not, one lead from the growler is contacted with the armature shaft and the other lead with the commutator segment. If the test lamp lights, the armature is grounded and should be replaced.

## **Testing for Shorts in Armature**

To test for shorts in armature coil, the armature is placed on top of the growler and with iron piece held over the armature coil, the armature is rotated by hand. If the iron piece is attracted to the armature coil, the armature coil is shorted and should be replaced.

## **Checking Armature Shaft and Bushing**

The clearance between the armature shaft and bearing bushing is checked and if the shaft is found to be worn or badly bent, it should be replaced. If there is excessive looseness between the armature and the core becomes non-uniform during rotation so that not only will the output be reduced and the smoothness of rotation be destroyed but this will cause the shaft to bend and cause the parts to touch. The specifications should be referred to and defective parts should be replaced or repaired.



## Checking Armature Coil

This is a visual check-up. The connection between the armature coil and the commutator are inspected and all loose or defective soldered connections are corrected.

## Checking Commutator

When the commutator becomes worn so that the ovality of 0.4 mm. (difference in diameters between the largest and smallest dimensions) is exceeded or the depth of the mica segments from the surface of the commutator becomes less than the allowable limit of 0.2 mm., corrections should be made. When the commutator surface dirty or rough, or is worn so that it is elliptical or stepped, it will not only result in the brushes contacting poorly and causing decreasing output and further the burning damage on the commutator surface, but will also hasten the wear of the brushes. If the commutator surface is only oxidized, it can be corrected with No. 00 sandpaper but if it is worn as described above, corrections can be made only by supporting both ends of the armature shaft and machining as shown in Fig 6. However, if worn over 3 mm., it should be replaced.

Continued use of a commutator which is worn so that the depth of the segment mica is shallow may result in part of the mica becoming higher than the surface of the commutator. This condition will make the brushes jump and produce sparks to burn and damage the commutator surface.

The depth of the mica is corrected by undercutting, the cuts being carefully made with a hacksaw to the condition shown in Fig. 6. The commutator surface is then finished by smoothing it with sandpaper or commutator stone.

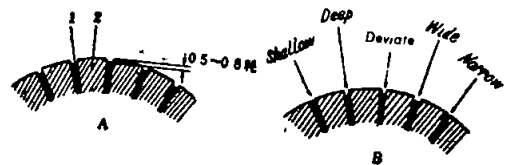


Fig. 6 Undercutting commutator

- A. Correct finish
- B. Incorrect finish
- (1) Mica insulation
- (2) Commutator segment

## Checking Brush and Brush Spring

(A) If the brush does not seat properly against the commutator surface, corrections are made by reseating. However, if the brush is worn beyond the wear limit or is broken, it should be replaced. To reseat the brush, a piece of sandpaper of about No. 150 fineness is wrapped around the commutator and with the brush installed in the holder over the sandpaper, the holder is revolved. For finishing, sandpaper of about No. 320 rating is used. After reseating, it should be blown with compressed air, and, after cleaning the dust off thoroughly, the brush is wiped with a dry cloth.

The max. permissible wear of the brush is 1/3 the length, over which the brush should be replaced.

(B) If the brush spring does not have the proper tension, it should be replaced.

Since the brush spring has considerable effect on the proper contacting between the brush and the commutator, it is necessary to determine the tension by the tester of spring tension with brush installed. A weak spring will increase the electrical resistance, causing sparking and pitting on the commutator, while too strong a spring will hasten wear in the brush and commutator. Thus, when replacing, a good grade brush and correct size spring should be used.

## VOLTAGE REGULATOR

On the voltage regulators is the carbon-pile Hitachi Model R123-02 used Hitachi generator.

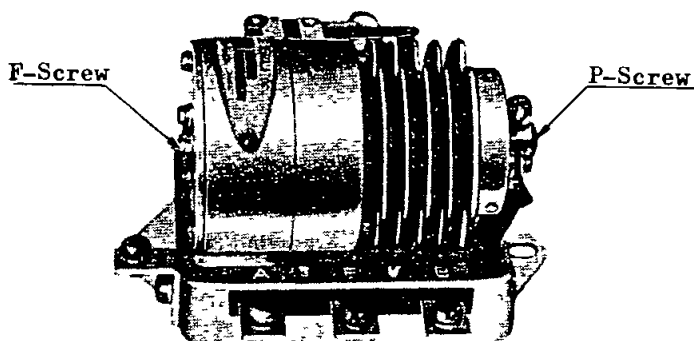


Fig. 1 Carbon Pile Type-Voltage Regulator

Model	R123-02
Type	Carbon Pile
Voltage setting no-load	14.5-15.5 volts (2500 rpm generator)
Cut-in voltage (relay)	12.5-13.5 volts (1300 rpm generator)
Release current	Less than 5 amp

## Construction and Operation

As shown in the above figure, the regulator consists of the carbon pile, magnet coil, moving core spring, and fixed resistances.

The principal part is the carbon pile which consists of several dozen layers of thin carbon discs. By applying pressure to both ends of the carbon pile as shown in Fig. A the resistance will change. The utilization of this characteristic is the carbon pile voltage regulator, the wiring diagram of which is shown in Fig. B.

Without a voltage regulator, the generated voltage will vary with the speed, load and other factors but a carbon pile regulator will maintain constant voltage by the following action.

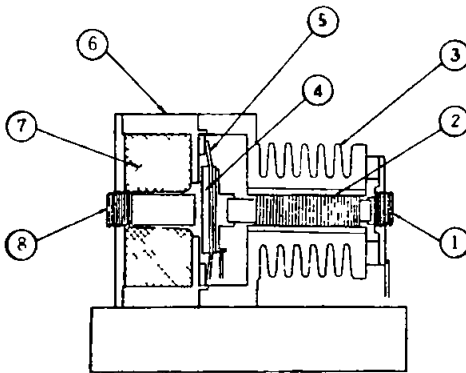


Fig. A.

Sectional view of carbon-pile regulator

- (1) Pile pressure screw
- (2) Carbon pile
- (3) Pile holder
- (4) Moving core
- (5) Compression spring
- (6) Compression spring
- (7) Magnet coil
- (8) Flux adjusting screw

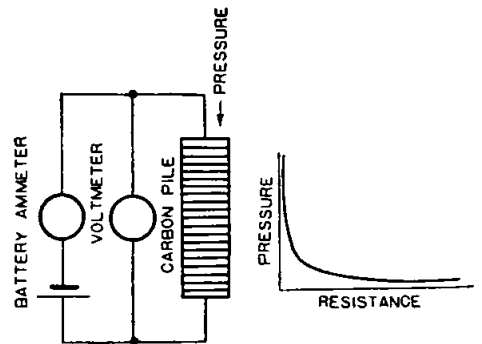


Fig. B.

Characteristics of carbon pile

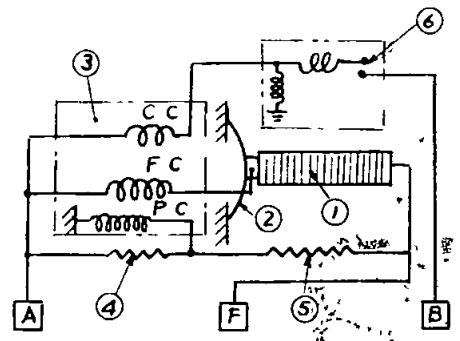


Fig. 2 Wiring diagram

- (1) Carbon pile
- (2) Spring
- (3) Magnet coil
- (4) Temperature compensating resistance
- (5) Stabilizer
- (6) Cut-out relay

When used in conjunction with the generator and the voltage becomes high, the current through the magnet coil increases and makes the attractive force greater. This increases the carbon resistance so that the current through the field coil is decreased and also decreases the generated current. Conversely, when the voltage becomes low, the generated current increases. Thus, by properly matching the carbon pile regulator limits the current by means of the current coil, there is no need of specially providing a current cut-out. Also, the coil in series with the field is for improving the charging characteristics at low speed while the fixed resistances are for preventing variations in characteristics due to temperature changes.

## Wiring Precautions

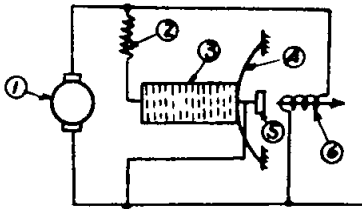


Fig. 3  
Voltage regulating principles

- (1) Generator
- (2) Field coil
- (3) Carbon pile
- (4) Compression spring
- (5) Moving core
- (6) Voltage coil

In connecting up the generator and the voltage regulator, care should be taken to note the signs on the terminals shown in Fig 4 to make the connections tight, and to make sure not to forget to connect the ground terminals. However, caution should be taken not to damage the terminals, screws, and other parts by tightening more than necessary. For wiring, heavy wires are used between A-A and B-B because of large currents flowing between these points and light wire is used between F-F. Care should be taken not to mistake the size of these wires. When the wires have been in service for a long period of time, they are repaired or replaced. In these cases, the same or larger size wires should be used to replace the wires formerly used and wire-to-wire connections should be amply soldered and wound with black tape to preserve the insulation.

## Repair, Adjustment & Inspection

The voltage regulating part of the voltage regulator has been subjected to rigid inspection so that there should be practically no change while in use and no necessity for adjustments. If trouble should occur, however, the regulator should not be touched without previous preparations, or this will, on the contrary, lead to bigger troubles. Before adjusting, the principles outlined above should be thoroughly understood, and, with a voltmeter and other instruments on hand, adjustments should be made correctly.

When adjusting the gap between the adjusting core and the moving core, it is difficult to determine this distance dimensionally so that it is of importance to make this adjustment electrically as shown in Fig. A.

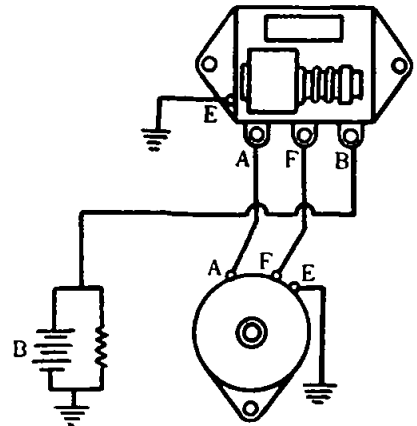


Fig. 4 Wiring diagram

### Adjusting when Voltage Changes after Long Period of Service

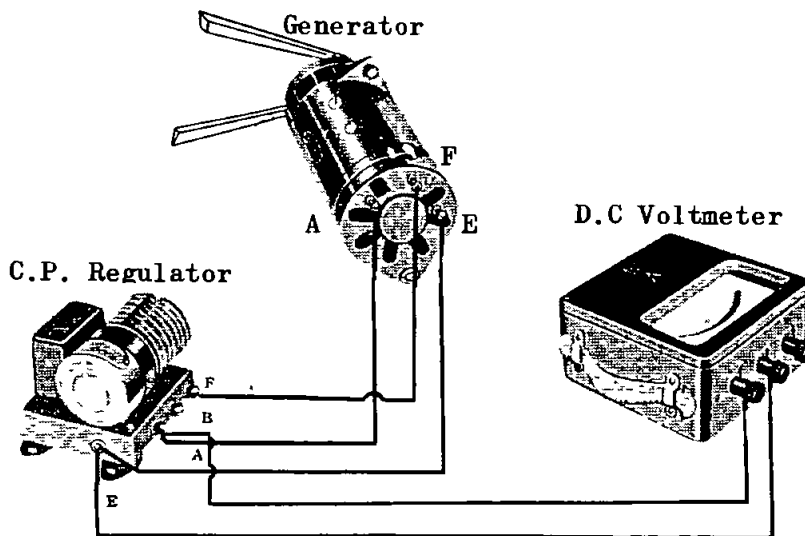


Fig 5

Wiring during adjusting

In this case, adjustments are made through the pile compression screw only. As shown in Fig 5 to the A terminal of the regulator a voltmeter is connected. Terminal B is connected via an ammeter to the circuit switch of the battery and variable resistance.

With the generator running at no load (battery and resistance circuit-cut out) and rated speed (generator, 2,500 rpm, engine, 1,860 rpm), the voltmeter is read.

As shown in Fig 5 tightening the pile compression spring will raise the voltage so that, if the voltage is low, screw in, and, conversely, if the voltage is high, unscrew.

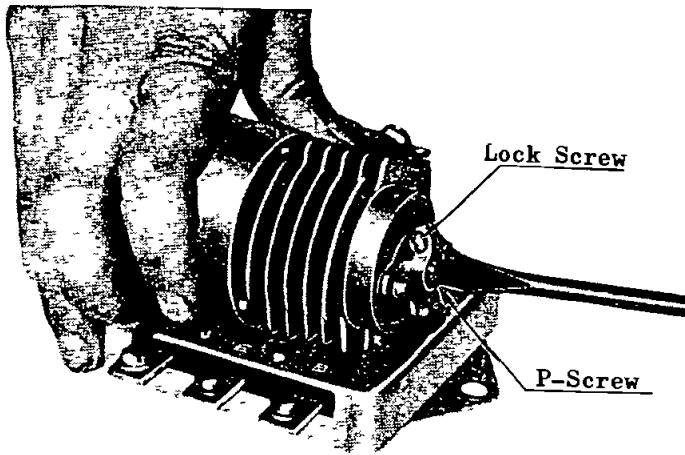


Fig. 6

ly the same. If there two voltages differ considerably, this indicated a resistance in the charging circuit. In this case, check the cut-out relay for such defects as burnt contact points and repair as necessary.

To measure the cut-in voltage and cut-out current, connect the voltmeter as shown with the dotted line in Fig. 5 to terminal B, and make measurements through the circuit of terminal B and A fully-charged battery. Measurement of the output is made by reading the voltmeter and ammeter through the variable resistance circuit with the battery circuit cut out. During the measurement of the no-load regulating voltage, the terminal A voltage and terminal B

## Adjusting Regulator after Reassembly

When reassembling, adjustments are made through the adjusting core and the pile pressure screw. The regulator is connected up to the generator at no-load and revolving at specified speed (2,500 rpm), the adjusting core (F screw) is tightened by turning it in clockwise direction as shown in Fig. 7.

This will cause the voltage to drop at first but it will rise again.

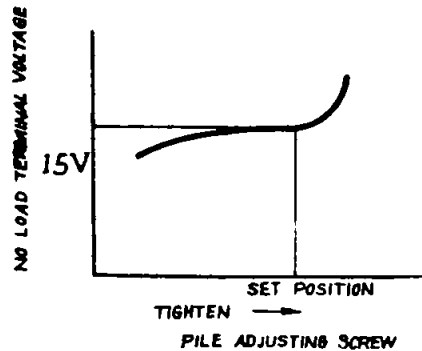


Fig. 8

Position of pile pressure screw and no-load terminal voltage

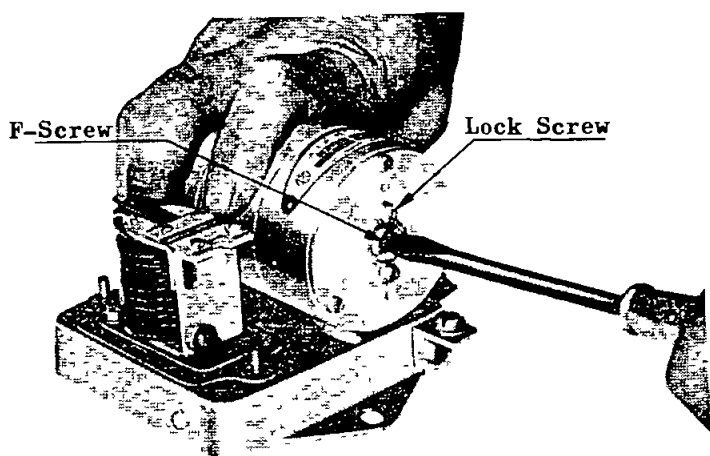


Fig. 8 Adjusting core

The procedure outlined below should be followed in making necessary adjustments from this stage on.

(1) With the connections made as shown in Fig. 9 have the generator at no-load (B terminal disconnected) and rotating at specified speed (2,500 rpm).

(2) Set the pile pressure screw position.

(3) Tighten the adjusting core (F screw) and determine the push-up voltage. If the F screw is tightened beyond the push-up voltage (10.5 volts/2,500 rpm.), the voltage rises extremely fast so that care should be taken to tighten as slowly as possible when near the push-up voltage.

(4) If by adjusting the F screw the specified push-up voltage cannot be obtained but is less than 10.5 volts (Case A<sub>2</sub>), the F screw is unscrewed back nearly to the no-load voltage and the P screw is slightly tightened. If more than 10.5 volts (Case A<sub>1</sub>), the P screw is lightly loosened. Then by following the procedure shown in (1), the push-up voltage is redetermined.

This is due to the fact that at first the gap between the F screw and the moving core to increase the contacting resistance of the pile sheets and lower the terminal voltage. As the F screw is tightened further, the gap to the moving core reaches 0 and the terminal voltage shows a minimum value. With further tightening, the flux adjusting screw being to push the directly and the voltage rises rapidly This as the push-up voltage. The voltage is measured by connecting a voltmeter between the A and E terminals as shown in Fig. 9.

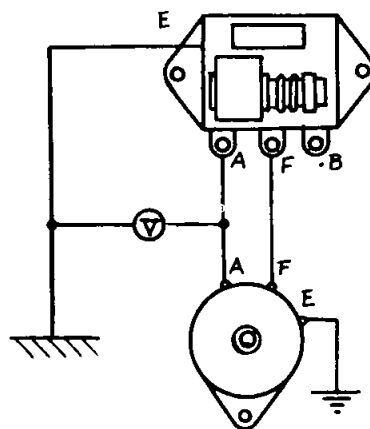


Fig. 9 Wiring hook-up for measuring push-up voltage

(5) When the required voltage is obtained, the P screw is fixed and the pile is given a light shock to settle the piles after which the push-up voltage is rechecked

(6) After rechecking, the F screw is unscrewed until the specified no-load voltage (15-16 volts 2,500 rpm.) is shown. The F screw is then fixed.

(7) After the P and F screws are fixed, the generator is stopped. It is then restarted until it reaches the specified speed and the no-load voltage is checked to see that it has the specified value. It is important that before making this test, the pile be given a light shock in order to bring it to a stable condition.

When the above adjustments have been completed, the output should automatically conform to the specified value. This is checked by rotating the generator at the specified speed and impressing a load.

## Checking Cut-out Relay

The voltage at which the cut-out relay points close is checked. This voltage is determined by slowly increasing the speed of the generator and reading the voltmeter connected as shown in Fig. 10 until the points close. The proper cut-in voltage is from 12.7-13.3 volts at 1,250 rpm. If the voltage checked is found to be too high when the points close, the relay adjusting arm shown in Fig. 10 is lowered to weaken the flat spring, and if too low, the adjusting arm is raised to strengthen the spring. However, it should be noted that the proper gap distance of the relay parts are

Relay point gap	0.9 mm.
-----------------	---------

Arm to core gap (points open)	0.7 - 0.8 mm.
-------------------------------	---------------

Arm to core gap (points closed)	0.4 - 0.5 mm.
---------------------------------	---------------

The cut-out relay points should be inspected about once in every two months. Burnt, pitted, and other poorly contacting points should be dressed with a fine file, No. 000 sandpaper, or point dresser but points found to be badly worn should be replaced.

After dressing, it will be necessary to readjust the point gap to the correct dimension. If the actuating voltage of the cut-out relay is found to be correct but the meter needle vibrates when the engine is idling, the points will be quickly damaged so that in this case, the idling speed should be lowered by adjusting the engine.

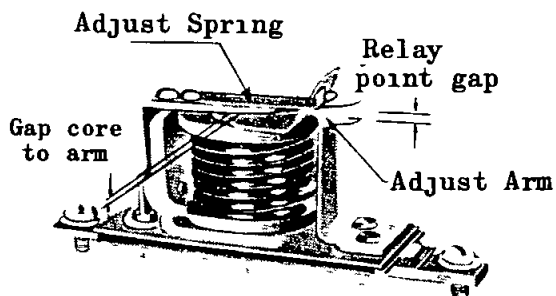


Fig. 10

Cut-out relay Upper left shows cut-out relay winding detail



## Checking through Ammeter Indications

(1) Those familiar with the third brush type when changing over to the pile type may think that there is insufficient charging when the ammeter indication is small during daylight. However, there is no need to worry since the battery is fully charged. Reversely, if after driving for several hours during the day and the ammeter pointer still indicated around 15 amperes on the plug side, it shows trouble. In this case, check the fluid level and specific gravity of the battery. Also check for incorrect wiring and see if any wiring paired immediately.

(2) During night, the ammeter pointer should indicate around 0 when driving at 30 to 40 km. per hour. If the indication is more than minus 10 amperes. check-up should be made in the manner as described in

(3) During the day, even with the battery fully charged, about 30 amperes charging current may be indicated immediately after operating the starting motor. There is no need to worry since this is to restore the temporarily consumed battery and it will return to the normal charging condition within 5 minutes.

## STARTER MOTOR

Model	MA 1.4/12 NRD 9, S114-03
Voltage	12 volts
Horse power	1.4 HP
Torque	1.8 kgm minimum
Brush spring tension	0.9±0.1 kg (1.98±0.2 lb)
Length of brush	14 mm (0.551 in)
Diameter of commutator	34 mm (1.340 in)
Number of pinion gear teeth	13.3
Starting current (voltage)	Less than 500 amps. (9.5 volts.)
Lock torque	Over 0.9 kg-m
Type of pinion gear	Bendex type
Number of tooth on pinion gear	9
Number of tooth on ring gear	120
Amendment limit of short dimension on shaft dia. (pinion side)	0.1 mm. (0.004 in.)

Ammendment limit of short demension of shaft dia. (rear end)	0.1 mm. (0.04 in.)
Gap between shaft and bush (pinion side)	0.038-0.095 mm. (0.0015-0.0038 in.)
Amendment limit dittoed gap	0.02 mm. (0.008 in.)
Gap between shaft and bush (rear end)	0.03-0.76 mm. (0.0012-0.0030 in.)
Amendment limit dittoed gap	0.2 mm. (0.008 in.)
Amendment limit of deflection on shaft	0.1 mm. (0.004 in.)
Amendment limit of short dimension	2 mm. (0.08 in.)
Dittoed degree of real circle	0.05 mm. (0.002 in.)
Dittoed limit of polarized wear	0.4 mm. (0.016 in.)
Bush length:	
Amendment limit	9 mm. (0.36 in.)

## Construction and Operation

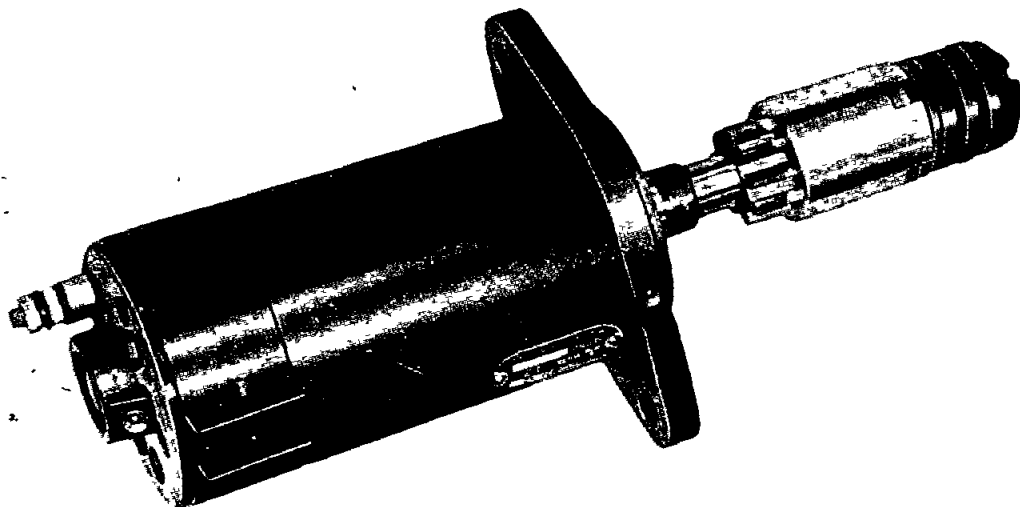


Fig. 1 Starter motor

The starter motor is a 1 4 horsepower sliding inertia type electric motor for use in starting. The motor when mounted on the engine is on the front right side of the transmission with its pinion gear directly opposite to the ring gear. The construction of the starter motor is similar to that of the generator but differs only in that its armature shaft extends out backwards with a pinion group installed on the end as shown in Fig. 2.

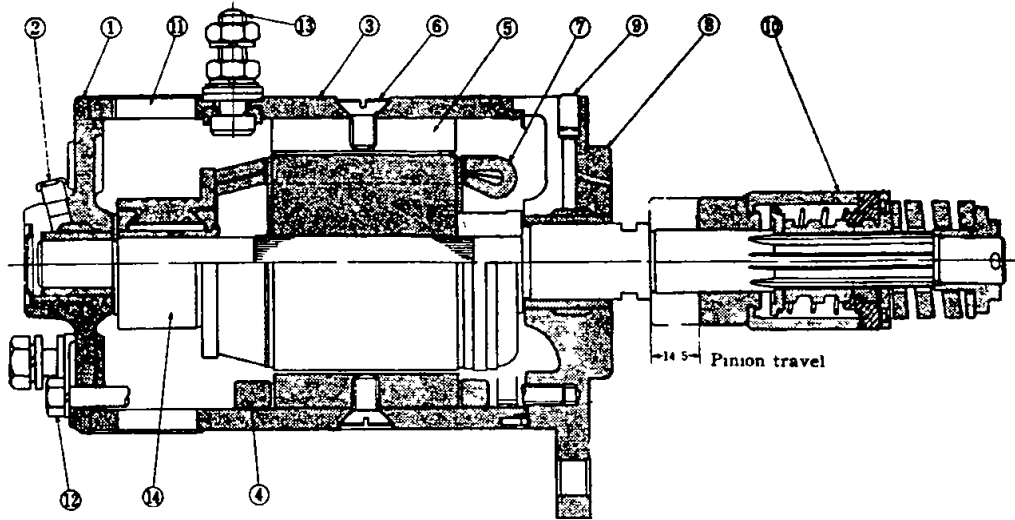


Fig. 2 A sectional view of starter motor

- |                               |                             |
|-------------------------------|-----------------------------|
| (1) Bracket (Commutator side) | (8) Brakcet (Mounting side) |
| (2) Oil cap                   | (9) Nipple                  |
| (3) Yoke                      | (10) Pinion group           |
| (4) Field coil                | (11) Band                   |
| (5) Field core                | (12) Through bolt           |
| (6) Flat head screw           | (13) Terminal bolt          |
| (7) Armature                  | (14) Commutator             |

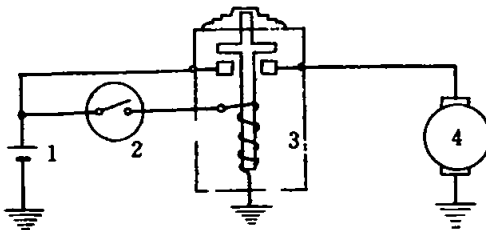


Fig. 3

Starter connection diagram

- |                    |                     |
|--------------------|---------------------|
| (1) Battery        | (3) Magnetic switch |
| (2) Starter button | (4) Starter motor   |

The connection diagram for the starter is shown in Fig. 3. The starter switch is a key type combined with the ignition switch. By turning switch to the right direction, the relay on the magnetic switch moves to permit current to flow to the starter and cause the armature to start turning suddenly. However, the pinion in the pinion group does not turn because of the counter-weight but advances along the screw cut on the pinion shaft and meshed into the

ring gear. After advancing about 14 mm., the pinion completes the meshing into the ring gear and drives it with a powerful torque. The direction in which the pinion moves is from the end of the shaft towards the starter bracket, thus reducing the bending torque. After the engine starts and its speed becomes greater than the no-load speed of the starter, the pinion is kicked back to unmesh and return to its former position.

## **Operational Precautions**

The instructions to be observed when starting the engine are as follows

(1) The starter should be securely mounted on the engine and should not show any looseness.

(2) The starter switch should be operated properly and should be released immediately when the engine starts.

Excepting in extremely cold weather, the engine should normally start within 10 seconds.

(3) The starter switch should not be operated when the engine is running. If the engine fails to start, allow time for the pinion to come to rest before turning the starter switch again.

(4) When the engine fails to start after turning the starter key for over 10 seconds, do not continue turning the key time after time but try to save the battery. In this case, check for the cause of the trouble and correct so that the engine will start.

## **Checking While in Operation**

(1) With a fully charged battery and with the lamps lighted, the starter switch is used. If the lamps become dim., especially when the engine does not start, the current is flowing through the starter motor coil but for some reason the armature is not turning. Careful check should be made since the starter pinion may be locked in the flywheel ring gear and unable to return, a trouble usually caused by turning on the starter while the engine is still running.

(2) When the starter switch is turned up and the starter motor fails to turn although the lights remain bright, the switch should first be checked. If the switch is in satisfactory condition, then the condition of all the terminal and ground connections of the battery, starter switch and starter are checked. If the starter motor runs but its movement is sluggish, it indicates either a high resistance due to loose connection in the starter circuit or a badly discharged battery.

(3) If after the above troubles are corrected and the starter fails to operate occasionally and shows defective performance, it is due to internal defects so that in this case, it should be dismantled and checked.



## ***Dismantling and Disassembling***

(1) The starter can be dismantled easily by removing the two stud nuts mounting the starter on the engine.

(2) The two stay bolts on the starter rear cover (front end when mounted on the engine) are removed.

(3) After removing the band cover, the brushes and lead wires are removed.

(4) By properly protecting and holding the starter body, the armature shaft is pulled out.

(5) The armature and the front cover are taken out together.

(6) To remove the pinion group from the armature shaft, the cotter pin on the end of the shaft is pulled out and by removing the pinion nut, the pinion group is removed.

## ***Inspecting and Repairing Parts***

The same procedure as that for the generator parts is followed, the parts being cleaned and inspected after which determinations are made as to whether they can be reused or if repairs or replacements are necessary.

(1) The pinion is inspected for defects and if the tooth face is worn or the tooth edge is damaged, the pinion should be replaced. Worn or broken teeth will not only make the gear mesh poorly but will hasten the wear on the opposing gear and also, poorly meshing gears will cause bending in the armature shaft. For this last reason, care should be taken, when inspecting, to also check the flywheel and take remedial measures if the ring gear is found worn or damaged. When the pinion is found defective, replace the entire pinion group.

(2) When inspecting the armature, check the armature to core gap, shaft to bushing clearance, bending in shaft, etc., in the same manner as that for the generator and are corrected to the specified limits, or the armature is replaced. Special attention should be given to the clearance between the armature and the core to see that they are not contacting, and corrosion found on the outside surface of the armature or the inner surface of the core should be removed by polishing, and the surfaces painted with rust preventive oil.

(3) The armature is inspected and repaired in accordance with the procedures outlined for the generator. Especially to improve or correct the brush contacting condition, the brushes are reseated. At the same time, the brush and brush spring are checked and are corrected or replaced.

(4) The insulation on the wires are carefully inspected and wires found with weak or damaged insulation should be replaced.

(5) An armature found with one part especially damaged by burning should be strictly tested by the insulation test.

## **Assmbling and Testing Starter**

Reassembling is performed by following the reverse procedure for disassembling. All frictional parts are lubricated with mobile oil (SAE 30) while the bearings are coated with a small amount of grease circuit in the magnetic switch and causes the main circuit  $S_2$  in the magnetic circuit to close. Releasing the starter switch button opens the magnetic circuit which also opens  $S_2$ .

(1) Causes for magnetic switch failing to operate can be divided into electrical and mechanical sources.

Causes for electrical troubles.

(A) Current failure in magnetic circuit.

When the starter switch button is pressed and the current fails to pass through the magnetic circuit, most of the trouble is due to broken soldered connection between the magnetic coil wire and the magnetic switch (+) terminal, and defective ground connection from the coil wire to the magnetic switch body.

(B) Defective contact in main circuit  $S_2$ .

When the magnetic circuit is satisfactory and  $S_2$  is closing but only a small current flowing due to high contact resistance, and the opposite case of switch  $S_1$  opening but  $S_2$  remains closed. In either case, the trouble lies in the faulty moving of the core or roughness of the contacting point surface. Therefore polished the surface well, then the operation will become satisfactory.

Causes for mechanical troubles

Failure to operate is caused in many cases by the guide shaft on the moving core of the magnetic switch main circuit  $S_2$  sticking against the cover hole. Correction can be made in this case by loosening the cover screws (4 pieces) and retightening them so that the shaft moves freely.

(2) Precaution

In removing nuts from the magnetic switch main circuit terminals when installing or removing cables, the lower nut of the double nuts should be kept in a tightened state while unscrewing. If the lower nut is loose, the terminal bolt may turn together and ground the terminal to the cover and cause damage.

## **Starter Troubles, Their Causes and Remedies**

The following is a list of troubles which can be determined from the state the starter is installed on the engine.

(1) Starter fails to turn.

The engine is checked to see if it can be cranked by hand.

If it cannot be cranked, the engine is at fault and should be checked.

If it can be cranked easily, the starter including the wiring should be checked and corrections made accordingly.

Is the battery run down? Check the specific gravity of the battery fluid to see if it is over 1.240 and recharge or replace the battery as found necessary.

All loose battery and ground cables should be cleaned and properly tightened.

(Magneto grease or Gargoyle BRB No 1) All cord connections are carefully tightened and special attention given to the condition of insulation. The assembly check is made by testing the starter as a single unit using a fully charged battery. Tests are made with a starter motor tester or with the apparatus shown in Fig. 4 by which braking torque is measured. In this case, the normal value should be 0.9 m. -kg.

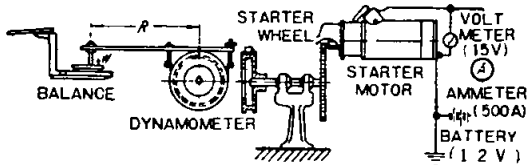


Fig. 4

Torque testing apparatus

To test the starter motor when installed on the engine, the engine is first warmed up. Then with the throttle valve in fully closed position, the starter is actuated.

In addition, if a starter motor tester is used, performance tests can be made easily and accurately.

## Construction of Magnetic Switch and Instructions

The magnetic switch is an apparatus when the engine is being started, serves to close the circuit between the battery and the starter motor, and permits a large current to flow and actuate the starter motor. After starting or when the engine is stopped, the switch serves to keep the circuit open. The principles of operation can be seen from Fig. 4. Closing the starter switch  $S_1$  allows the current to flow through the magnetic.

If there is trouble in the magnetic circuit, it should be corrected.

For improperly contacting starter brushes, the brushes together with the armature should be checked, and corrections or replacement made as found necessary.

If all of the above checks with their corresponding repairs have been made and the starter still fails to operate, the trouble can be assumed to be in the starter itself so that it should be removed from the engine and checked.

This is exceedingly rare but care should be taken to see that the starter pinion is not locked into the flywheel ring gear. Cases like this are usually caused by badly worn gears meshing improperly and if the defect is not too severe, it can be remedied by placing the gear shift lever into fourth speed and rocking the car back and forth to free the gears. If this trouble is frequently repeated, the starter should be dismantled from the engine for checking and repairs.



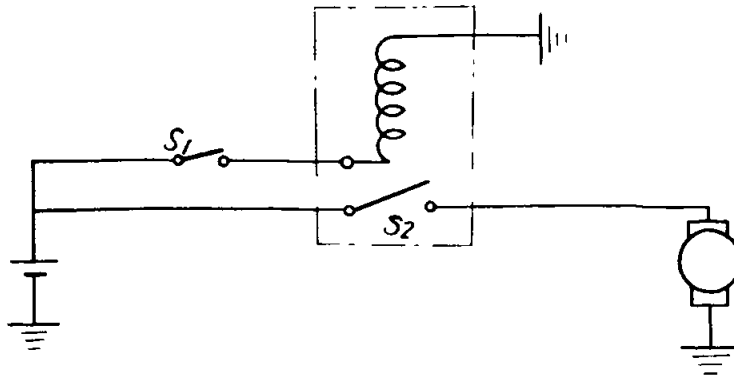


Fig. 5 Magnetic switch

(2) Starter turns but its turning power is weak and fails to start the engine

If the trouble is due to a run down battery, loose terminals, troubles in magnetic switch, worn and sticking brushes, dirty and damaged commutator, etc., the checking, and repairs are made in the same manner as described in the preceding chapters

If the outer surface of the armature is rubbing against the core, the starter should be dismantled, disassembled and repaired

Besides the above, there is the case of the pinion meshing improperly. If the trouble is due to the gear teeth being badly worn, the gears should be replaced but if it is due to the screw guide on the pinion shaft being dirty and not allowing the pinion to advance smoothly and causing improper meshing, the shaft should be cleaned and oiled

(3) Starter exceedingly noisy when in operation

The flywheel ring gear is checked and if the teeth are deformed, they should be repaired or the gear replaced

Rattling noise caused by loose starter mounting bolts are corrected by retightening the bolts.

Noise caused by brushes improperly contacting the armature requires correcting as this condition not only produces noise but will hasten wear on both parts.

Noises made by the armature rubbing against the core while in operation is caused by too large a clearance between the armature shaft and the bushing so the worn parts should be replaced. Wear between the shaft and bushing is due to lack of oil so that attention should be given to proper lubrication. Lubricate once every half year using good grade of machine or mobile oil and lubricate the parts through the oil nipples. The amount of oil required is about 0.5 cc for each bracket

# BATTERY

Voltage	12V		
Capacity	50AM (20H)		
Earth			
Specific gravity of electrolyte	1,280	at 20°C	
Level of electrolyte	10 mm.	Above electrode	

The CEDRIC is equipped with one of the above makes of batteries meeting the specifications of the Japanese Standard Type battery. The interior construction consists of 6 cells each having a terminal voltage of 2 volts, the voltage produced between the (+) and (-) terminals being 12 volts, and when installed on the car, the (-) terminal is made the ground.

The battery when installed on the car is located on the right side of the engine room which makes it easy to inspect when the hood is raised.

However, there is a tendency to be lax in servicing the battery. Improper care will not only shorten the life of the battery itself but will lower the performance of the car so that care should be taken to always maintain the battery in the best of condition.

The construction of the battery together with the chemical action caused by charging and discharging are shown in Fig. 1.

The construction is exceedingly simple, consisting of ebonite cells filled with electrolyte in which are placed chocolate colored positive plates and gray colored negative plates with wooden separators inserted in between the plates.

When a load is placed between the positive and negative terminals, the battery will discharge due to the chemical action of the active substances, i. e., lead dioxide in the positive plates, sponge form lead in the negative plates, and dilute sulphuric acid in the electrolyte, occurring within the battery as shown in Fig. 1. In this case, the lead dioxide and the sponge form lead react with the dilute sulphuric acid, the lead portion and the sulfate portion combining to form a lead sulfate film on the surfaces of both the positive and the negative plates.

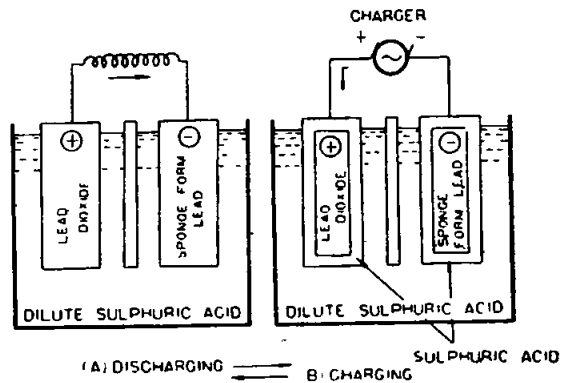


Fig. 1

Chemical action of battery

Thus, as the discharging continues, the sulphuric acid in the electrolyte becomes more dilute, the specific gravity drops, and the discharge capacity becomes less. If, at this time, a charger is placed between the positive and negative terminals and current forced to flow in the opposite direction to that of discharging the lead sulfate covering the plates will be decomposed to increase the density of the dilute sulphuric acid, raise the specific gravity and restore the battery to its former state. The above is an outline of the discharging and charging principles of the battery. It is requested that these principles be thoroughly understood before servicing the battery.

## Servicing

### (1) External inspection

Rust or corrosion on battery terminals

Damage in battery case

Damage in battery posts and improper contact

It is feasible to check the above points without removing the battery from the car. Care should be taken to keep the battery clean at all times so that any abnormal corrosion of the connections, overflowing of the battery fluid, and other visible troubles can be quickly detected and the cause determined.

### (2) Battery electrolyte

Fluid level

Since the battery fluid gradually decreases due to the loss of water caused by evaporation and electrolytic action, the vent plugs in each cell are removed and the fluid level checked. It is important to maintain the fluid level at about 20 to 24 mm above the battery plates. If the fluid level becomes low, the specific gravity will rise due to fluid becoming concentrated, the paste in the exposed part of the plate will become severely concentrated through oxidation, the battery performance will be lowered together with difficulty in recovery and shortening of the battery life. The fluid level should be checked about twice a week during summer (or in hot regions) and about once a week during winter (or in cold regions), and the fluid replenished if found low. If visual caps are used, the fluid can be observed directly from the top without the necessity of removing the vent plugs. As shown in Fig. 2 the plug center will appear colored if the fluid level is normal and appear white if the level is low.

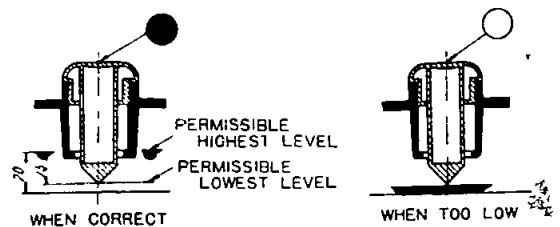


Fig. 2

Checking fluid level through vent plug

### Replenishing fluid.

The battery fluid is replenished with distilled water provided the loss is due to water only and not to battery troubles or overflowing. Dilute sulphuric acid is not used in this case. If distilled water is not obtainable, water from city mains or other clean water may have to be used. As city water, in many cases contains iron or purifying agents, a filter such as puric should be used.

After replenishing the battery fluid, the battery should be charged at least 20 minutes in order to allow the fluid to mix thoroughly. This procedure should be specially observed in cold regions due to the fact that if the replenished fluid is slow to stand without mixing, there is a danger of the water separating to the top and freezing. If the fluid level becomes low due to leakage caused by overflowing from vent plug or from damages in battery, the trouble should be corrected first and the fluid replenished or replaced with dilute sulphuric acid made up to the same specific gravity as that in the cell. When the fluid becomes exceedingly dirty, it should be replaced since there are impurities mixed in the fluid. The density of the replenishing or replacing fluid is determined by the specific gravity determination procedure described in the following chapter. A slightly lower specific gravity of 1.260 is used instead of the normal 1.280 (at 20°C). After replenishing, the battery is wiped to remove all traces of spillage and the vent plug screwed in tightly. The plug is cleaned at this time to allow the gas to escape freely from the vent hole.

## Specific Gravity

The specific gravity of the battery fluid varies with the state of battery charge, and, when the battery is fully charged, the specific gravity should normally be from 1.270 to 1.290 (at 20°C). By measuring the specific gravity of the battery fluid with a hydrometer

The state of battery charge can be determined.

The specific gravity is read at the upper part of the graduation as shown in the illustration. The specific gravity varies with the temperature so that the temperature of the fluid is measured and with the use of the following conversion factor, corrections are made to the condition at 20°C in order to determine the actual state of battery charge. If the specific gravity falls below 1.220, the battery should be charged at once until the fully charged state of 1.280 is reached.

Specific gravity when fully charged

1.280 at 20°C

Temperature conversion factor for 1°C

-0.0007

For each 1°C rise in temperature, the specific gravity decreases 0.0007 and reversely, a drop in temperature increases the specific gravity correspondingly.

The reason for using a fluid having specific gravity of 1.260 for replenishing or replacing as mentioned above is to take into consideration the

fluid becoming concentrated due to charging and lowering of fluid level in making the fully charged specific gravity about 1.280. Even if a specific gravity of 1.280 is shown when the fluid is at the normal level of about 22 mm. above the top of the plates, the fluid level, when it becomes even with the top of the plates, will concentrate the fluid to a specific gravity of over 1.310

If the specific gravity becomes higher than 1.30, caution should be taken since the life of the battery will be shortened rapidly

(3) Terminal voltage at each cell.

By the above method of determining specific gravity, the state of battery charge can be determined, but the following methods can also be used to determine the condition of the battery charge.

An tester is used to determine the voltage drop by contacting both terminals of the cell and permitting a large current to flow through the tester.

A battery tester is used to measure the terminal voltage of each cell. By the values measured, the condition of the battery charge can be determined

A method frequently used to determine the state of battery charge is to place a wire or metal tool across the battery terminals to permit a spark to fly, and making the determination by observing the strength of the spark. This method should absolutely be avoided as there is danger of igniting the gas generated from the battery or nearby combustible fumes. The previously described methods and the following chart should be used instead, to determine the condition of the battery.

Although the internal performance of a battery can be easily determined by making a discharge test with a battery tester, frequent use is not recommended as it will lower the capacity of the battery. It is necessary that tests be made in accordance with the following chart and within 15 seconds.

Terminal voltage	Specific gravity (20°C)	Battery condition
Under 1.75	Under 1.140	Complete discharge
1.80	1.140	Impossible to use
1.85	1.170 - 1.190	1/4 charged
1.95	1.200 - 1.220	1/2 charged
2.00	1.230 - 1.250	3/4 charged
Over 2.10	1.260 - 1.280	Fully charged

## Determining Repairability

The above completes the instructions on correct use and maintenance of the battery. If the battery is overdischarged, the plates inside the cells will become warped and the surface of the plates will be covered with white lead sulphate

This will plug the many small holes in the wooden separators to increase internal resistance and cause the voltage drop which will make recharging difficult. It will be necessary in this case to repair or replace the plates in the battery.

## Charging

Whenever the battery has been repaired, and when the battery fluid has been replaced, and also while the battery is in use and the voltage drops due to large electrical consumption, the generator installed on the car is unable to maintain sufficient charging. In such cases, the battery fluid is replenished or replaced if in faulty condition and the battery charged by connecting it to a battery charger.

### (1) Instructions on normal charging procedures

The fluid level is checked to see that it is about 22 mm. above the top of the plates (on visible type plugs, it should be up to the normal level indication).

Note: The vent plugs on all cells should be removed while charging.

The terminals should be polished to remove all dirt and fluid adhering to the surface.

The (+) of the battery terminal is connected to the (+) direct current terminal of the charger and the (-) terminal of the battery to the (-) terminal of the charger. The charging is made with a current of 6 to 8 amperes.

As the charging progresses, the battery voltage rises so that the charging current begins to decrease while small bubbles appear and the specific gravity starts rising.

If the charging is continued as is, the charging current being small will make the charging time very long so that the voltage should be adjusted from time to time in order to maintain a steady charging current of 6 to 8 amperes. When the charging progresses so that the voltage in each cell becomes higher than 2.5 volts and the specific gravity over 1.280, gas will be given off vigorously and the fluid will present a milky appearance.

When this condition is reached, the charging current is reduced to about 4 amperes and the charging continued until the specific gravity becomes constant. That is, the charging is continued until three consecutive readings of the terminal voltage and the specific gravity (Corrected to temperature) taken every hour shows a constant value, the charging being made by passing a 20-hour rate current through the battery.

If the temperature should rise higher than 45°C during charging, the current is reduced to one-half or the charging is discontinued for a while until the temperature drops.

The above is the constant current charging method generally used. Initial charging is made by using a low current and long charging time but for ordinary recharging, a current described above is used and the charging completed in about 12 to 16 hours.

The point to be observed in charging is determining the time when the charging should be discontinued. The completion time must be such that there is no overcharging or undercharging. If overcharged more than necessary, the charging current will be used up in decomposing the water in the battery fluid, and not only will the loss be great but this will hasten the aging of the plates due to temperature rise. Efficient charging is attained when the charging is made with the least possible amount of gas being generated. Gas begins to be generated at the time the battery voltage begins its sudden rise from around 2.3 to 2.4 volts. Therefore, if the electrical source voltage is maintained at 2.3 to 2.4 volts, the battery voltage will be unable to rise higher and the battery can be charged with the least amount of gas being generated. This is the constant voltage charging method, in which an exceedingly large amount of current flows at the start but as the charging progresses, the current decreases, and, when the battery voltage becomes equal to the electrical source voltage, there will be practically no current flowing. However, to adjust the specific gravity after completing the charge, it is necessary to use the constant current charging for this purpose.

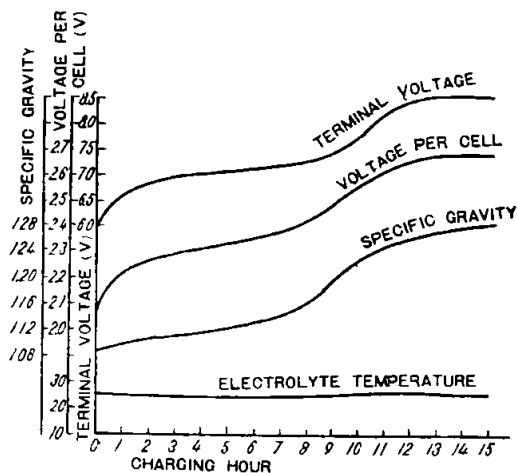


Fig. 3 Constant current charging characteristics

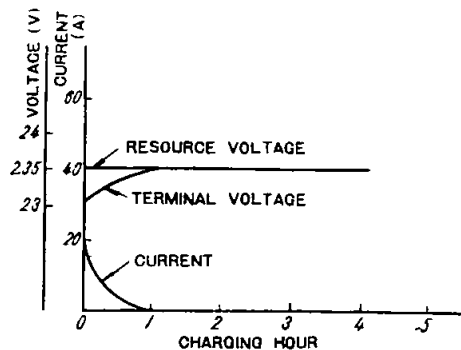


Fig. 4 Constant voltage charging characteristics

(2) Instructions on quick charging

For charging without the necessity of removing the battery from the car and for making the charge in a short time, the quick charger is used. In using the quick charger, there is a tendency to pass a large current to hasten the charging time, but in order to protect the plates and also the life of the battery, the specified current should not be exceeded and the charging current made as small as possible.

## Storing Instructions

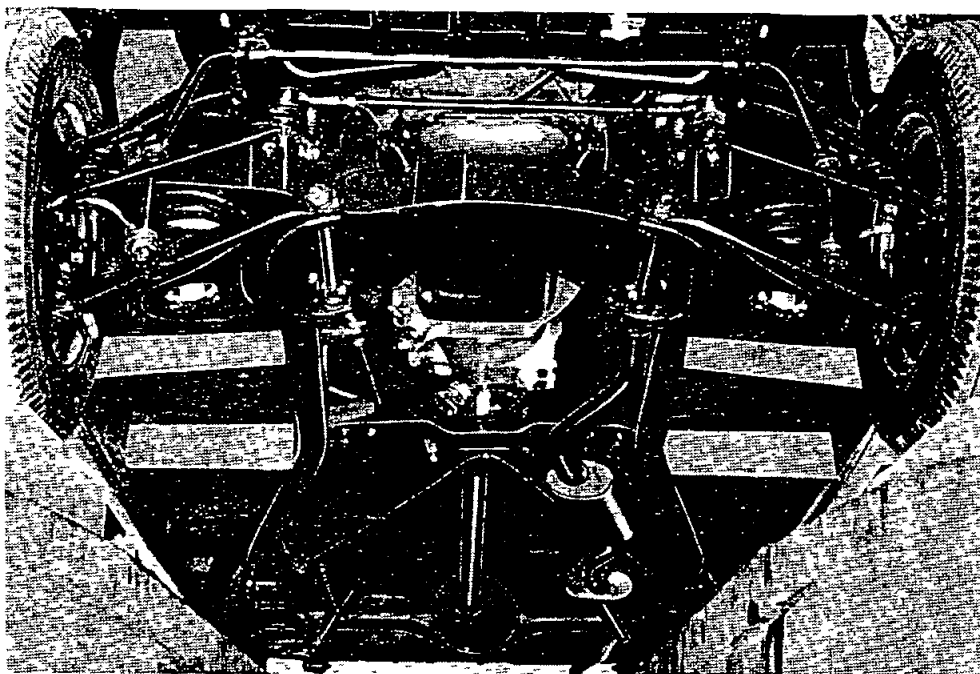
(1) Even if the battery is not being used, it will self discharge. Therefore, a battery which has not been in use for a long period of time should be checked for its state of charge. If the battery is not to be given a full charge at the start and a light maintaining charge every month thereafter.

(2) If the battery is not removed from a car which is to be stored, the ground terminal on the battery should be disconnected in order to prevent discharging and fire hazards.

(3) If the battery alone is to be stored, it should be kept in a cool place and away from direct sunlight.

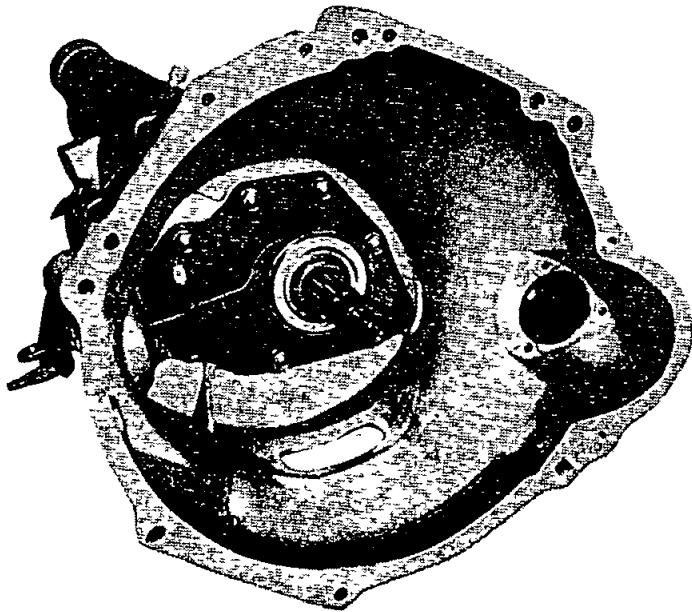
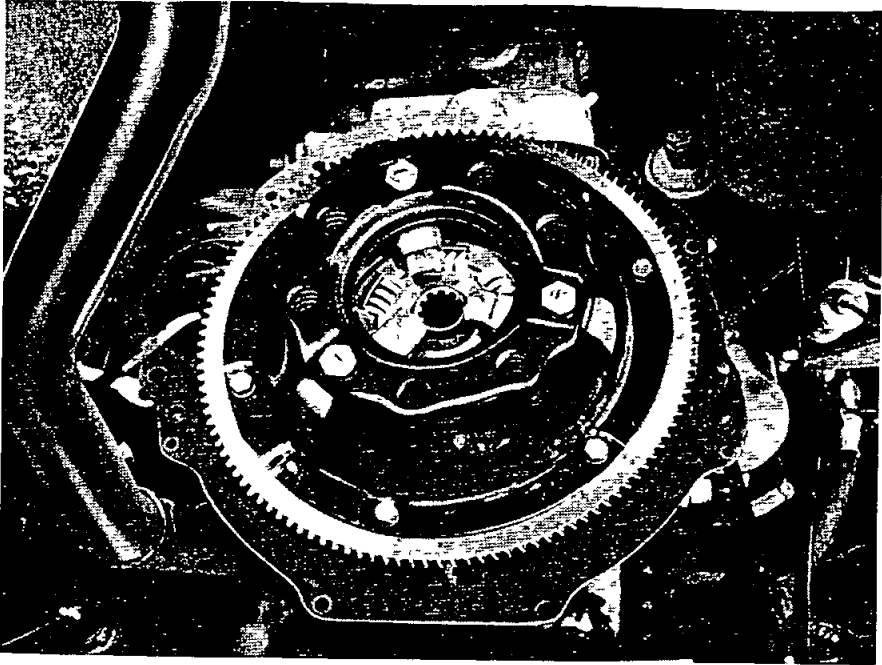
(4) When battery fluid overflows and adheres to the surface of the battery, the acid should be neutralized by wiping with alkali solution and the surface wiped to keep it in dry condition.





## Construction of Chassis

# CLUTCH



## GENERAL DATA

Type	Single dry disc plate
Method of operation	Hydraulic
Clutch master cylinder bore	15 875 mm (5/8 in)
Clutch operating cylinder bore	19 05 mm (3/4 in)
Number of facings	2
Facing size	203 x 146 x 3 2 mm (8 x 5.7 x 0.125 in)
Total friction area	312 sq cm (48 4 sq in)
Thickness of disc ass'y	
Free	Less than 8 45 mm (0.333 in)
Compressed	Less than 7 15 mm (0.282 in)
Pressure plate spring	
Free length	55 mm (2 17 in)
Fitted length & load	39 6 mm at 79±2 kg (1.56 in. at 173.8±4.4 lb)
Release bearing	Angular contact ball bearing (40 TNK 20)
Height of release plate	52±0 2 mm (2 05±0.01 in)
Release plate run-out	0 03 mm (0.001 in)
Flywheel facing run-out	0.05 mm (0.002 in)
Clutch pedal play	12-20 mm (0 6-0.8 in)
Clutch pedal hight	160±5 mm (6 3±0.2 in) at center of pat from toe board.

## DRIVEN PLATE ASSEMBLY

This is the flexible type in which the splined hub is indirectly attached to a disc, which transmits the power and the over-run through a number of coil springs held in position by retaining wires.

Two friction linings are riveted to the disc.

## COVER ASSEMBLY

The cover assembly consists of pressed steel cover, and a cast iron pressure plate located by six springs.

Mounted on the pressure plate are three release levers which pivot on floating pins retained by eye-bolts. Adjustment nuts are screwed on the eye-bolts and secured by staking. Struts are interposed between the lugs on the pressure plate and the outer end of release levers.

Anti-rattle springs load the release levers, and retainer spring connect the release lever plate.

# RELEASE BEARING

The release bearing consists of sealed type ball bearing it located by the operating fork and the release bearing retainer spring.

# CLUTCH PEDAL

When depressing the pedal, the return spring works to push back until the pedal comes to half way, but when the pedal goes over this position, it works reversely to push down the pedal. As the return spring is adjusted so that the lower end of the pedal has tension of 2 - 2.5 kg at position, 182 mm from the toe board, required strength to the pedal is about 17 kg in a full depressing, but it becomes 12 - 17% lighter due to the operation of this return spring.

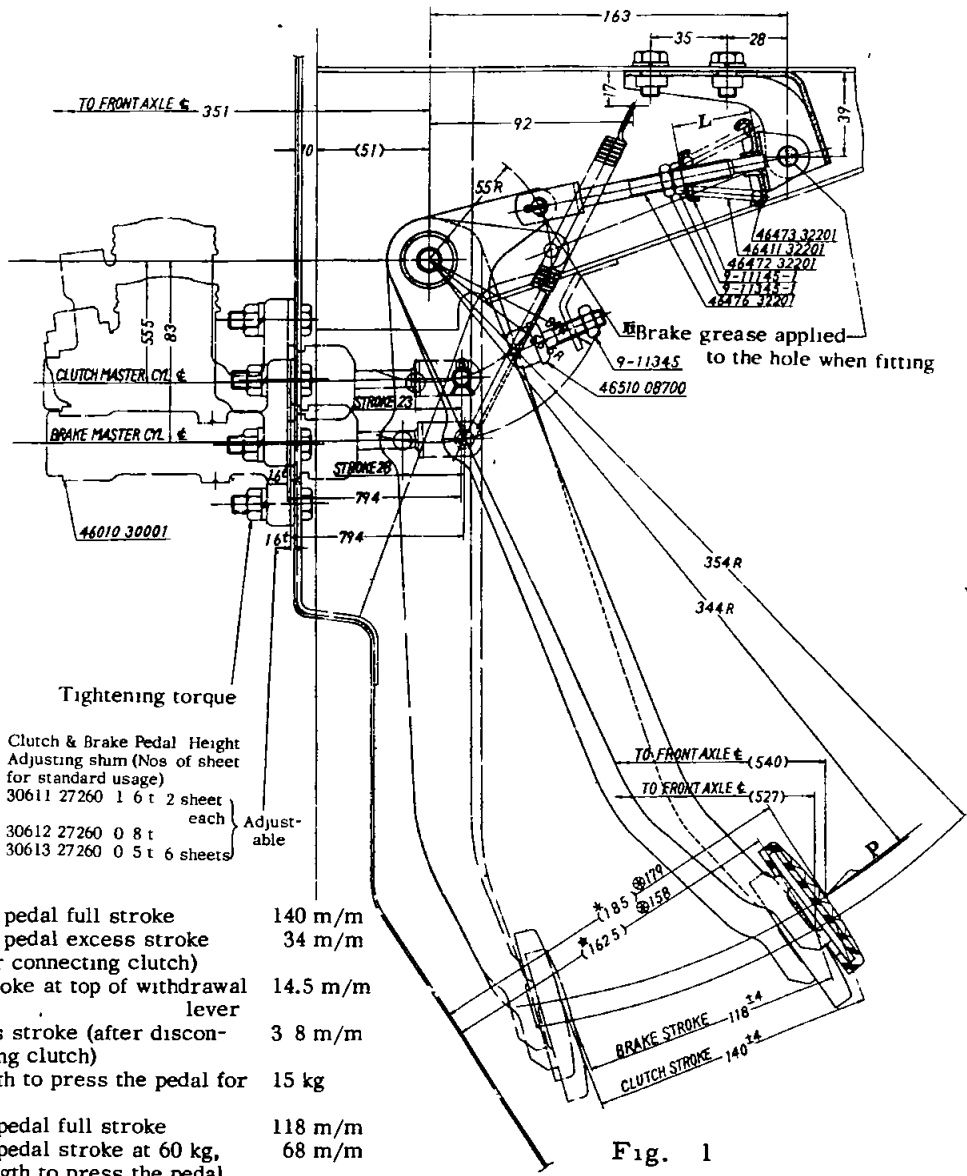


Fig. 1

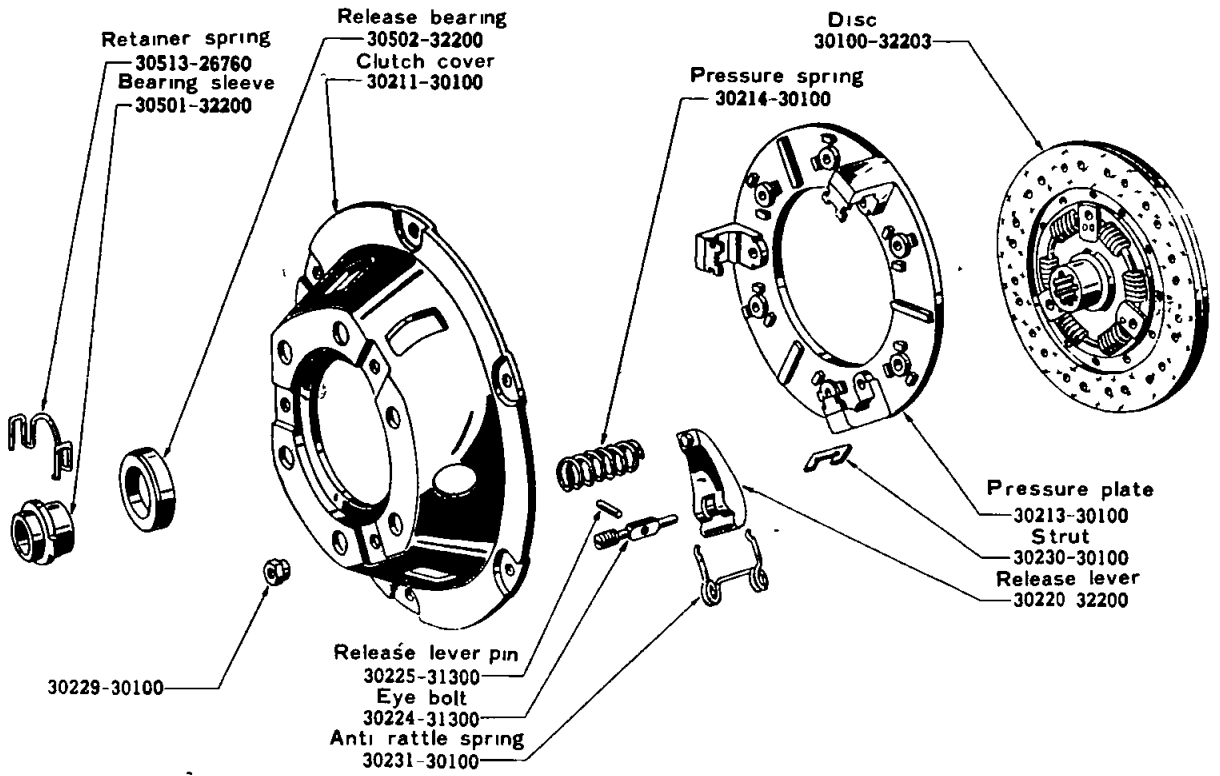


Fig. 2 Clutch

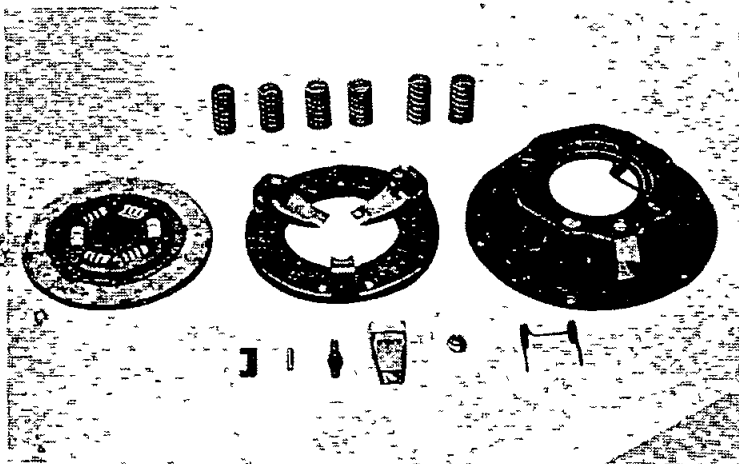


Fig 3

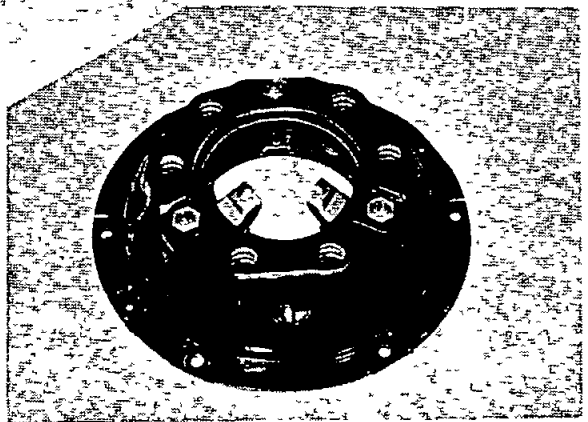


Fig 4

## Removing the Clutch

To gain access to the clutch it is first necessary to remove the transmission complete from the engine.

Once the transmission unit is free, a turn at a time by diagonal selection until the spring pressing is relieved

Then remove the screws completely and lift the clutch assembly away from the flywheel. Finally, remove the driven plate assembly

The release levers are correctly set on assembly. Interference with this setting, unless new parts have to be fitted, will throw the pressure plate out causing judder.

## Dismantling, Assembling & Gauging

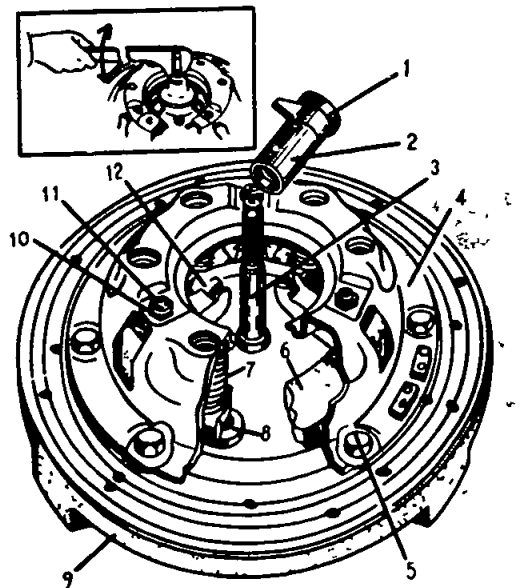
By using service tool (Fig 5 ) the clutch can be quickly dismantled, reassembled and adjusted to a high degree of accuracy.

The tool comprises the following parts, base plate centre pillar, spacing washers, distance pieces, hight finger actuating mechanism, setscrews, speed brace and metal box. As this tool is universal, a chart indicating the particular parts to be used for particular types of clutch will be found on the inside of the lid of the box (Tool No. 4799)

### Dismantling

With the clutch assembly, select three spacing washers (Fig 5 inset) and place them over the code letter "B" on the

1. Release lever height indicator.
2. Distance piece
3. Center pillar
4. Clutch cover
5. Set screw
6. Pressure plate
7. Thrust spring
8. Spacing washer
9. Base plate
10. Lock nut
11. Adjusting screw
12. Release lever



Now place the clutch assembly on the three spring washer so that the holes in the cover coincide with the tapped holes in the plate, insert

the setscrews provided and tighten them, a little at a time, by diagonal selection until the cover is firmly attached to the base plate at all possible points. This is most important if the best results are to be achieved.

Mark the cover, pressure plate lugs and release levers with a centre punch so that the parts can be reassembled in their relative position in order to maintain the balance of the clutch.

Detach the release lever plate from the retaining springs and remove the three eye-bolt nuts or adjusting nuts.

Slowly release the pressure on the springs, unscrewing by diagonal selection, the setscrews securing the cover to the base plate. The clutch can be lifted to expose all components for inspection. The release levers, eye-bolts, struts and springs should be examined for wear and distortion. Renew these parts if necessary, bearing in mind that the thrust springs must only be renewed in sets.

Clean all parts and lubricate the bearing surfaces of the levers, eye-bolts, etc., sparingly with grease.

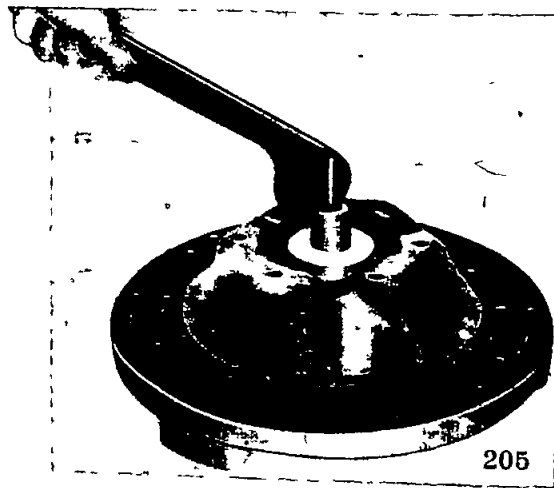
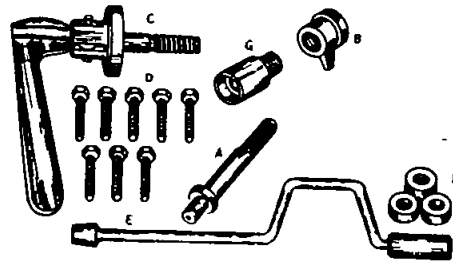


Fig. 5 Assembling tool

## Assembling

Place the pressure plate over the three spacing washers on the base plate, with the thrust springs in position on the pressure plate (see Fig 6). Assemble the release lever, eye-bolt and pin holding the threaded end of the eye-bolt the inner end of the lever as close together as possible.

With the other hand, insert the strut in the slots on the pressure plate lug sufficiently to allow the plain end of the eye-bolt to be inserted in to the hole in the pressure plate.

Move the strut upward into the slot in the pressure plate lug and over the ridge on the short end of the lever and drop it into the groove formed in the latter.

Fit the other two levers in a similar manner. Place the cover over the assembled parts, ensuring that the anti-rattle springs are in position,

and that the tops of the thrust springs are directly under the seats in the cover. In addition the machined portions of the pressure plate lugs must be directly under the slots in the cover through which they have to pass

Compress the pressure springs by screwing down the cover to the base plate by using the special set screw placed through each hole in the cover. Tighten the screw, a little at a time, by diagonal selection to prevent distortion to the cover.

The eye-bolts and pressure plate lugs must be guided through the holes in the cover at the same time

Finally repeat the procedure to make quite sure the release levers are seating properly and gauge again. Secure the eye-bolt nuts and fit the release lever plate on the tips of the release levers, then secure by means of the three retaining springs

Release the setscrews, a little at a time, by diagonal selection, and remove the clutch assembly from the base plate

## Gauging

Screw the nuts into the eye-bolts and proceed as follows,-  
Screw the centre pillar into the base plate and slip the distance piece over the pillar followed by the cam-shaped height finger. Adjust the height of the release levers by screwing or unscrewing the eye-bolt nuts until the height finger, when rotated, just contact the highest point on the tip of the release levers.

Replace the height finger and pillar by the clutch actuating mechanism (see Fig. 5) and actuate the clutch several times by operating the handle

This will enable the parts to settle down on their knife edges

Replace the height finger and distance piece and readjust the height of the release levers, checked for "run out" as near the edge as possible as, if the error is more than 0.02 in. press over the high spots until it is true within this figure. It is important to keep friction facings free from oil or grease.

## Refacing the Driven Plate

If a new complete clutch driven plate is not available new linings may be fitted to the old driven plate in the following manner,

Each rivet should be removed by using a 3.5 mm diameter drill. The rivets should not be punched out. Rivet one new facing in position, then if the correct tool is not available, use a blunted center punch to roll the rivet shanks securely against the plate. The second facing should then be riveted on the opposite side of the plate with the clearance holes over the heads already formed in fitting the first facing. The plate should then be mounted on a mandrel between centers and checked for



"run out" as near the edge as possible, if the wobbling is more than 0.02 in. press over high spots until it is true within this figure. It is important to keep friction facings free from oil or grease.

## Refitting the Clutch

Place the driven plate on the flywheel with the longer chambered splined end of the driven plate hub towards the transmission.

The driven plate should be centralised by a dummy drive shaft which fits the splined bore of the driven plate hub and the pilot bearing of the flywheel.

The clutch cover assembly can now be secured to the flywheel by means of the holding screws, tightening them a turn at a time by diagonal selection.

There are two dowels in the flywheel to locate in the clutch cover. Remove a dummy shaft after these screws are fully tightened (35 ft lbs = 4.84 kg-m).

Refit the release bearing and transmission case. The weight should avoid strain on the drive shaft and distortion of the driven plate assembly.

# DESCRIPTION OF CLUTCH CONTROL

The clutch is operated from a master cylinder by means of a suspended pedal

A cylinder mounted on the clutch bell housing is coupled to the clutch operating shaft

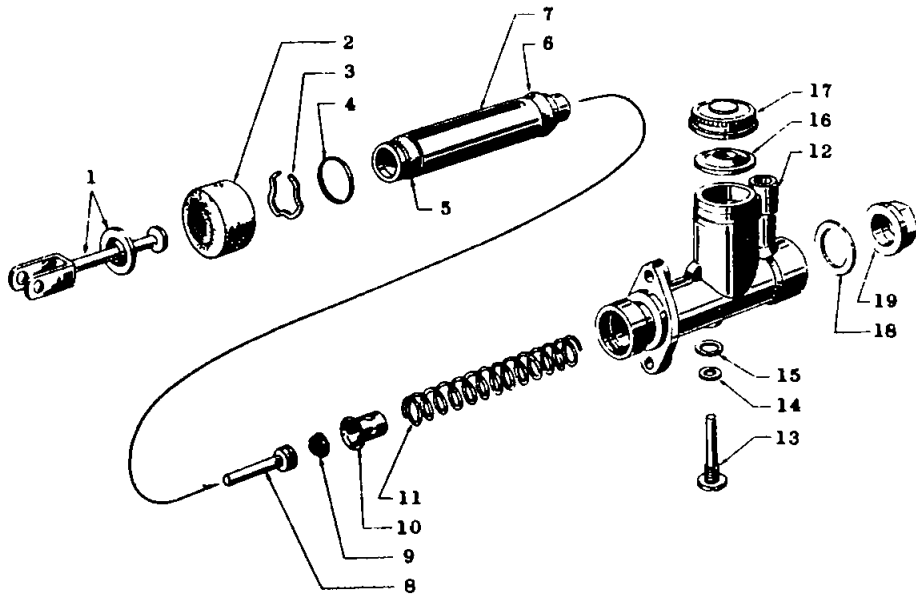


Fig 1 Components of the master cylinder

- |                                |                                       |
|--------------------------------|---------------------------------------|
| 1 Push rod assembly            | 11. Piston return spring              |
| 2 Master cylinder rubber boots | 12. Clutch master cylinder body ass'y |
| 3 Stopper ring                 | 13 Let-in valve release pin           |
| 4 Piston secondary cup ring    | 14 Ring                               |
| 5 Secondary cup                | 15 Gasket                             |
| 6 Primary cup                  | 16 Filler cap gasket                  |
| 7 Master cylinder piston       | 17 Cap                                |
| 8 Let-in valve assembly        | 18 End plug gasket                    |
| 9 Let-in valve spring          | 19. End plug                          |
| 10 Return spring seat          |                                       |

When pressure to the clutch pedal is applied the piston of the master cylinder displaces the fluid in the cylinder and via a pipe line, in turn, moves the piston of the cylinder, pushing against the lever of the clutch shaft.

## **The Master Cylinder**

The master cylinder consists of an alloy body with a polished finish bore, and reservoir with cap. The inner assembly is made up of the push rod, ring, stopper ring, piston, cups, spring seat, spring, valve and valve spring.

The end of cylinder is protected by a rubber boot.

## **Dismantling the Clutch Master Cylinder**

Disconnect the pressure pipe union from the cylinder and remove the securing bolts, then the master cylinder and may be withdrawn complete from the car.

Remove the filler cap and drain out the fluid. Pull back the rubber boot and remove the stopper ring with a pair of long nosed pliers. The push rod and ring can then be removed, and unscrew the release pin.

When the push rod has been removed the piston with cups attached will be exposed, remove the piston assembly complete.

The assembly can be separated by lifting the spring seat edge over the shouldered end of the piston. Depress the piston return spring allowing the valve assembly to slide through the elongated hole of the spring seat thus releasing the tension on the spring.

Examine all parts, especially the gasket, cylinder bore and piston cups, for wear or distortion and replace the new parts where necessary.

## **Assembling**

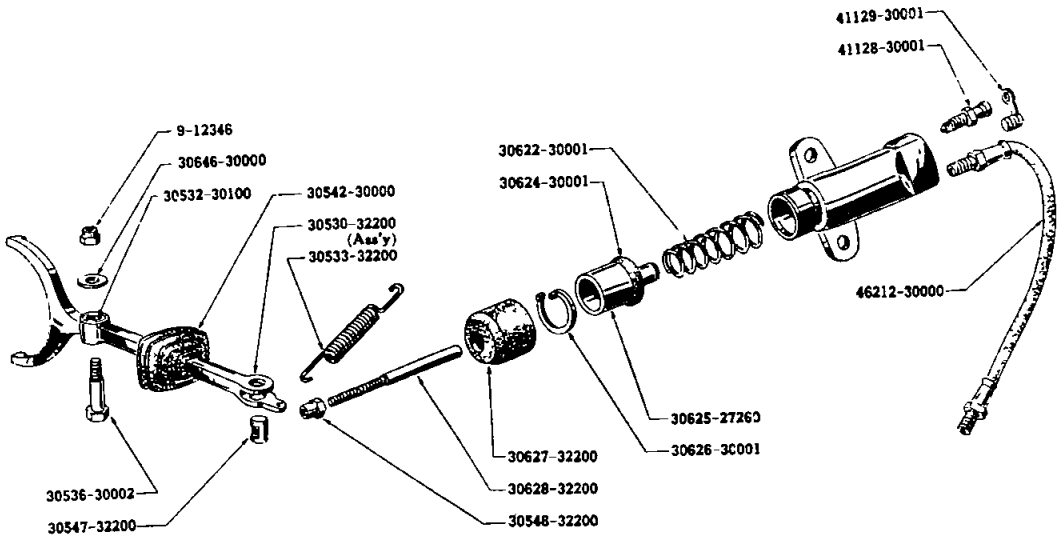
Smear the assembly well with the recommended brake fluid, and insert the assembly into the bore of the cylinder, end with piston cups lips in the bore.

Replace the push rod, with the secondary cup ring, into the cylinder followed by the stopper ring which engages into the groove machined in the cylinder body.

Replace the rubber boot and secure the unit by means of the two bolts on the flange and refit the pressure pipe union into the cylinder.

## **The Operating Cylinder**

This cylinder is of simple construction, consisting of the body, piston, piston with cup, spring and bleed screw, the open end of the cylinder being protected by a rubber dust cover. The cylinder is mounted under side of the starting motor.



**Clutch Operating**

## Dismantling

Remove the rubber dust cap from the bleed screw attach a bleed tube, open the bleed screw three-quarter of a turn and pump the clutch pedal until all the fluid has been drained into a clean container

Unscrew the flexible pipe union and adjustable push rod The operating cylinder can now be removed. Remove the rubber cover and if compressed air line is available, blow out the piston from the side of union

Examine all parts, especially the seal, and replace if worn or damaged.

## Assembling

Place the seal into the stem of the piston, with the back of the seal against the piston, replace the springs with the small end on the stem, smear well with the recommended fluid and insert into the cylinder.

Replace the dust cover and mount the cylinder in position, making sure the push rod enters the hole in the rubber boot. Secure the cylinder with the pinch bolt, and screw in the pipe union

## Bleeding the Clutch System

Remove the bleed screw dust cap at the operating cylinder, open the bleed screw approximately three-quarters of a turn and attach a tube immersing the open end into a clean receptacle containing a small amount of brake fluid. Fill the master cylinder reservoir with the recommended fluid and by using slow, full strokes, pump the clutch pedal until the fluid entering the container is free from air bubbles. On a down stroke of the pedal, screw up the bleed screw, remove the bleed tube and replace the dust cap. When the clutch pedal is depressed, the force is transmitted to the bearing, and the surface pushes the release plate.

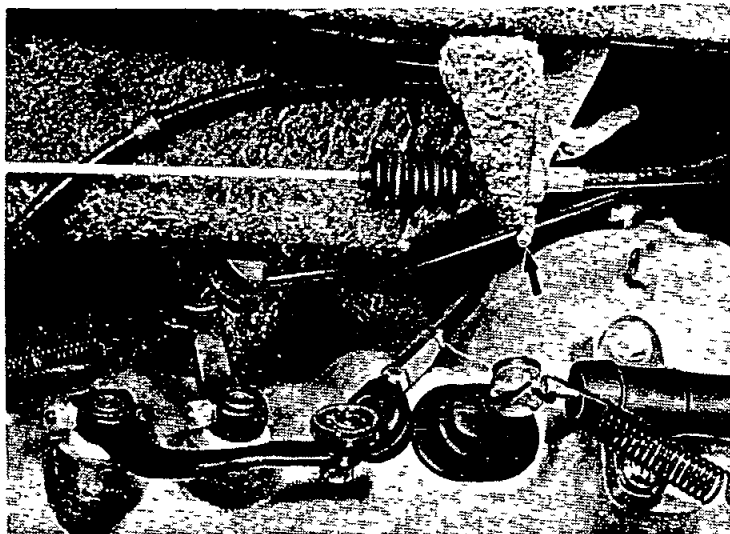
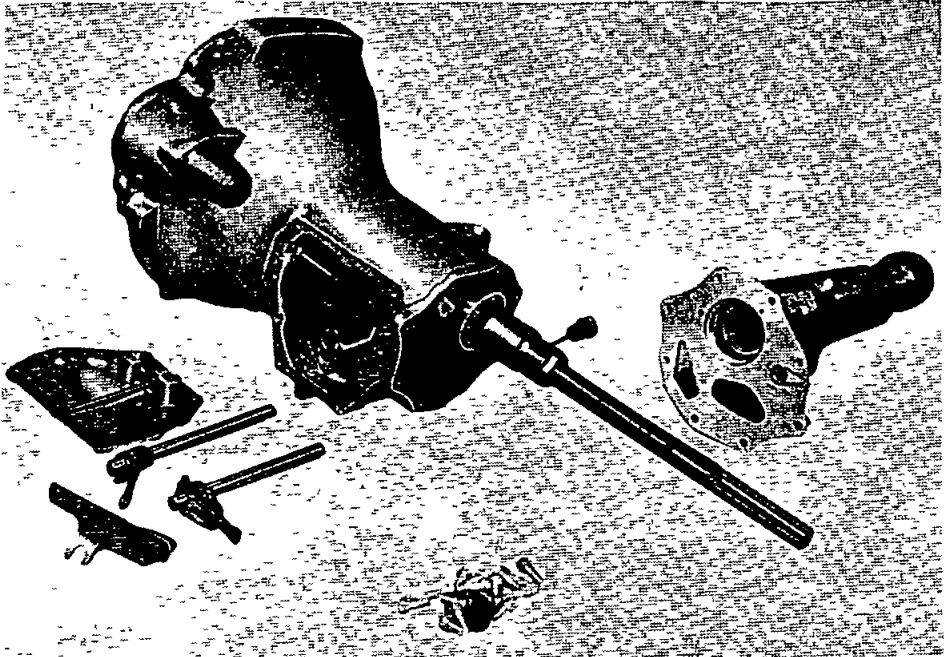


Fig. 2

# TRANSMISSION



# GENERAL DATA

Model	4 stages for forward, 1 stage for reverse remote controled
Type of gear	Synchro-meshed for speed # 2, 3 & 4
Speed #1	Synchro-meshed helical gear type
Speed #2	3 94
Speed #3	2 40
Speed #4	1 49
Reverse	1.00
No. of tooth of gear	5.16 1
Main drive gear	20
Main shaft 3rd gear	25
Main shaft 2nd gear	31
Main shaft 1st gear	28
Counter drive gear	31
Counter third gear	26
Counter second gear	20
Counter first gear	11
Reverse idler gear	13 & 17

## BACKLASH OF VARIOUS GEARS

(Play on revolutional direction)

Between main drive gear and counter drive gear	0.075-0.125 mm (0.003-0.005 in)
Between third gears	0.075-0.125 mm (0.003-0.005 in)
Between second gears	" ( " )
Between low gears	" ( " )
Between speed # 3 & 4 Synchronizers and main	0.03-0.12 mm (0.0014-0.0048 in)
Between peripheral gears of speed # 3 & 4 synchronizers and coupling sleeve	0.075-0.125 mm (0.003-0.005 in)
Between speed # 3 & 4 coupling sleeves and main drive gear	" ( " )
Between speed # 3 & 4 coupling sleeves and speed # 3 gear	" ( " )

Between speed #2 syn- chronizer and main shaft spline	0.003-0 12 mm (0.0014-0.0048 in)
Between #2 synchro- nizer and speed #1 gear	0.075-0 125 mm (0.003-0.005 in)
Between speed #1 gear and speed #2 gear	0.075-0 125 mm (0.003-0.005 in)

## MAIN DRIVE GEAR AND SHAFT

Inner diameter of bearing at rear end of main drive gear	20 485-20.503 mm (0.8064-0.8072 in)
Outer dia of bearing at front end of main shaft	14 460-14.448 mm (0.5693-0.5688 in.)
Main shaft pilot bearing	Needle roller bearing
No of needles of needle roller bearing	18
Dia x height of dittoed bearing	3 mm x 28 mm (0.118 in x 1.102 in)
Inner dia of 3rd gear bearing hole	33 388-33 401 mm (0.3144-0.3149 in)
Outer dia of 3rd gear bush (before pressing in)	33 312-33 325 mm (1.3114-1.3119 in)
Play of periphery of 3rd gear bush	0.06-0.09 mm (0.0023-0.0035 in)
Amendment limit of dittoed play	0.15 mm (0.0059 in)
Inner dia of 2nd gear bearing hole	33 388-33 401 mm (1.3144-1.3149 in)
Outer dia of 2nd gear bush	33 312-33 325 mm (1.3114-1.3119 in)
Gap at periphery of 2nd gear bush	0.06-0.09 mm (0.0023-0.0035 in)
Amendment limit of dittoed gap	0.15 mm (0.0059 in)
Thickness of front thrust washer on main shaft	3.975-4.001 mm (0.1564-0.1575 in)
"	4.026-4.051 mm (0.1585-0.1595 in)
"	4.077-4.102 mm (0.1605-0.1614 in)
Thickness of interlocking ring on 2nd & 3rd gear bush	3.937-3.962 mm (0.1549-0.1559 in)
Thickness of gear thrust washer on main shaft	4.826-4.801 mm (0.1900-0.1890 in)
End play of 2nd & 3rd gear	0.12-0.16 mm (0.0048-0.0062 in)



Amendment limit of dittoed play	0 25 mm (0 01 in )
Synchronizer spring	
Free length	127 mm (0.49 in )
Outer diameter	6 7 mm (0 25 in )
Coil diameter	0 8 mm (0 03 in )
Tension	2 kg. at 8 mm
Outer dia of synchronizer locating hole	9/32 in (7 144 mm )

## COUNTER GEAR

Inner dia. at gear bearing	22.420-22.433 mm (0 8826-0 8831 in )
Outer dia. of shaft	16 391-16.401 mm (0 6452-0 6456 in )
Type of bearing	Needle roller bearing
No. of needles	20 x 2 (front & rear)
Dia. x length	3 mm. x 23 8 mm (0 118-0 936 in )
Thickness of front thrust washer	3.91-3.96 mm (0 154-0 156 in )
Thickness of rear thrust washer	3 96-3.91 mm (0.1560-0.1540 in )
	4.013-3.988 mm (0.1580-0 1569 in.)
	4.089-3 140 mm (0.161-0 160 in.)
	4.166-4 140 mm (0 164-0 163 in.)
End play	0 04-0 06 mm (0.0015-0 0023 in )
Amendment limit of dittoed play	0.10 mm (0 004 in )

## REVERSE GEAR

Inner dia of bush	14 338-14.376 mm (0 564-0 566 in )
Outer dia of reverse shaft	14 249-14 262 mm (0.561-0.5614 in )
Gap between shaft & bush	0.076-0 127 mm (0 003-0 005 in )

## SHIFT ROD

Shift rod Poppet spring		
Free length x Coil dia	34 7 x 8 mm	1.366 x 0.32 in
Wire dia.	1.4 mm	0 055 in
Tension when installed	6.5 kg at 28 mm	14 4 lb at 1.10 in
Dia. of check ball	7 9 mm	0 311 in
Spring, reverse fork pin		
Free length x Coil dia	29.5 x 10 5 mm	1 161 x 0 413 in
Wire dia.	1 2 mm	0 047 in

Tension when installed	3 kg at 20.5 mm	6.6 lb at 0.807 in
Spring reverse fork pin		
Free length x Coil dia	20 x 6.2 mm	0.79 x 0.244 in
Wire dia	1.2 mm	0.047 in
Tension when installed	7 kg at 16 mm	15.6 lb at 0.63 in
Inter lock ball dia	6.035 mm	0.25 in
Oil capacity	2.4 L	0.63 US. Gal
Genuine gear oil	MP #90	
In warmer district than 32°C		
Use #40		

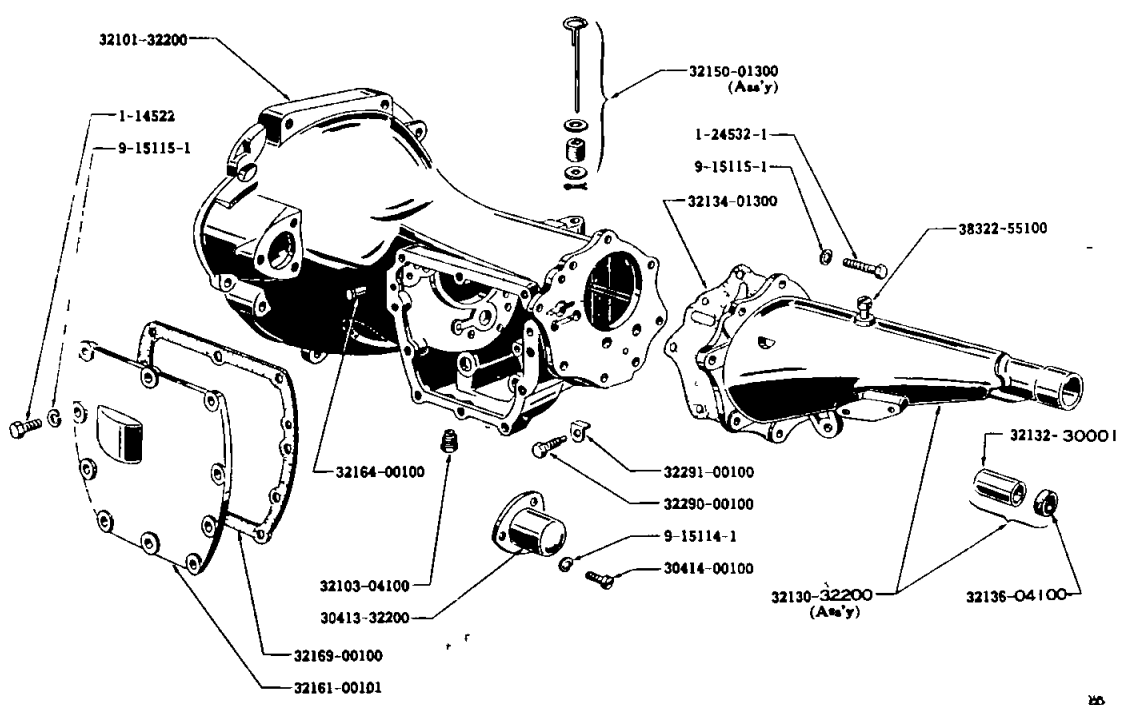


Fig 1 Components of Transmission Case

## DISASSEMBLING THE CASE

First drain the oil from the transmission by removing the drain plug. The drain plug is situated beneath the case at the left-hand side.

## **Clutch Withdrawal Lever**

Bend back the lock washer, remove the nut its spring washer, and screw the bolt out of the bracket. The leg of the clutch withdrawal support bracket on the steering part of the car is threaded, do not therefore, try to knock the bolt out, or the threaded in the support bracket will be stripped. Screw the bolt out. Detach the rubber dust cover around the withdrawal lever from within the clutch housing

## **Cross Shaft Levers**

The cross shaft levers are positioned on the right-hand side of the case of transmission if the car has right-hand steering, and on the left-hand side if left hand steering

A cotter pin, spring washer, and nut, secures each lever to its shaft. After the nuts and washers have been removed, the pins may be tapped out, and the levers lifted off the shafts

## **Side Cover**

Holding the side cover in position are set-bolts and set-screws with serrated washers, all of which must be removed, when the cover can be taken off

## **Change Speed Cross Shafts & Selector Arm**

Once the side cover is removed both the selector arm and change speed lever cross shafts can be drawn from the case, bringing with them the change speed gate. Gentle pressing prising may be necessary to assist removal of the gate, as its rounded ends are a tight fit in the machined recesses on the side cover seating. After withdrawal, the gate can be threaded off the selector arm and change speed lever. At this stage the shafts, oil seals, and felt washers can be withdrawn from the case at the operating lever side

To remove the selector arm the shaft, tap out the securing pin. The engagement lever is anchored in its pivot by a nut and bolt whilst the pivot is connected to the cross shaft

## **Front Cover**

Release the front cover situated within the clutch housing by removing the nuts and spring washers. At this stage of disassembling do not attempt to remove the cover and front washer

The operation will prove easier if the shift fork selector rods are tapped forward, thus pushing the cover away from the casing

## Selector Rods & Forks

Using a soft metal drift, tap forward for a short distance, each of the three rods and prise out the keys which are fitted to prevent the rods from turning

Now drive each rod forward, clear of the forks and extract them from the case. Care should be exercised in order not to lose the spring loaded ball fitted to each fork. Lift out the three forks, noting carefully their respective positions to assist reassembly

Fitted behind the third speed fork is a distance piece which must be retrieved from the case when removing this fork

## Reverse Gear

A lug, which is an integral part of the main casting locates the forward end of the reverse gear shaft. To secure the shaft in position, a setpin is screwed through the lug locating in the shaft. The setpin is locked by a tab washer. Straighten the tab washer, release the setpin, then tap forward and remove the reverse gear shaft. Lift out the reverse gear

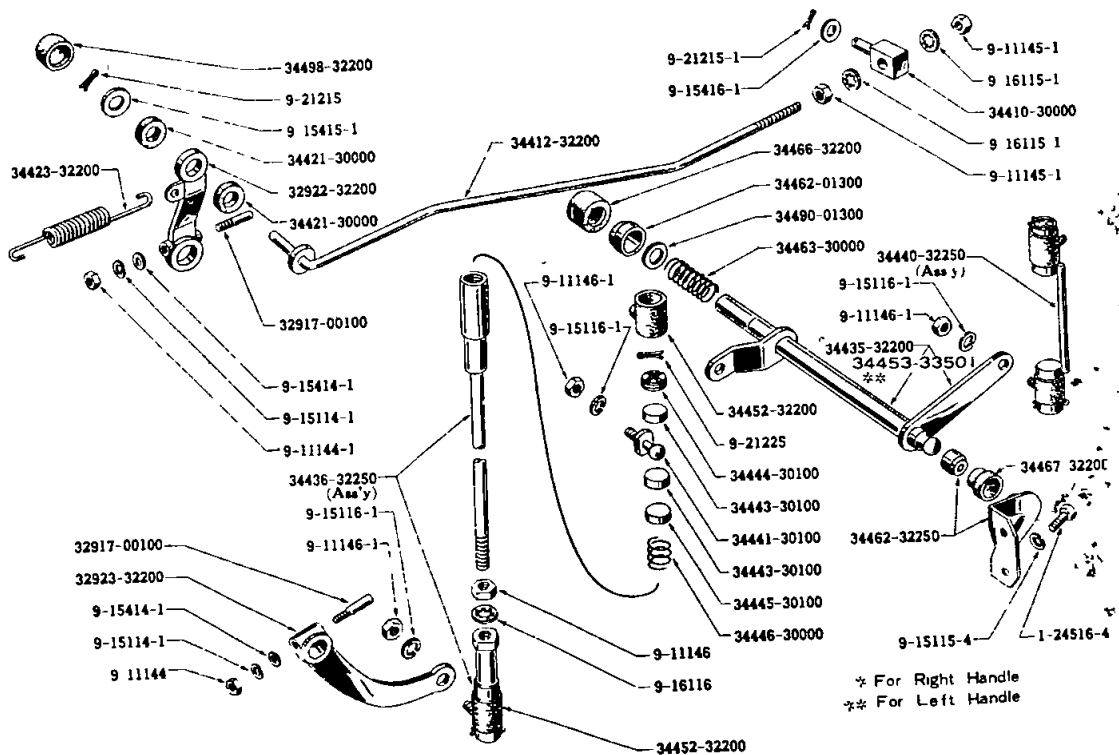


Fig. 2 Remote Control Linkage

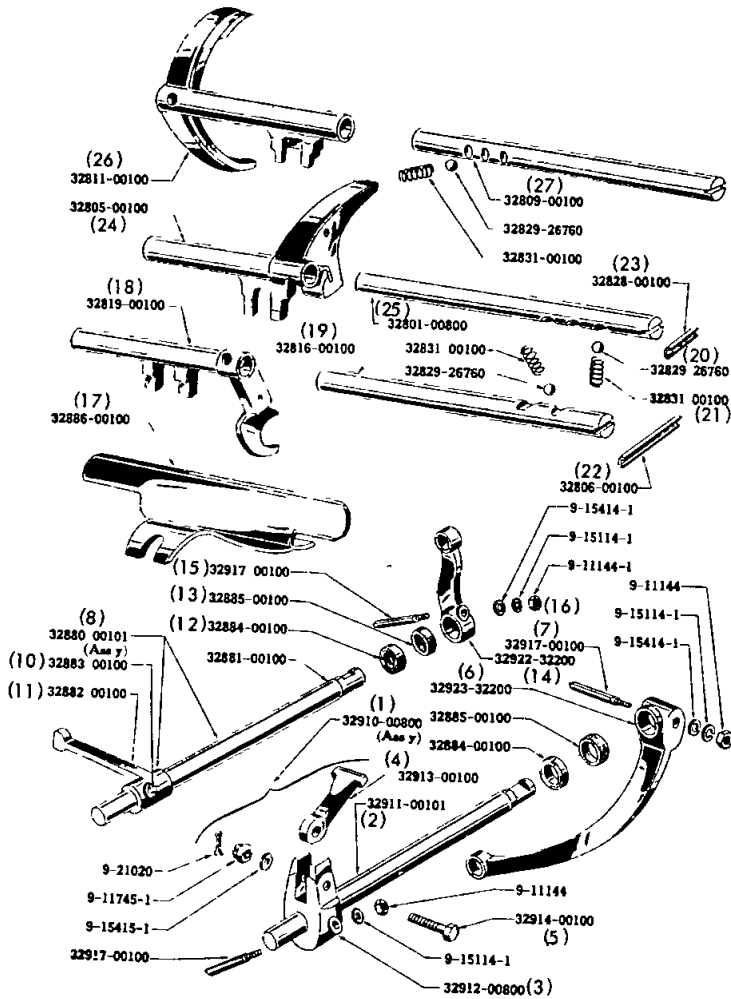


Fig. 3 Fork & Shaft

- |  |                                   |
|--|-----------------------------------|
| 1 Operating change speed fork assembly | 14 Selector cross shaft lever     |
| 2 Change speed cross shaft             | 15 Lock pin                       |
| 3 Change speed operating fork          | 16 Plane, lock washer & plane nut |
| 4 Change speed operating fork          | 17 Change speed gate assembly     |
| 5 Fulcrum pin                          | 18 Reverse fork                   |
| 6 Lever-change speed cross shaft       | 19 Reverse fork rod               |
| 7 Lock pin                             | 20 Check ball                     |
| 8 Selector shaft assembly              | 21 Locking ball spring            |
| 9 Selector shaft                       | 22 Fork rod locking strip (big)   |
| 10 Taper pin                           | 23 Fork rod locking strip (small) |
| 11 Selector cross shaft inner lever    | 24 First & second speed fork      |
| 12 Cross shaft oil seal                | 25 First & second speed fork rod  |
| 13 Felt ring                           | 26 Third & fourth speed fork      |
|  | 27 Third & fourth speed rod       |

## Counter Shaft & Gear

Using soft metal dirt, drive the counter shaft forward and out of case, when the counter gear cluster and two thrust washers will drop to the bottom of the case.

These gears can only be lifted from the casting when the main and drive shafts together with their respective gears, have been removed

To remove the needle roller bearing within the counter gear cluster it is necessary to break the retaining circlips before driving out the bearing with a suitable piece of metal tubing



Fig. 4

## Main Shaft

The main shaft can now be withdrawn from the transmission casing To remove the gears from the main shaft first slide off the third and fourth speed synchronizer assembly, then with a piece of wire inserted through the hole in the gear cone, depress the small spring loaded plunger which locates the splined washer at the forward end of the main shaft, turning the washer into line with the splines. The third and second speed constant mesh gears, together with their common phosphor bronze sleeve, can now be pulled over the steel plunger and so clear of the main shaft As the phosphor bronze sleeves and their common driving washer are a tight fit on the shaft, the shaft should be immersed in warm oil in order to expand the sleeves so that they will slide off the shaft, when the second speed gear can be removed Take out the steel plunger and spring

Next remove the splined washer separating the second speed constant mesh gear assembly from the first gear unit, and then slide the first gear assembly free of the main shaft. To release the speedometer wheel from the main shaft, straighten the tab washer and unscrew its securing nut, then slide the speedometer wheel off the shaft Do not lose the key Take off the distance piece, and the main shaft bearing, can be separated from its housing after the nut has been prised from the shaft

If it is desired to dismantle the fourth and third speed coupling sleeve, or the first speed gear, these can be pressed clear of their splined synchronizers, but care must be taken to retrieve the three balls and springs in each assembly. Take out the main shaft front needle roller bearings from the end of the drive gear shaft.

## Rear Oil Seal

This oil seal is situated in the end of the rear cover and should not be dismantled unless suspected of leaking It is almost impossible to take off



Fig 5 Components of the Transmission

- (1) Gear case front cover
- (2) Front cover gasket
- (3) Main drive gear nut
- (4) Lock washer
- (5) Main drive gear bearing
- (6) Main drive gear
- (7) Main shaft pilot bearing
- (8) Third & fourth speed synchronizer sleeve
- (9) Third & fourth speed synchronizer ring
- (10) Third & fourth speed synchronizer hub
- (11) Third & fourth speed synchronizer ring
- (12) Main shaft
- (13) First speed gear
- (14) Main shaft second speed gear
- (15) Main shaft third speed gear
- (16) Main shaft front thrust washer
- (17) Main shaft gear third speed bush
- (18) Main shaft cotter throust washer
- (19) Main shaft gear second speed bush
- (20) Second speed synchronizer ring
- (21) Main shaft rear thrust washer
- (22) Second speed synchronizer hub
- (23) Synchronizer spring
- (24) Second speed shifting insert
- (25) Main shaft bearing retainer assembly
- (26) Bearing retainer locator
- (27) Key
- (28) Main shaft spacer
- (29) Speed meter drive gear
- (30) Main shaft lock washer
- (31) Main shaft nut
- (32) Locking peg
- (33) Locking peg spring
- (34) Counter shaft gear
- (35) Counter shaft needle roller
- (36) Counter shaft front thrust washer
- (37) Counter shaft snap ring
- (38) Counter shaft spacer
- (39) Counter shaft
- (40) Snap ring
- (41) Rear thrust washer
- (42) Needle roller
- (43) Reverse shaft
- (44) Reverse gear bush
- (45) Reverse gear assembly



the seal without damaging it, consequently a new oil seal should be fitted if the old one has been moved. It will be seen that the oil seal housing is pinched into position. This can be removed by using a punch and hammer.

## **Drive Gear Shaft**

Before driving the drive shaft from its position, tilt the counter gears, now in the bottom of the case, to clear the drive shaft gear. Using a long drift, inserted through the main shaft opening, drive the drive shaft forward, complete with bearing and circlip, from the case.

The counter gears may now be removed from the case.

To remove the bearing from shaft, knock back the tab locking washer and unscrew the shaft nut. This nut has a left-hand thread.

The bearing can now be driven from the shaft, preferably by resting the circlip of the outer race on the jaws of an open vice and driving the shaft downward.

Use a hide or lead hammer for the operation, as great care must be exercised to prevent the end of the gear shaft from spreading.

# ASSEMBLING THE TRANSMISSION

## Synchromesh Sub-Assembly

During manufacture 2nd speed gear, the third and fourth speed coupling sleeves are each paired with their respective synchronizers. Only mated pairs of these parts should therefore fitted

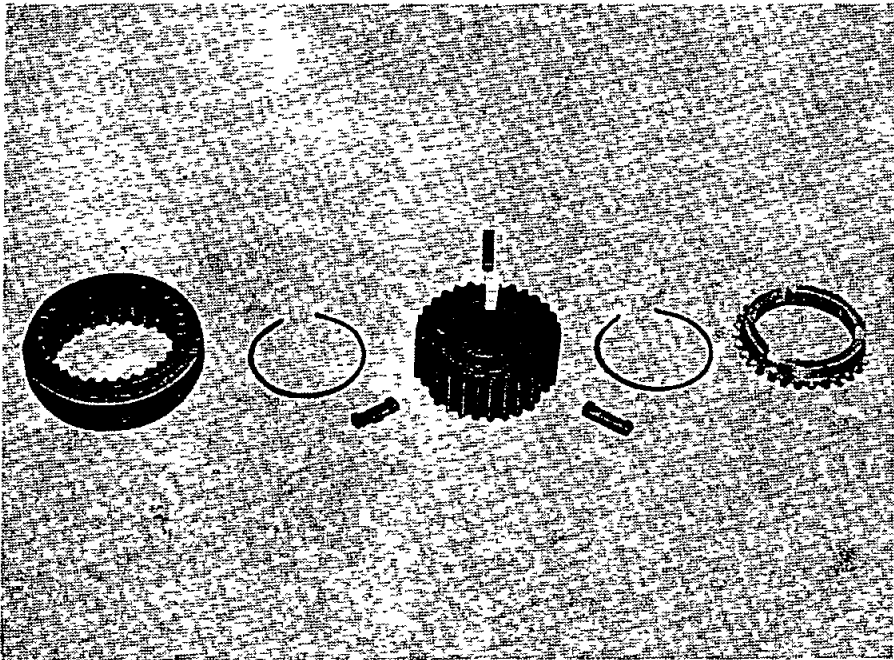
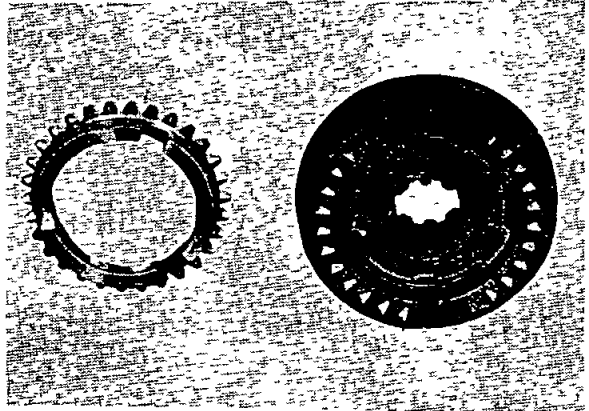


Fig. 1 3rd & 4th Synchronizer

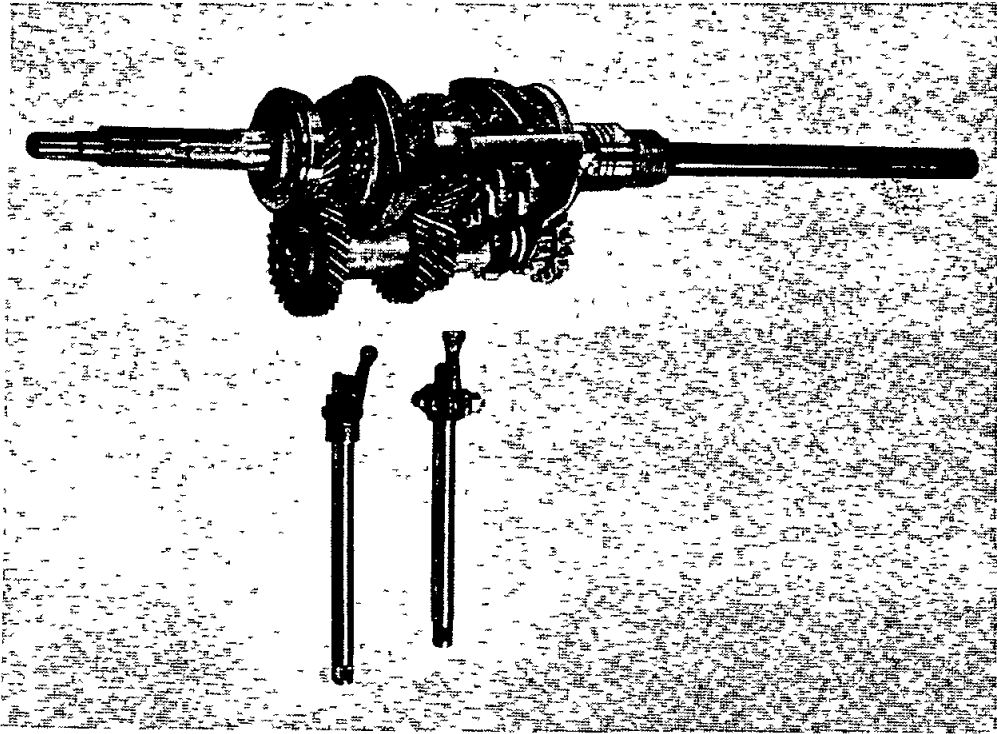


Fig 2 Assembly order of Transmission Gears

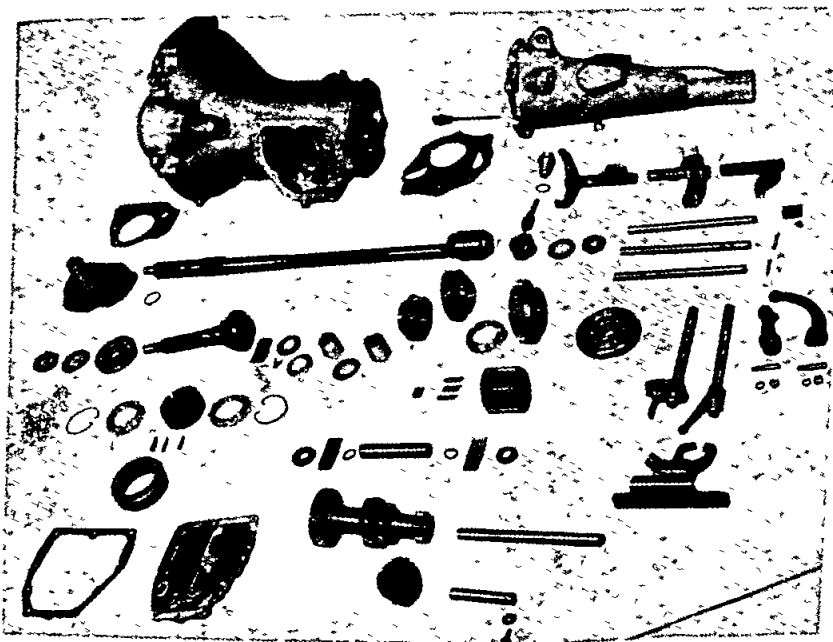


Fig 3 Components of Gears & Synchronizer

## Counter Shaft Gears

First locate the two thrust washers to the counter gears, ensuring that the larger washer is at the front, and then place the gear cluster in the gear case

Check that there is end play for the cluster gears of between 0.04 - 0.06 mm (0.0015- 0.0023), and remedy if necessary by fitting a thicker or thinner rear washer

Thickness of front thrust washer

3 91-3 96 mm (0.154-0.156 in )

Thickness of rear thrust washer

3 96-3 91 mm (0.156-0.154 in )

4 013-3 988 mm (0.1580-0.1569 in )

4 089-4 064 mm (0.161-0.160 in )

4 166-4 140 mm (0.164-0.163 in )

0 04-0 06 mm (0.0015-0.0023 in )

Temporarily replace the counter shaft with a thin rod which will permit the gear cluster to remain out of mesh with the main and drive shaft gears

## Drive Gear Shaft

The ball journal bearing should now be drifted on to the shaft, with its spring ring away from the geared end. Position the geared end of the drive shaft in a dummy 3rd and 4th speed coupling sleeve, put the washer over the bearing, tighten the nut and lock it in position.

Smear grease in the end of the shaft, where the main shaft locates, then load the 18 needle rollers so that they adhere in position by means of the grease.

Turn the gear casing to ensure that the counter teeth are below the drive shaft bearing housing. Failure to do this will result in damage to both the counter gear and drive shaft geared ends.

The drive shaft can now be drifted into position from the clutch housing end.

Ensure that the spring ring resisters properly in the recess on the gear case.

## Main Shaft

Press the main shaft center bearing complete with housing on to the shaft from the rear. The bearing must be pressed firmly against the shoulder of the center splined portion of the shaft.

Lightly oil the shaft forward of the bearing and refit the first speed wheel assembly with the synchronizer pointing forward.

Refit the thrust washer on to the shaft followed by the baulking ring.

The phosphor bronze sleeve which carries the second speed is a tight fit on the shaft, there it must be first immersed in warm oil and then slid into position on the shaft. Fit the second speed wheel over the sleeve, then the driving washer and the second bronze sleeve which carries the third speed wheel. The two sleeves are locked together by the driving washer. Now position the third gear over its sleeve. Place the spring and plunger into the hole in the main shaft and slide the splined washer. Depress the plunger with a piece of wire through the hole in the third speed, and slide the splined washer over the plunger. Then turn the washer for the plunger to engage with a groove in the washer.

The gears are now assembled on the main shaft and there should be end movement for the first speed gear between the center bearing and the keyed washer at the rear of the second speed gear. Assemble the two baulking rings to the third and top speed synchronizer and coupling sleeve.

When fitted to the shaft, the large boss of the inner splines of the synchronizer must face towards the front of the box. Also note that in each case the pointed ends of the baulking ring lugs face inwards to the synchronizers. Slide the third and fourth synchronizers slightly forward on the shaft to clear the counter gears and then carefully guide the main shaft assembly into the gear casing. When the housing surrounding the main shaft bearing is flush with the gear casing, the counter shaft gear cluster should be raised into mesh with the gears and counter shaft oiled and fitted into position. The lipped end must be flush with the gear casing.

FRONT THRUST WASHER	THICKNESS
32264 26761	3.975-4.001 mm (0.1564-0.1575 in.)
32265 26761	4.026-4.051 mm (0.1585-0.1595 in.)
32266 26761	4.077-4.102 mm (0.1605-0.1614 in.)

## Reverse Gear

Refit the reverse gear into the gear casing with the large gear to the rear. Oil the reverse gear shaft before inserting and secure the shaft with locating pin and tab washer.

## Selector Rods & Forks

Before commencing to locate the selector forks within the gear case it is advisable to pre-load the spring and ball into each fork, and with the aid of a pilot bar, retain the spring and ball in position until each fork rod has entered its correlative fork

With the gear in the neutral position, first fit the first speed selector fork and then locate the third and fourth speed fork. Now tap the third and fourth fork rod through the casing. Continue tapping the rod through its fork until it reaches its final position. Next locate the reverse gear fork and then enter the first and second selector fork rod and the reverse gear fork rod, through the casing and into their respective forks. When driving the fork rods hole remember to retrieve the pilot bars as they leave the forks. The key ways in the rod ends are offset and when fitted the narrow face should be at the bottom.

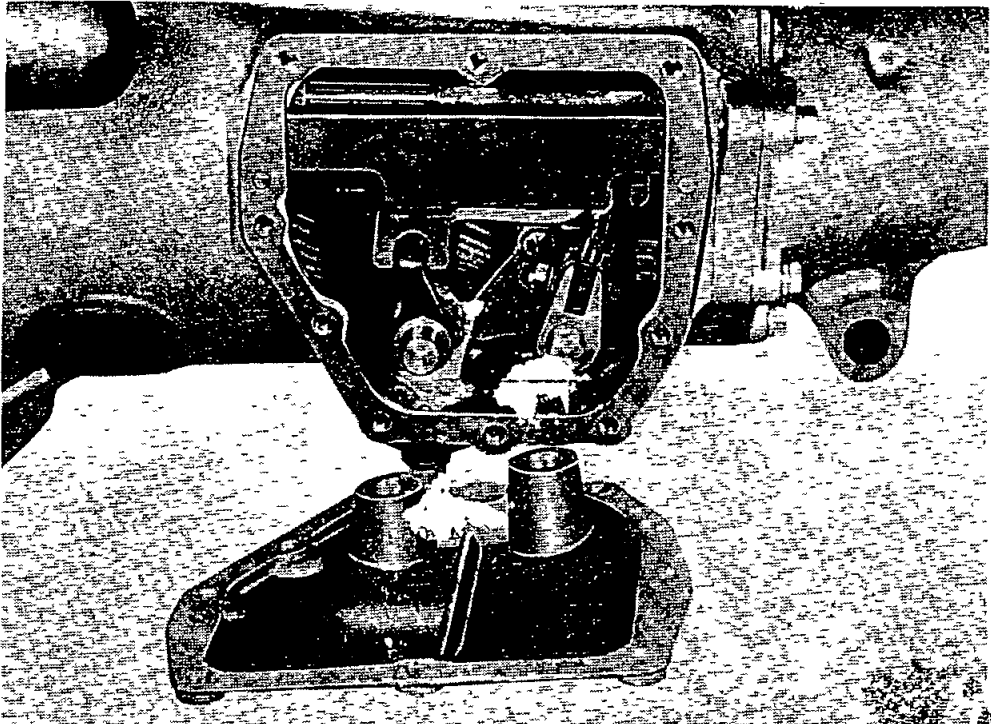


Fig. 4 Selector Rods & Forks

# SELECTOR INNER & OPERATING LEVER CROSS SHAFT

With the selector lever (Fig 4), pinned to its respective cross shaft, also change speed cross shaft lever assembly, cottedered to its own cross shaft, the two shafts should be positioned in the case with the respective levers nearest to the side cover opening. Note that the selector cross shaft takes the forward position in the case. At the same time that the shafts are placed in the case, the change speed gate should be threaded over the levers and the whole assembly put into the case as one unit. The gate is located in position by its rounded ends in the machined recesses of the side cover seating.

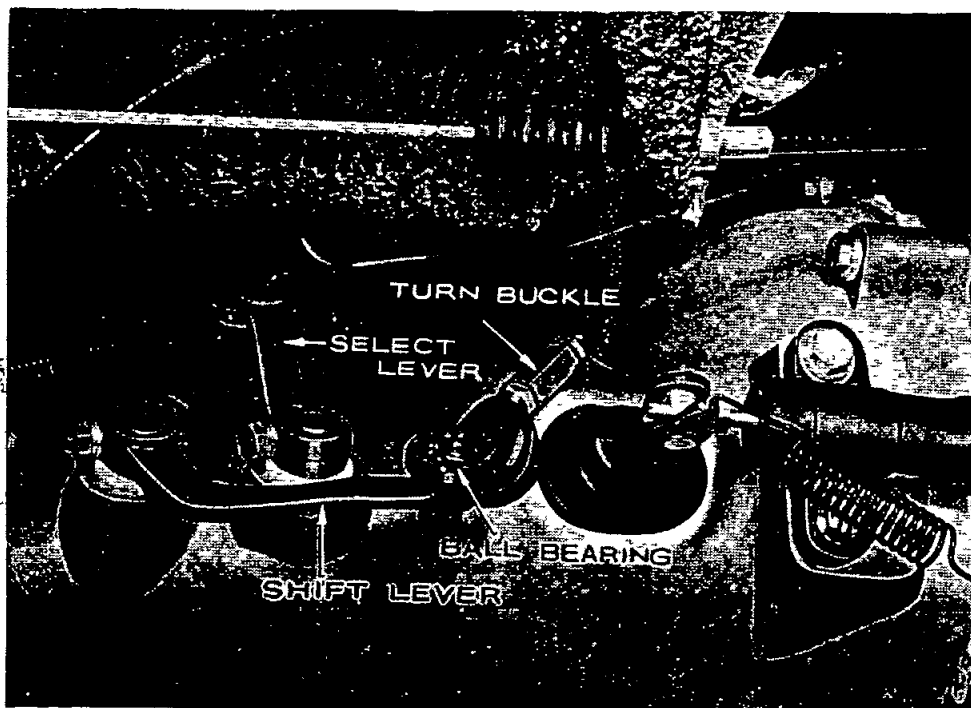
Before fitting the levers, the oil seal and felt ring must be fitted to each shaft in that order. The levers are cottedered to their respective shaft.

## Side Cover

Secure the side cover into position by means of the bolts and screws, ensuring that the side cover is intact.

## Front Cover

The front cover and gasket should now be positioned over the securing studs and attached by means of the seven nuts and lock washers.







# PROPELLER SHAFT & UNIVERSAL JOINTS

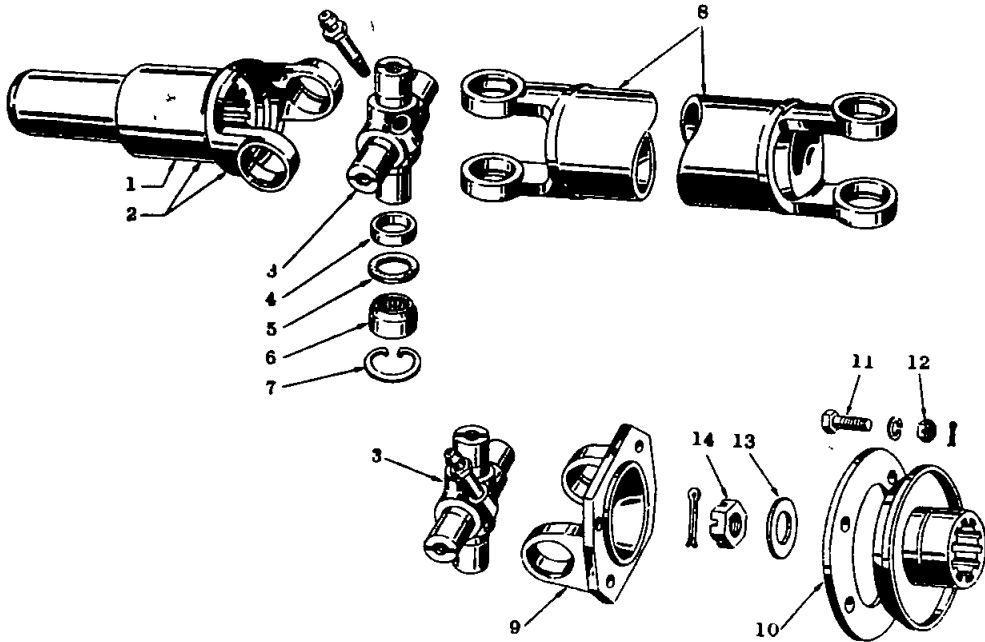


Fig. 1 Propeller shaft & joint

- |                               |                              |
|-------------------------------|------------------------------|
| (1) Dust cover                | (8) Propeller shaft assembly |
| (2) Sleeve yoke               | (9) Flang yoke               |
| (3) Journal                   | (10) Companion flange        |
| (4) Oil seal bearing retainer | (11) Bolt                    |
| (5) Oil seal                  | (12) Nut                     |
| (6) Bearing assembly          | (13) Plane washer            |
| (7) Snap ring                 | (14) Drive pinion nut        |
|                               | (15) Cotter pin              |

## PROPELLER SHAFT & UNIVERSAL JOINTS

Dimensions	Length x Outside diameter x Inside diameter	
	1124 x 63.5 x 60.25 (44 25 x 2 50 x 2.372 in)	
Universal joint		
Journal diameter	14.7 $\phi$	0.579 in
Bearing race inside diameter	19.5 $\phi$	0.769 in
Number of needle (roller) bearings	22	
Needle bearing outer diameter	2.4 $\phi$	0.095 in

### Lubrication

An oil nipple is fitted to each center spider for lubricating the bearings.

The central oil chamber is connected to the four oil reservoirs and to the needle roller bearing assemblies. (Fig. 1)

The needle roller bearings are filled with oil on assembly. Oil from the transmission

Lubricates the sliding splined joint between propeller shaft and the transmission.

Before refitting the propeller shaft to the transmission case, smear the splines with the oil.

### Removal

Remove the rear propeller shaft flange from the pinion flange of the rear axle by taking out the securing nuts, bolts and lock washers

Place a clean tray under the rear end of the gear box to collect any surplus oil that may drain off. The operator should now take the weight of the propeller shaft and then draw the splined end out of the transmission.

### Dismantling

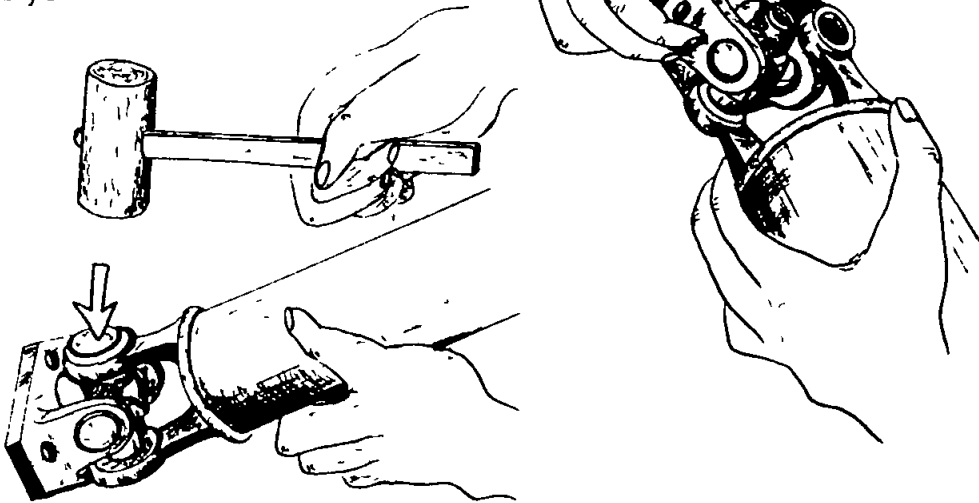
Clean away the paints from all the snap rings and bearing faces to ensure easy extraction of the bearings

Remove the snap rings by pressing these ends together and prise out with screw driver. If the ring does not come out, tap the bearing face lightly to relieve the pressure against the ring.

Hold the splined end of the shaft in one hand and tap the radius of the yoke with a lead or copper hammer, when the bearing will begin to emerge.

If difficulty is experienced, use a small bar to tap the bearing from the inside, taking care not to damage the race itself, being careful not to lose any of the needles

Repeat this operation the other bearing and the splined yoke can be removed from the spider. The same procedure can be utilized to detach the other spider from its yoke.



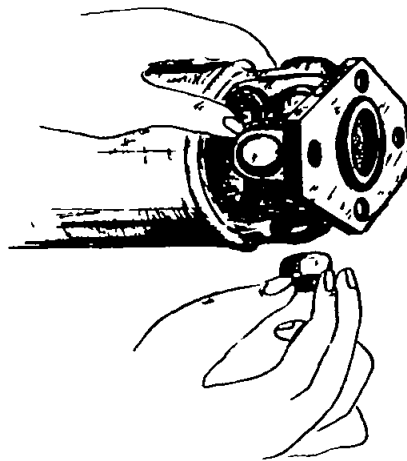
## EXAMINATION & CHECKING FOR WEAR

When the propeller shaft has been in use for a long time, the parts most likely to show signs of wear are the bearing races and the spider journals.

The complete assembly should be renewed if looseness or stress marks are observed, as no oversize journals or bearings are provided. It is essential that bearing races are a light drive fit in the spider trunions.

Any scoring in the trunion bearing holes indicates the fitting of new yokes.

The straightness of the shaft is determined by measuring the off-center deflection of the shaft in rotation with a dial gauge applied both ends. If the deflection exceeds clearance limit, (Less than 0.4 mm) correct or replace the shaft.



## **Reassembling**

Inspect that the drilled holes in the hournals are cleaned out and filled with oil. Assemble the needle rollers in the bearing races and fill with the oil. Should difficulty be experienced in assembly, smear the walls of the races with petroleum jelly to retain the needle rollers (22, Nos ) in place. Insert the spider in the yoke and tap the bearing in position with a foot nosed drift smaller in diameter than the hole in the yoke. It is essential that the bearing races are a light drive fit in the yoke trunnions. Repeat this operation for the other bearings.

The spider journal shoulder should be coated with shellac prior to fitting the retainers to ensure a good seal

If the joint appears to bind, tap lightly with a wooden mallet which will relive any pressure of the bearings on the end of the journals. It is advisable to renew cork washers and washer retainers on spider journals, using a tublar drift

## **Replacing the Shaft Assembling**

Smear the propeller shaft splines with oil and slide the splines into mesh with those of transmission main shaft.

Wipe the rear companion flange and flange yoke faces clean to ensure that the pilot flange registers properly and the joint faces bed evenly all around and securely lock them in position. It is advisable to use new lock in position. It is advisable to use new lock washers

# STEERING

## STEERING GEAR

Type	Hindley, worm & roller
Gear ratio	19 7 1
Steering wheel (out dia. )	430 mm (16 93 in)
Turning torque of worm shaft	0.08-0 15 kgm (0 58-1.09 ft. lb) at outer round of steering wheel
Back lash of worm & roller	0, -0.2 mm (0, -0 01 in) (at the top of gear arm of center position)
Play of turning direction at wheel	35-40 mm (1.38-1.57 in)
Off-set, worm and roller center (standard)	4.5 mm (0 177 in)
Center distance between worm & roller	52 mm (2.05 in)
Locking angle	$\pm 40^{\circ}$
End play of worm roller	0 02-0 04 mm (0.0008-0 0016 in)
Tightening torque Cover bolts	2.5 kg-m (18.2 ft. lb)
Roller shaft bolts	14 kg-m (102 1 ft. lb)
Gear box fix bolts	4 5 kg-m (32.8 ft lb)
Oil capacity	0.3 L (0 008 U.S Gal)
Thickness of adjusting shim for housing end play	
Shim for adjusting front end play	0.762 mm (0.030 in.)
"	0.254 mm (0.010 in.)
"	0 127 mm (0 005 in.)
"	0.075 mm (0 003 in.)
"	0 050 mm (0 002 in.)
Shim for adjusting rear end play	0.254 mm (0.010 in.)
"	0.127 mm (0.005 in.)
"	0.075 mm (0.003 in.)
"	0 050 mm (0.002 in.)

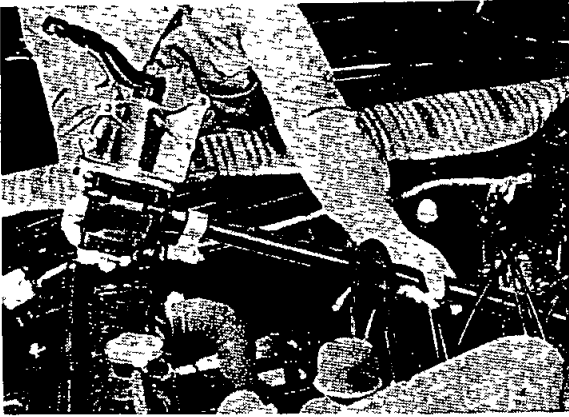
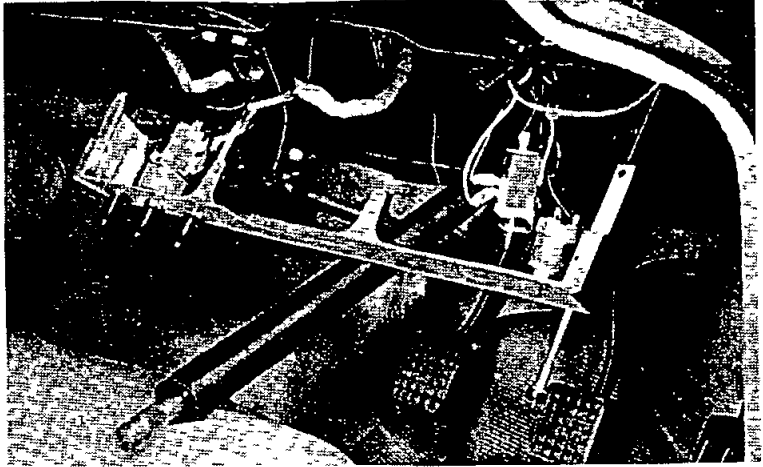
The type of steering gear is worm and roller and has the drum type of worm gear at the lowest end of main steering shaft.

The main steering shaft is incased in the jacket tube, and the steering wheel is fixed with at the top end of it

The worm gear inter locks with the roller which is fixed on the roller shaft and works upon it to turn and through which turns the steering arm around the axle of shaft at the operation of steering wheel

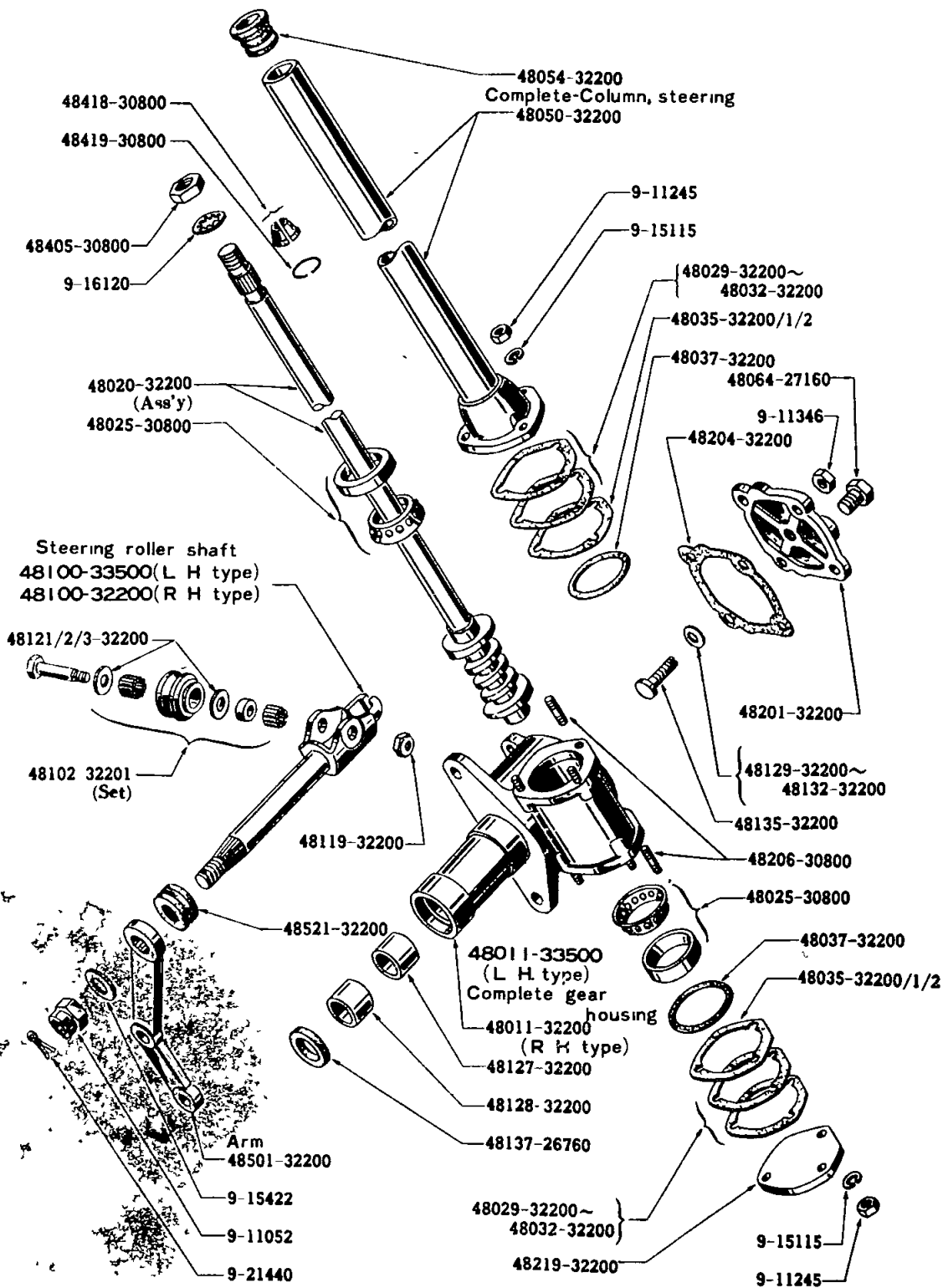
The motion of the steering arm is that of back and forth in front of drag link, and turns the spindle around the king pin with the connecting knuckle arm, through which changes the bushings of front wheels.

The roller shaft itself is supported by the two bearings both sides in the gear housing.



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5





**Fig. 1 Steering Gear**

## **Assembling and Inspection**

In case the replacement of parts is required due to the defacements and damages of steering gear and housing bush, disassemble and adjust in the following order.

### **Dismounting of the Steering**

- 1) Take off the steering wheel  
Pull out the three screws of the back side of steering wheel boss, then take off the horn button retainer as well as horn button.  
After unscrewing and taking off the wheel nut, pull out the steering wheel with the steering wheel puller.
- 2) Disconnect the clamp on and under the remote control rod which is fixed on the jacket tube after unscrewing the steering jacket clamp bolt under the instrument panel, and disconnect the horn cord.
- 3) Disconnect the steering gear arm with the drag link, unscrewing the end plug at the side of steering gear arm of drag link, thus is taken off from the gear arm.
- 4) Take off the fixing bolt of steering gear box which is fixed with the side member of frame.
- 5) Pull out the steering assembly to the downward direction

### **Disassembling and Inspection of the Steering Gear**

After the steering assembly is dismounted and the gear oil is completely drained, the steering gear box should be fixed on the vice setting the steering tube on level.

- 1) Taking off the steering gear arm.  
Take off the nut of gear arm and roller shaft cover and strike out lightly the bolt, then pull the gear arm out of roller shaft.
- 2) Dismounting the housing cover and roller shaft assembly.  
In dismounting the cover, the column jacket and roller shaft assembly after unscrewing the three nuts, the adjusting shim of the housing gear must be handled with care not to loose them.
- 3) Taking off the housing end plate.  
Unscrew the three nuts, at the front end of the housing and they should also the handled carefully not to loose them.



- 4) Dismounting and inspection of the worm shaft and bearing  
The main shaft could be dismantled together with the roller bearing assembly and upper bearing cone by fixing the wheel nut on the tip of main shaft and striking out lightly, without damage.
- 5) Take the column jacket out of the gear housing, thus the outer race of upper bearing can easily be dismantled.  
The adjust shim must be carefully handled not to lose them in taking off the housing gear.
- 6) Inspection and adjustment of gear housing column jacket and front cover. Adjust the steering gear by changing the total thickness of the adjust shims of the worm bearing so that the starting torque for revolving worm shaft is 0.08 - 0.15 kg at the circumference of steering wheel. In this case, tighten it with the end cover by applying the "O" ring. Use the said ring 0.3 - 1.1 mm thicker than the used shims. And further adjust by changing the thickness of the worm bearing adjust shims exchanging the rear and front shims.
- 7) Inspection and adjustment of the roller shaft  
The shaft itself should be checked and replaced with new one when it is worn out. The roller shaft assembly should be replaced in a unit in case the roller pin becomes loose and damages or defacement of surface of roller is found. The replacement can be limited to the worn out parts after disassembling. Fit the roller shaft to the gear housing after inserting the adjust shims to the adjust screw and adjusting said screw so as the end clearance along the roller shaft is to be 0.01-0.03 mm with the shims. The back lash at the top of gear arm is to be 0-0.2 mm in the vertical rolling center of the roller shaft and lock the nut up after confirming that the roller is smoothly rolling over the worm gear.
- 8) Assemble and Disassemble of the linkage  
The joint parts of the linkage are constructed with the spring sheet, spring plug, and so forth, and this order must be conformed with in assembling the unit. Otherwise, the spring would not action besides giving a shock to the every part of the unit, wearing out both the steering gear arm and linkage of the steering, which furtherly will be easily pulled off endangering the operation.  
It is, therefore, important to check and to set aside the parts in assembling order when disassembled.



Fig 2 Adjusting of Backlash Worm & Roller

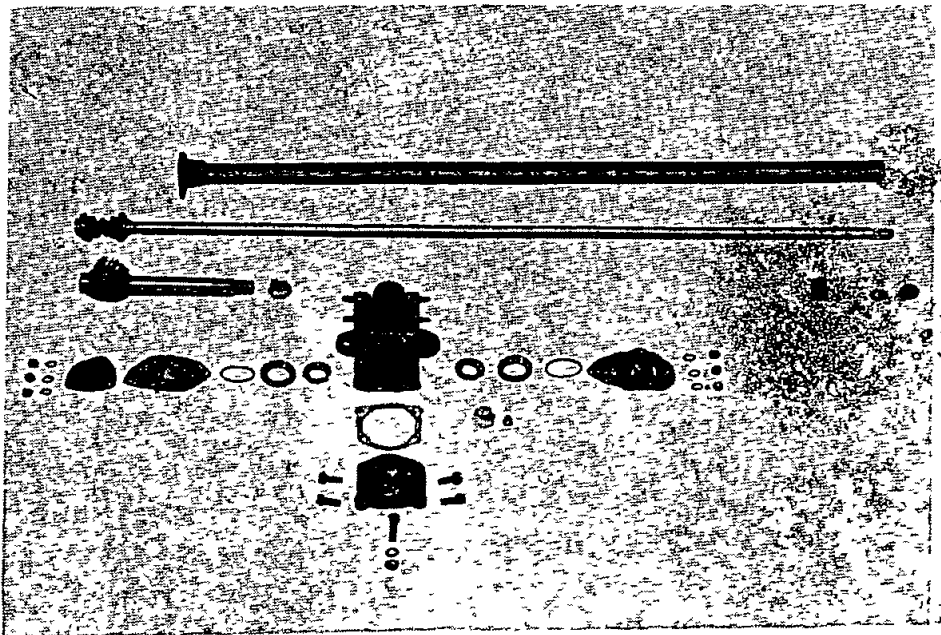


Fig 3 Components of Steering Gear Case

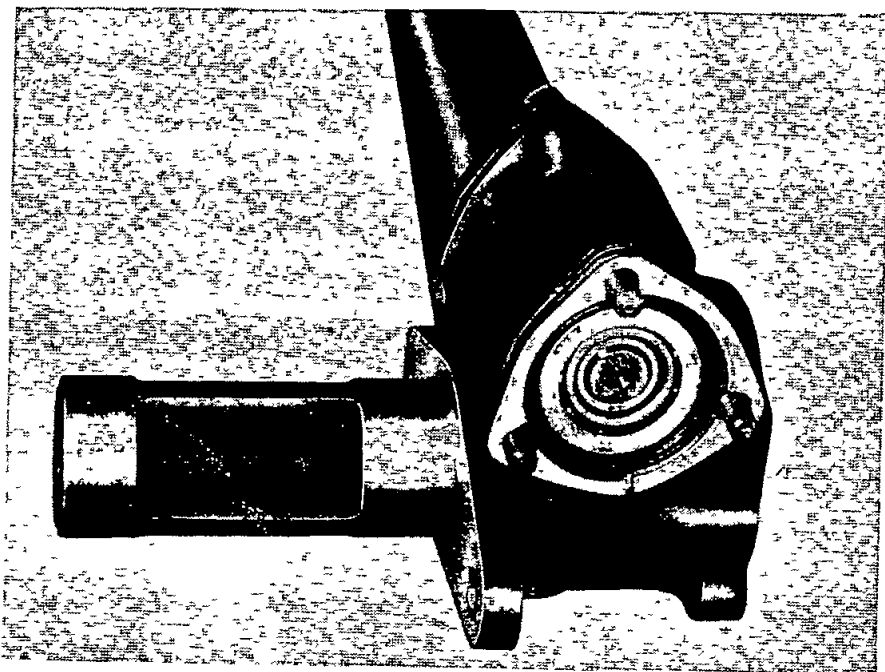


Fig. 4

## ***Inspection and Adjustment after Assembling***

It is important that the center of interlocking roller is located in the center of worm gear.

The inspection for this should be made in a way as to make sure of the equal conditions of backlash at the position of steering wheel when turned fully to left and right. In case the backlash differs, greatly, the interlocking position of worm gear must be adjusted again.

The correct backlash at the both ends of worm gear should be made sure of, after putting the more shim in the side of larger backlash at the gear arm and for equalizing, pull out the shim on the opposite side and tighten up the bolt again, adjusting with the shim in front of and the shim behind the gear housing.

The backlash at the center locking should also be checked and adjusted, if necessary.

## ***Installation of Steering Wheel***

Inspection by steering wheel

The steering wheel is relation-locked with the shaft and it may as be fixed to the forwarding direction, tightened may as well be fixed to the forwarding direction, tightened with nuts.

The standard revolving weight gravity of the wheel on the wheel rim circle, as for as it is rightly assembled, is 0 08-0 15 kgm (0 58-1 09 ft lb) measured by the spring scale

The play allowed on the circle of wheel is 35-40 mm

Installation and adjustment of horn button

The horn button should be installed in a reverse order of dismounting

## **Inspection and Adjustment of Steering Fixed on Car**

The inspection and adjustment of the steering system installed in the car should be made in following order

- 1) Set the car on the levelling place with the front wheels fixed to the forwarding direction

Take measure of the position of lower part of wheel and tube with the finger of one hand, spin the wheel to left and right to the extent of wheel's play by another hand. When the wheel moves up and down, there should be found a play in the worm bearing to the direction of axle

In this case, the fixing bolts in front and rear (upper or lower) of gear housing are loose on the bearing is worn out.

The shim should be pull off in a way as explained in the item of worm bearing and the adjustment should be made as explained in the item of inspection and adjustment after assembling

- 2) In case the roller shaft moves to the direction of axle shaft, as the wheel spined hardly to left and right, the roller shaft adjusting screw is loose. The adjustment should be carried in a way as explained in adjustment of the position of steering roller.
- 3) In case the roller shaft shakes to left and right, the roller shaft or the bush is worn out, therefore, they should be replaced with new one and adjusted.
- 4) In this case the fixing bolt for gear housing front and gear (upper or lower) is loose or the bearing is worn out, for which the shim should be pulled out in a way as mentioned in the item of worm bearing, and the adjustment should be made as inspection and adjustment after assembling.
- 5) In case the roller shaft moves to the axle shaft, by returning the wheel to left and right, the roller shaft adjusting screw is loose, for which the adjustment should be made in a way as explained in adjustment of the position of steering roller.

- 6) In case the roller shaft trembles to left and right, the roller shaft or the bush is worn out and they should be replaced with new one and adjusted.
- 7) Take off the drag link at the end of steering gear arm. In case the play should be found by holding the arm and move it strongly back and forth, the backlash of roller and worm gear is too large. The adjustment for this should be done in a way as explained in the above section setting the steering wheel at the center of turning to left and right.
- 8) In case the operation of steering wheel felt heavy and becomes light when the front axle is jacked up, the trouble is with the front axle system.  
In case the wheel is still felt heavy even when the front axle is jacked up, the trouble is connected with the front axle.
- 9) When the front axle is jacked up, the inspection of contacting and tightening parts of tie-rod socket, neckle arm, drag link and the steering arm should be possible.

## **ADJUSTING IDLER**

In the standard adjustment, pressure is not given on the rubber spring. When the idler arm is positioned in parallel with the idler body, screw in the shaft so that its protruding from the body top is 34 mm. Then fit the rubber spring to it and tighten the nut at the top to the extent that the rubber is slightly compressed and clinch the nut. In this case, overall height of the rubber spring is 20.7 mm approx. In the next, after it is mounted to the car and toe-in is adjusted, tighten the rubber spring with bolt to eliminate residual dimensions on it by utilizing the long hole in the rubber spring fitting plate.

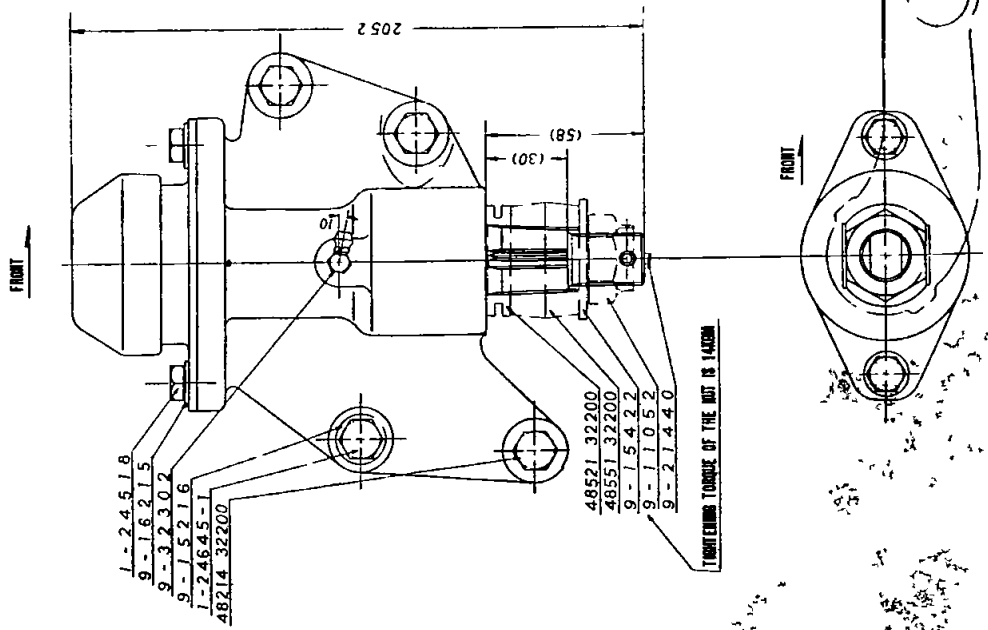
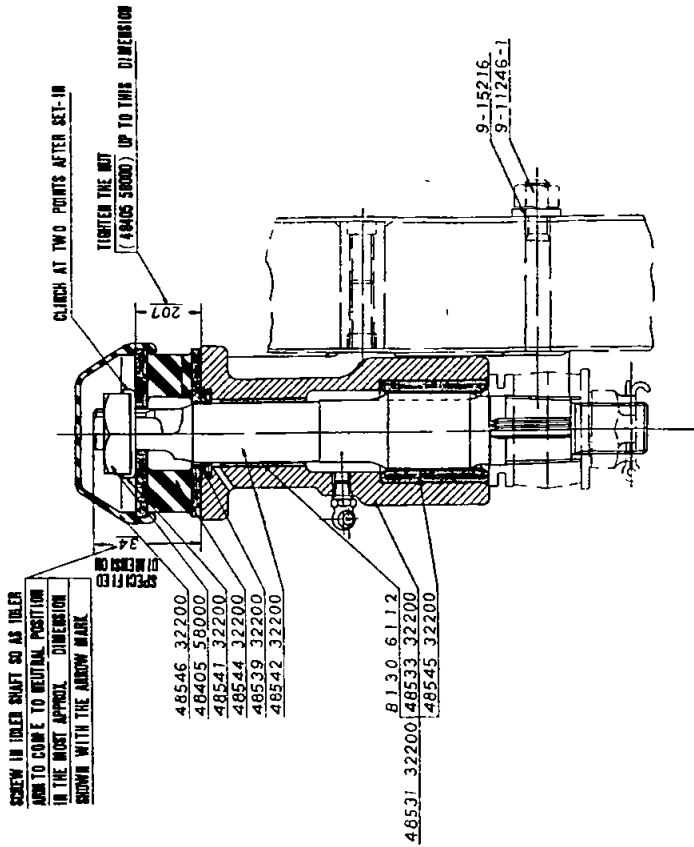
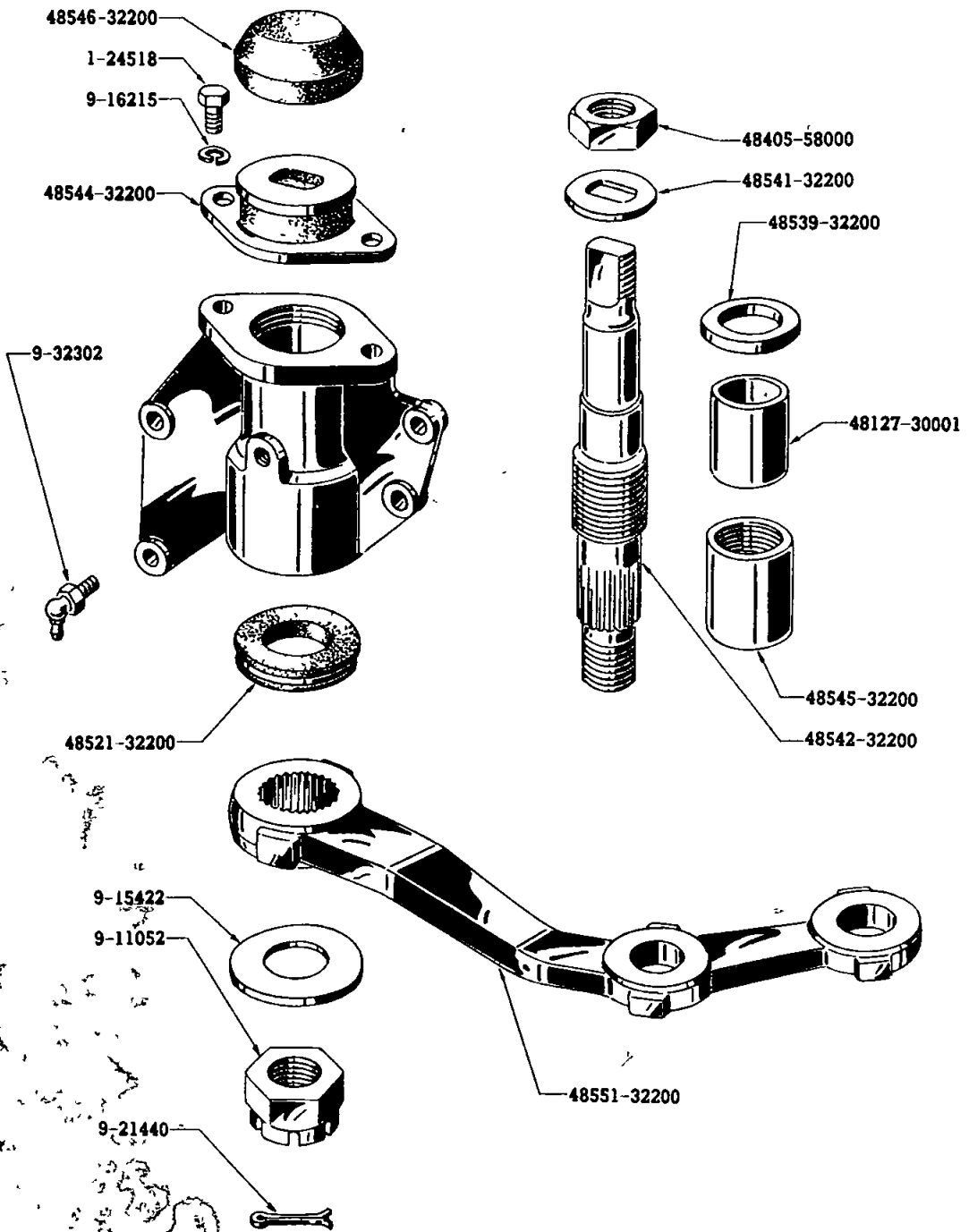


Fig. 5



**Fig. 6 - Steering Idler & Arm**

## ***THE CAUSE OF TROUBLE***

The cause of the trouble caused in regards with the steering in operation, is closely connected with those of the front axle, therefore it is hard to judge then Separately

The following are main troubles caused in steering

Heavy and difficult operation of handle

- 1) The oil in gear box.
- 2) Adjustment of worm and roller is poor
- 3) Damage on corn of worm bearing
- 4) Hard locking of column jacket bush
- 5) Steering shaft or tube is bended

### ***Insufficient Amount of Turning***

- 1) Adjustment of worm and roller is poor.
- 2) Fixing port of gear housing with frame is loose
- 3) Locking position of roller shaft and steering arm is bad

### ***Unsteady or Trembling Handle in Motion***

- 1) Too much backlash of worm and roller (wheel play is too large)
- 2) Worm bearing and roller shaft bush is worn out
- 3) Looseness of each bolts on gear housing.
- 4) Looseness of fixing bolts for frame

### ***Insufficient Return of Handle***

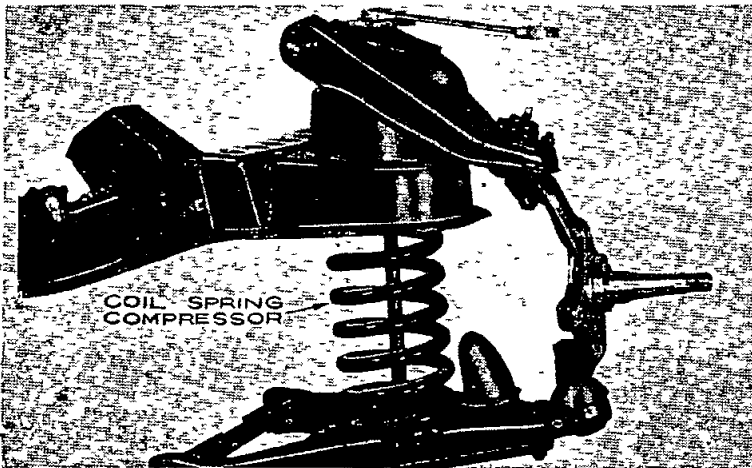
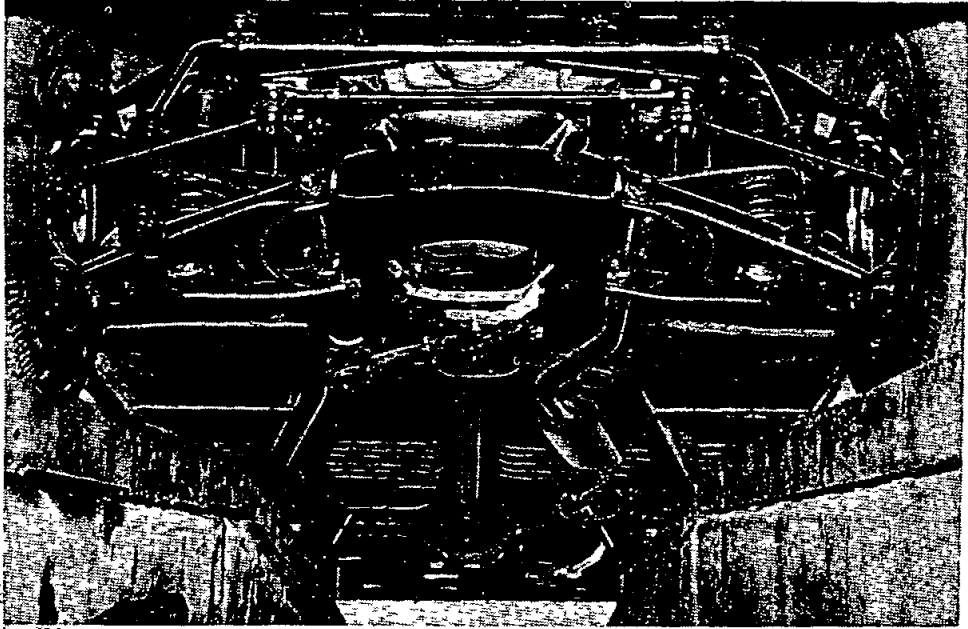
- 1) Tightness of each parts
- 2) Worn out parts partial defacement.

### ***Noise in the Gear Housing***

- 1) Backlash of worm and roller
- 2) Insufficient gear oil



# FRONT AXLE



# FRONT AXLE

Type	Independent suspension with double wishbones, ball joint, Coil spring & telescopic shock absorbers Stabilizing bar
Hub bearing	
Inner type	Tapper roller
Size mm	Outer dia x Inner dia. x Width 65 x 32 x 18 25(2.55 x 1.26 x 0.7185 in)
Outer type	Taper roller
Size mm	52 x 20 x 16 (2.05 x 0.79 x 0.63)
Toe in	2 - 3 mm (0.08 - 0.12 in)
Camber	1° 30'
Caster	1° 30'
Angle of inclination of Swivel axle	6° 30'
Tread	1330 mm (52.36 in)
Turning angle of front wheel	
Inside	35°
Outside	29° 30'
Wheel bearing adjustment	Tighten wheel bearing nut with wrench, turning wheel at the same time, pull up the adjust nut until resistance against bearing is felt, then turn back nut 1/8 turn and insert cotter pin

## FRONT SPRING

54010 32201	668 - 688	225(8 86 in)	377(14 84 in) - 382(15 04 in)	Red tape with 1 white line
54010 32202	688 - 708	225(8 86 in)	382(15 04 in) - 386(15 20 in)	Red tape with 2 white lines
54010 32203	703 - 728	225(8 86 in)	386(15 20 in) - 391(15 40 in)	Red tape with 3 white lines
54010 32204	728 - 748	225(8 86 in)	391(15 40 in) - 395(15 56 in)	Red tape with 4 white lines
54010 32205	668 - 688	217 5(8 957 in)	366(14 42 in) - 371(14 62 in)	Yellow tape with 1 white line
54010 32206	688 - 708	217 5(8 957 in)	371(14 62 in) - 375(14 76 in)	Yellow tape with 2 white lines
54010 32207	708 - 728	217 5(8 957 in)	375(14 76 in) - 379(14 92 in)	Yellow tape with 3 white lines
54010 32208	728 - 748	217 5(8 957 in)	379(14 92 in) - 384(15 12 in)	Yellow tape with 4 white lines

# FRONT AXLE & SUSPENSION

The front axle is equipped with the independent suspension with coil spring and telescopic shock absorber, and connection of the upper and lower swivel axles with the double transverse links is of a ball joint type and the swivel pin is not used for it.

The upper spindle bracket is bolted to the front suspension member with caster shims and the lower spindle is connected to the lower bracket of the suspension member with the shims.

Fig 1

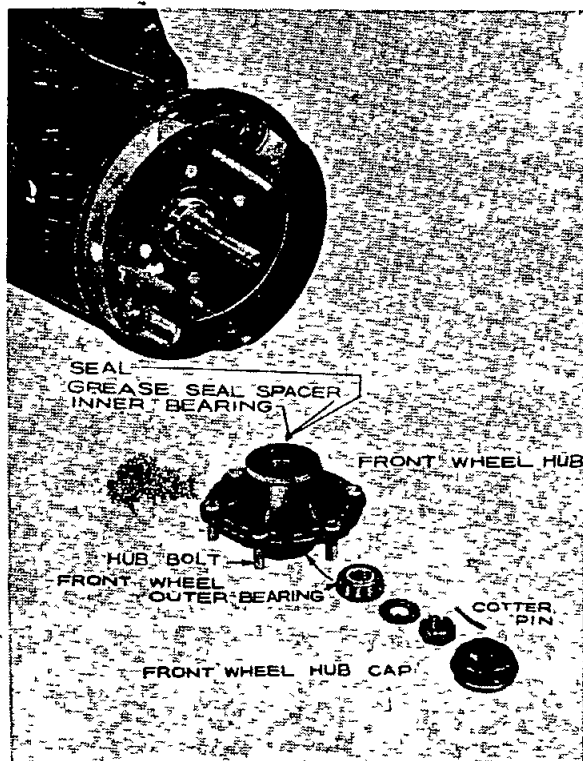
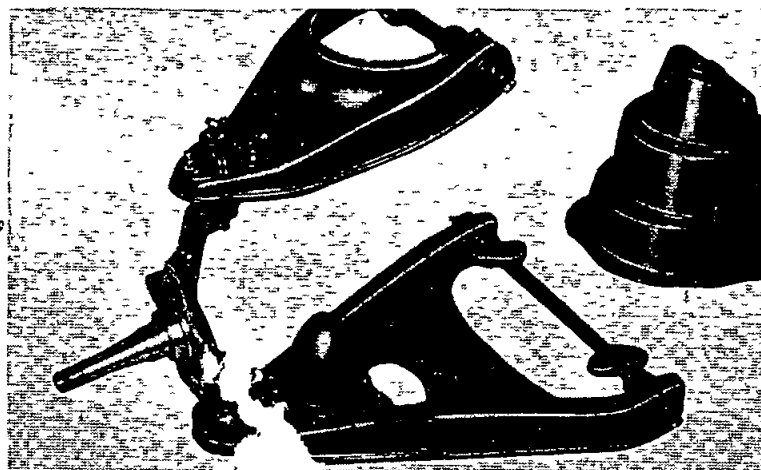
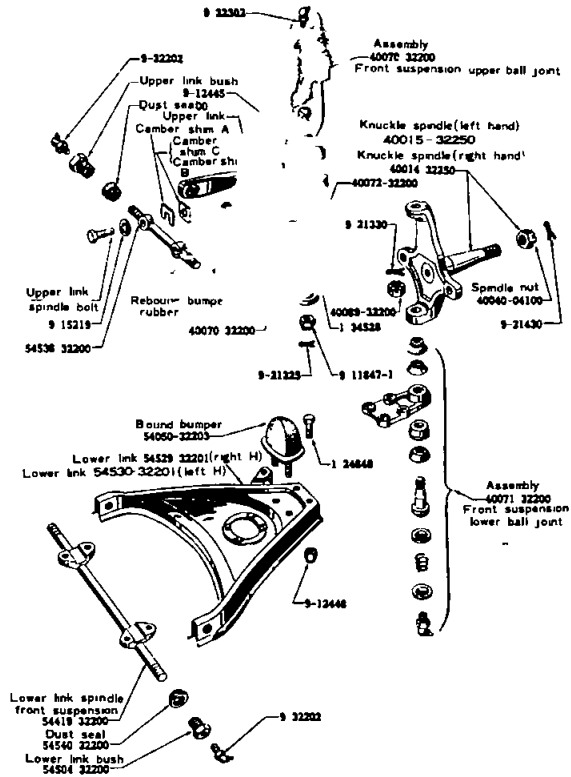
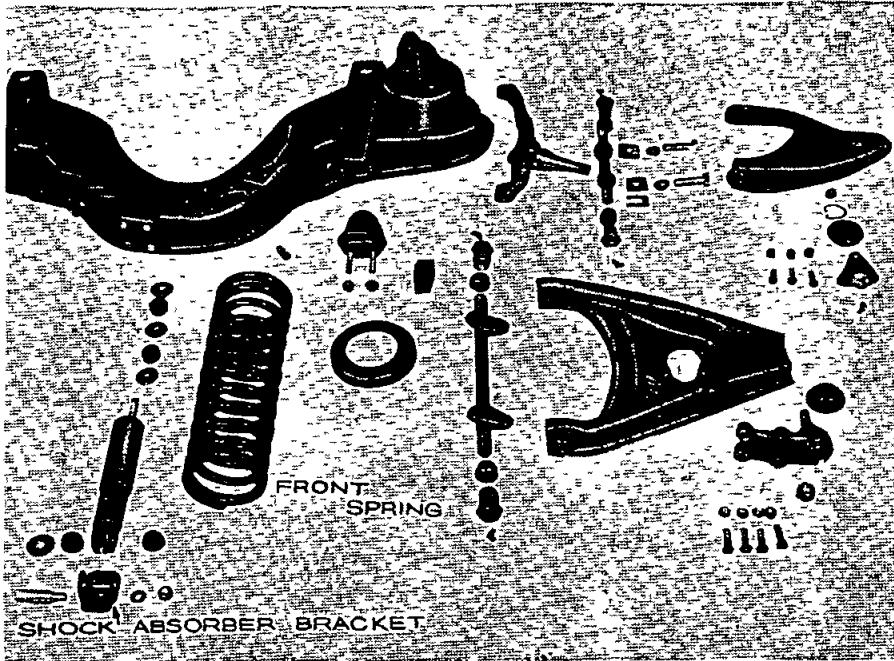
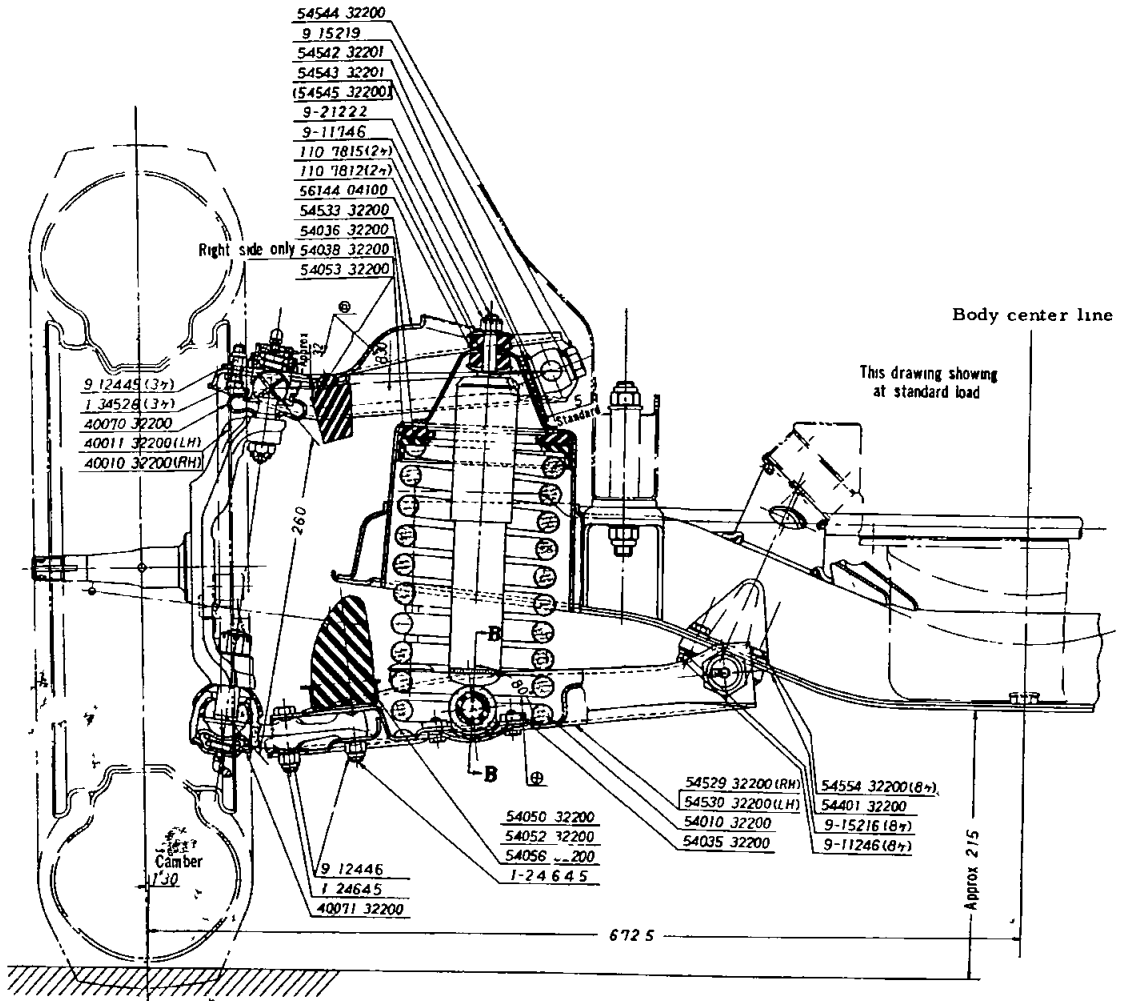


Fig. 2



**Front Suspension Link & Spindle**



**Front Suspension Section**

## Disassembling the front hub

Dismantling of the front hub, first jack up the car until the wheel is clear of the ground and then place under independent suspension spring plate

Lower the car on to the blocks. Remove the wheel. If the drum appears to bind on the brake shoe, the adjuster should be slackened

Lever off the hub cap, and then extract the split pin from the spindle nut

Using a box spanner remove the spindle nut and ease flat washer under the nut, clear of the axle thread by carefully using a narrow rod into small holes, in turn, each side of the spindle and tapping the race lightly.

With the hub removed, outer bearing can be dismantled, and by inserting a drift through the inner bearing and tapping the out bearing clear of the hub.

The inner bearing and oil seal can then be removed by inserting the drift from the opposite side of the hub.

## Assembling the front hub

When assembling the hub and the inner bearing race should first be inserted into the hub

Pack the hub with recommended grease

Replace the hub oil seal over the inner bearing. Renew the seal if it is damaged any way. The hub can now be replaced on the spindle. Gently tap the hub into position until the inner race bear against the shoulder on the spindle.

Place the spindle flat washer into position and screw the nut down finger tight.

Spin the wheel and examine the resistance.

Tighten the nut.

A slightly increased resistance to the spinning of the wheel will then be noticed. The bearing are now preloaded and the split pin should be inserted to lock the nut

Tap the hub cap to the hub after packing the cap with grease.

Replace the brake drum and secure with machine screws. It is important that the drum is fully home before this screws is tightened and if necessary, the drum should be pressed in position by tightening two wheel nut.

Refit the wheel and nuts are best finally tightened when the car is off the packing blocks but readjust the brake shoes if necessary the car is lowered to the ground.

# REAR AXLE

Type	Semi-floating type
Housing	Banjo type with steel plate welded
Driving method	Hypoid bevel gear
Number of teeth on drive gear & pinion	35 . 8 (4. 375) (L)P31,(L)G31,(L)H31,(L)WP31) 41 . 8 (5. 125) (L)31-U)

## DRIVE PINION

Tightening torque of pinion nut	13. 8 - 16. 6 kg cm (100-120 ft-lb)
Pre-load for pinion bearing (without oil seal)	7-10 kg cm (0. 07-0. 10 lb ft)
Thickness of adjusting shim on pinion bearing	0. 75 mm (0. 030 in. )
Thickness of adjusting shim on pinion bearing	0. 25 mm (0. 010 in. )
Thickness of bearing adjusting shim	0. 125 mm (0. 005 in. )
Thickness of bearing adjusting shim	0. 075 mm (0. 003 in. )
Standard position to install with drive pinion	
Dimension from center of drive gear to rear side of pinion	61. 00 mm (2. 401 in. )
Off-set dimension(upper & lower)	25. 4 mm
Thickness of pinion adjusting shim	0. 75 mm (0. 030 in. ) 0. 25 mm (0. 010 in. ) 0. 125 mm (0. 005 in. ) 0. 075 mm (0. 003 in. )

## DRIVE GEAR

Backlash between drive gear and pinion	0. 10-0. 15 mm (0. 004-0. 006 in. )
Thickness of side bearing adjusting shim	0. 75 mm (0. 030 in. )
Thickness of side bearing adjusting shim	0. 25 mm (0. 010 in. )
Thickness of side bearing adjusting shim	0. 125 mm (0. 005 in. )

Thickness of side bearing adjusting shim	0.075 mm (0.003 in.)
Thickness of side bearing adjusting shim	0.050 mm (0.002 in.)
Tightening torque for clamp bolt of side bearing cap	4.1-4.8 kgm (30-35 lb ft)
Run-out of opposite side of drive gear	0.05 mm (0.002 in.)
Tightening torque for clamp bolt of drive gear	4.8-5.5 kgm (35-40 lb ft)

### BEVEL SIDE GEAR AND PINION MATE

Number of tooth on side gear	18
Thickness of thrust washer on side gear	0.76-0.81 mm (0.030-0.031 in.)
Number of tooth on pinion mate	10
Thickness of pinion mate thrust washer	0.76-0.81 (0.030-0.031 in.)
Backlash between side gear & pinion mate	0.1-0.2 mm (0.004-0.008 in.)
Clearance between side gear & case	0.2-0.4 mm (0.008-0.016 in.)
Amendment limit of dittoed clearance	0.5 mm (0.020 in.)
Tightening torque for wheel bearing nut	12 kgm (87.5 lb ft)

### OIL USED

Standard of oil	Gear oil MP #90 (Hypoid gear oil) In warmer district than 32°C use MP #140
Oil quantity necessary	0.9 lr (0.23 U S Gal)



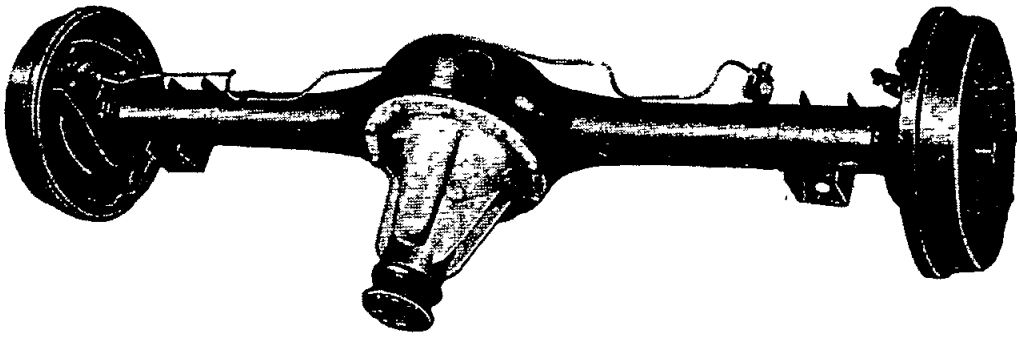


Fig. 1

## THE CONSTRUCTION & HANDLING

The rear axle is semi-floating and the hypoid bevel gear is used for slowing down the speed. The engine power is transmitted through the transmission to the propeller shaft, then to the drive pinion and finally drives the left and right rear axle with the differential gear which is housed in the axle housing. The axle housing is made out of the pressed steel plate in the form of Banjo and is constructionally strong enough against the torsion or the bending for its light weight with its rear cover being welded.

The gear carrier is made out of light and strong alloy of aluminum and the differential gear ass'y is so constructed as to make easy dismounting and the adjustment of each gear carrier. The rear axle shaft is materially made out of molybdenum chrome steel of highly strength, and the spline is of the involute gear type.

Inside the housing, the drive pinion drives the bevel gear which is closely connected with the differential gear case. The each two pinions and side gears are fixed in this case and locked each other. The pinion locks with the pinion shaft which is supported by the gear case, while the side gear, which is so supported as to function freely inside the gear case, is connected with the spline at the top end of rear axle shaft.

Thus the construction of differential gear combined with these gears has the function of controlling the difference of revolution of the rear wheels in the turning to the various directions. The pinion as it stays on the pinion shaft drive equally the side gear on left and right and drives at the same speed the rear axle on the straight line. In case of turning or meeting at the resistance of some obstacles on the ground the pinion revolves itself on the pinion shaft and drives differentially the side gear, as well as the rear axle when the revolution of left and right wheels differs.

The external side of axle shaft which locks with the side gear, is inclined and fixed to axle housing with the brake disc.

The shaft is supported by the taper roller bearing to the axle tube with the brake disc fixed by the four bolts together with the adjusting shim.

It is not necessary to check the lubrication to the bearing, but need to feed the new wheel bearing grease in proper quantity when disassembled. The proper lubrication to the gear housing is also necessary, otherwise it would shorten the durability of the gear to cause the trouble.

The following points must be taken into consideration

1. Nominated Hypoid gear oil No. MP 90 must be used.  
(Temperature over 32°C SAE. MP 140)
- 11 It is prohibited to use any other kinds of gear oil or any oil of different viscosity. The same brand must always be selected

The standard capacity of oil is about 0.9. The method of feeding oil should be done by taking off the feeler plug at the rear cover of the housing and fill in full up to the feeding hole.

The brake system would not work if over-feed the oil by causing it to flow out of the bath end of the rear axle housing into brake drum

#### Dismounting & Disassembling of Differential Gear Carrier

- 1) Take off and drain out the gear oil
- 2) At the time of dismounting the gear carrier, pull out the both left and right axle shaft or pull out for at least 4 inches
- 3) Take off the joint flange from the side of propeller shaft.
- 4) Pull off the nuts of the housing and dismount forward the carrier ass'y
- 5) Take off the side bearing cap of carrier and pry with a lever the differential gear case and the bearing
- 6) Dismount the differential side bearing.  
As illustrated in Fig. 2 with the aid of side bearing puller, pull out the bearing. The puller should be handled with care in catching the hedge of bearing inner race which is hard to hook. Both the left and right bearing should be arranged separately.
- 7) Dismount the differential drive gear, by loosening the screws on the differential gear case, and spreading out the lock washer. Loosen them in a diagonal line considering to keep from the gear bending

8) Take out the differential pinion as well as the side gear. The pinion mate shaft should first be pulled out by striking out the pinion mate shaft locking pin which is fixed on the differential case from left side (from the side of ring gear fixed) to the right before pulling out the pinion, side gear and the thrust washer. The gear as well as the thrust washer should be arranged separately as left and right, front and rear

9) After taking the nut of the carrier, pull out the companion flange. The drive pinion flange wrench should be employed, setting its four points in the holes of flange to keep it from moving, take off the nuts with the box wrench.

10) Take out the drive pinion of gear carrier by striking out lightly to the backwards the front end (at the side of companion flange) of drive pinion with the drift of soft metal. Thus, the pinion would be taken out together with the inner race of rear bearing and roller, distance piece, and the adjusting shim and the oil seal, outer race and pinion of front and rear bearing as well as the pinion adjusting shim left in the carrier.

11) Pull out the rear bearing inner race of the drive pinion. The drive pinion rear bearing inner race replacer and the adaptor should be employed in this case. The adaptor in the round form is for fixing and the other for taking off. It is easy to handle with the vice fixing one end of replacer.

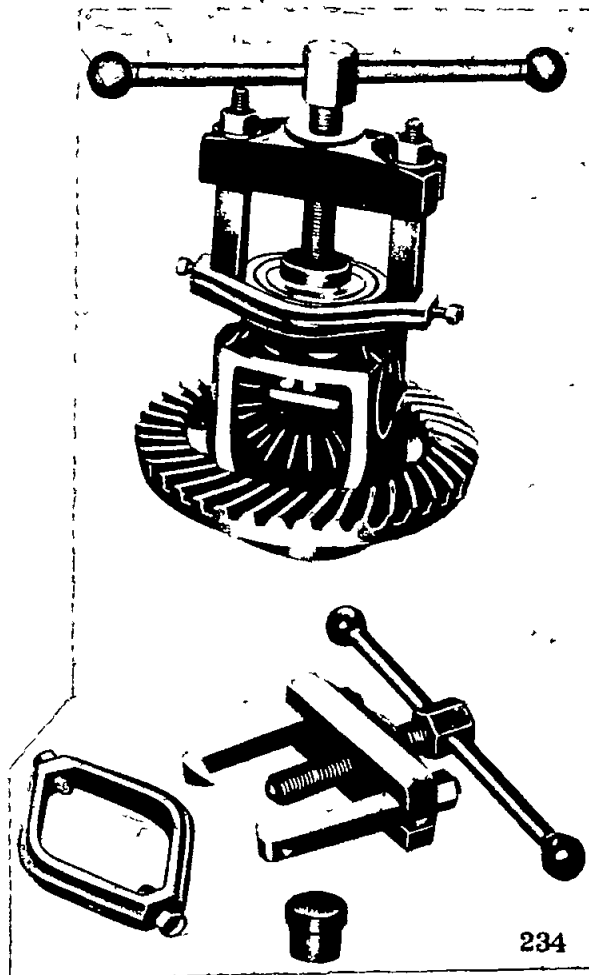


Fig. 2 Using of side bearing puller

Assembly gear carrier with gear

38300 37000	41/8	5.125
38300 37800	35/8	4/375
38300 37001	39/7	5.572
38300 36800	37/8	4.625

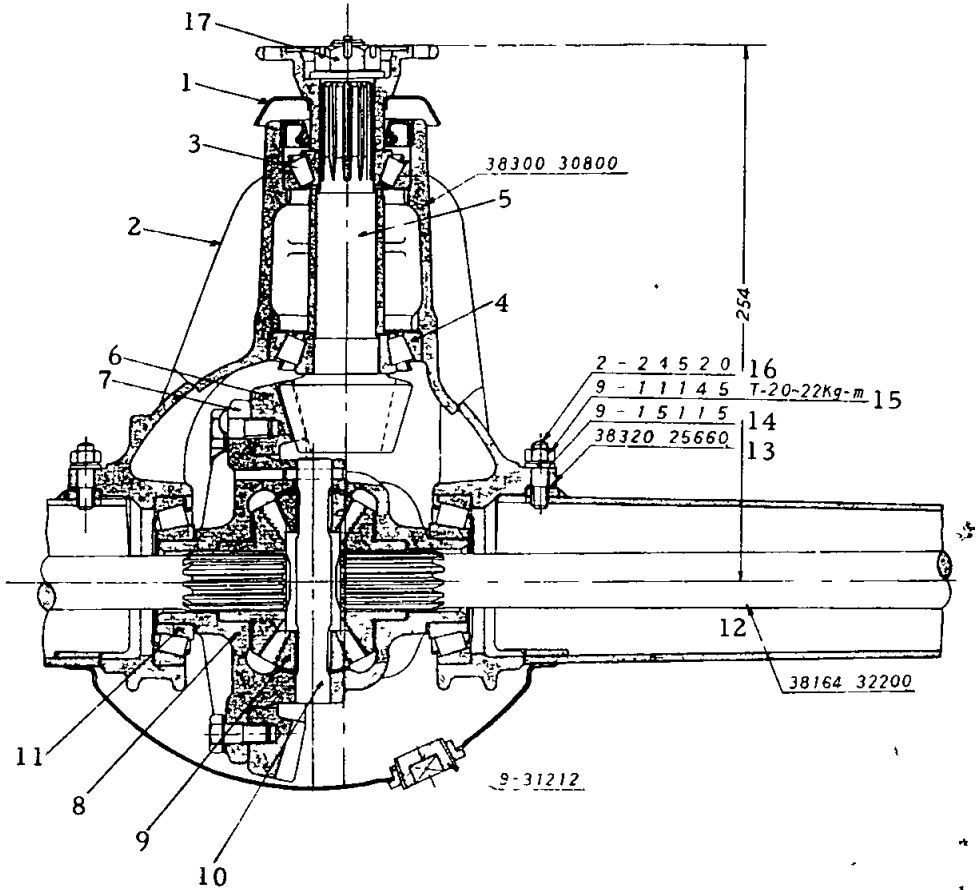


Fig. 3 Differential gear carrier

- |                               |                          |
|-------------------------------|--------------------------|
| 1. Companion flange           | 10. Pinion shaft         |
| 2. Carrier assembly           | 11. Diff. side bearing   |
| 3. Drive pinion front bearing | 12. Rear axle shaft      |
| 4. Drive pinion rear bearing  | 13. Gear carrier packing |
| 5. Hypoid drive pinion        | 14. Washer               |
| 6. Hypoid drive gear          | 15. Nut                  |
| 7. Diff. gear case            | 16. Stud                 |
| 8. Diff. bevel side gear      | 17. Drive pinion nut     |
| 9. Diff. bevel pinion mate    |                          |

- 12) Taking out the rear bearing outer race of gear carrier.

The drive pinion bearing outer race replacer should be employed in this case. In other upon the stud so as to make the screw at the center of carrier, and set the adapter at the lower firm of the race. Supporting the tommy bar and screw up till the cone closely touches the adapter, then screw the wing nut to take out the rear outer race.

- 13) To pull out the front bearing outer race from the gear carrier, set the tool body pull it out with adapter in the way of rear race

## INSPECTION & REPAIRING OF DISASSEMBLED PARTS

Every parts after they are disassembled should be cleaned and cleaned by the compressed air before making an inspection and adjustment.

- 1) Each bearing should be inspected in every unit of ass'y in regard with the defect and defacement before deciding to reused them
- 2) Every gear should be inspected as to the locking condition defacement or any defects on the surface to see if they can be reused. In case of insufficient standard backlash, deformation or found, replacement is necessary. Specially the drive pinion and drive gear should be replaced in a set whenever the locking condition gets worse and the defacement is already in progress, because it would cause the noise in later operation and be difficult to adjust even with proper adjustment is made.

The perfect driving condition at the surface of drive pinion gear should be about from  $2/3$  mm to  $3/4$  in unloaded driving while the gear surface should start to touch from tip to full surface in an ordinary loaded driving

The inspection of this condition can be made as it is

If it is hard to inspect them as it is, do otherwise by cleaning the both with the rags before disassembling and paint thinly and evenly with the mixed with thin oil on the gear surface (drive side) then turn the pinion with hand to print the trace of it on the gear. Which shows the situations of considerably worn out gear.

In case of unloaded test, it is perfect that the gears contact for about three quarter at the center of  $1/4$  of whole gear length from tooth (interior tip end of gear) on the pitch line

- 3) Lock the side gear with pinion together with respective thrust in the gear case

In case of the backlash over 0.2 mm and the clearance between the side gear and thrust washer exceeds 0.5 mm replace the thrust washer

The else worn out parts should also be replaced

The contact when ring gear is too close to pinion center in case of backlash should be adjusted closely or it gives much noise

- 4) Put the drive gear (ring gear) on the buoy block as it is fixed in the differential gear case, and measure with the dial indicator. Revolve the drive gear to turn around the differential gear case as the bearing do not move on the buoy block.

Measure the shake at the rear side of gear by the scale and the shake should be within 0.5 mm. In mounting the gear, clean well the fitting face and rear face (measured face) of it and fix correctly, then there should not be any shaking.

## ASSEMBLING, ADJUSTMENT

### Assembling differential Gear

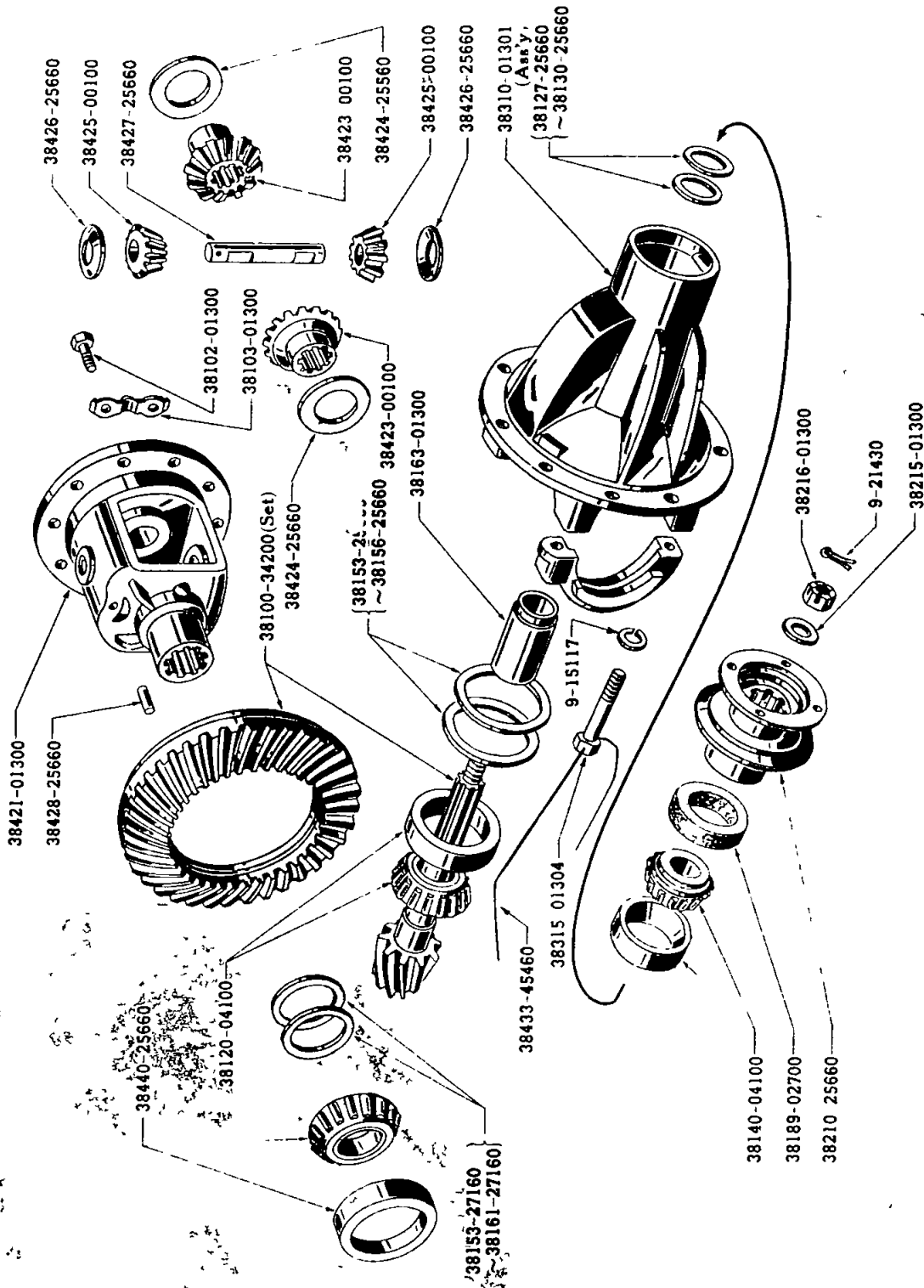
- 1) Assemble the pinion and side gear in the differential case

Every parts should be cleaned and oiled with new gear oil, then the pinion mate side gear and the thrust washer should be assembled by the mentioned inspection and selection before pushing in the pinion mate to shaft. Inspection should be made again in the clearance of between the washer or the backlash. Adjustment must be made in case any abnormal, is found.

Strike in the pinion shaft locking pin from the right side of the case (opposite side of drive gear) and must be fixed by setting well the striking hole of it after putting it to the required piston so as the pin should not loosen.

- 2) Fix the drive gear (ring gear) with the differential case

The drive gear as well as the drive pinion should be well inspected or they must be replaced as a set whenever the replacement is required. Otherwise, they would not properly lock after assembling is completed. In mounting in the case, the fitting surface must specially be cleaned and fixed with 8 Nos screws as well as lock washer. Bend the washer with sureness after the drive gear shake is adjusted. In tightening up the screw, it should be set and supported by vice or any other setting tools, so as not to damage it and screw up in a diagonal line with a wrench which fit correctly with the head of the screws. The standard screwing torque for this is 35 ft/lbs. to 40 ft/lbs. Screw in for sure, striking lightly the head of screw by one quarter pound hammer



**Fig. 4. Gear Carrier & Gear**

- 3) Mount the side bearing in the differential case

Press in the both side of the bearing by using the drift.

It is important in this case to assemble by putting the side bearing adjusting shim to give the bearing a proper preload in fixing with the carrier

## **ASSEMBLING & ADJUSTMENT BY GEAR CARRIER ASS'Y**

It is to decide the assembling & adjustment of gear which is most important in an rear axle ass'y and should be carried in accordance with the exact sample shown by the manufacture. The construction and mechanism must well be comprehended referring to Fig 5 & 11 and the adjustment & repairing exactly according to the condition of practical use based on the adjustment by exact calculation

### **A) The Preparation for Mounting the Drive Pinion in the Gear Carrier**

- 1) If the drive gear, drive pinion, and bearing are to be reused they are as a result of disassembling and inspection, they should be assembled in order of disassembling at the previous condition of adjusting shim

In case any item should be replaced or required to reuse even if any item is worn out prepare the various shims as mentioned later because the position of drive pinion to be fixed with carrier must be adjusted by the adjusting shim between the carrier and pinion rear bearing outer race

- 2) There are few numbers with 0 & + or - besides set number marked by an electric pen on the tip head surface of drive pinion. They show the manufacturing error in a figure at the unit of 0.001 in (0.025 mm) to decide the thickness of adjusting shim for adjustment of standard position (The standard pinion height is 61.0 mm from axle center as shown in Fig 6). If the figure is difficult to discriminate due to the corrosion, scrape off the oxidized substance on the surface by a somewhat narrow grind stone with care not to scrape off even the mark



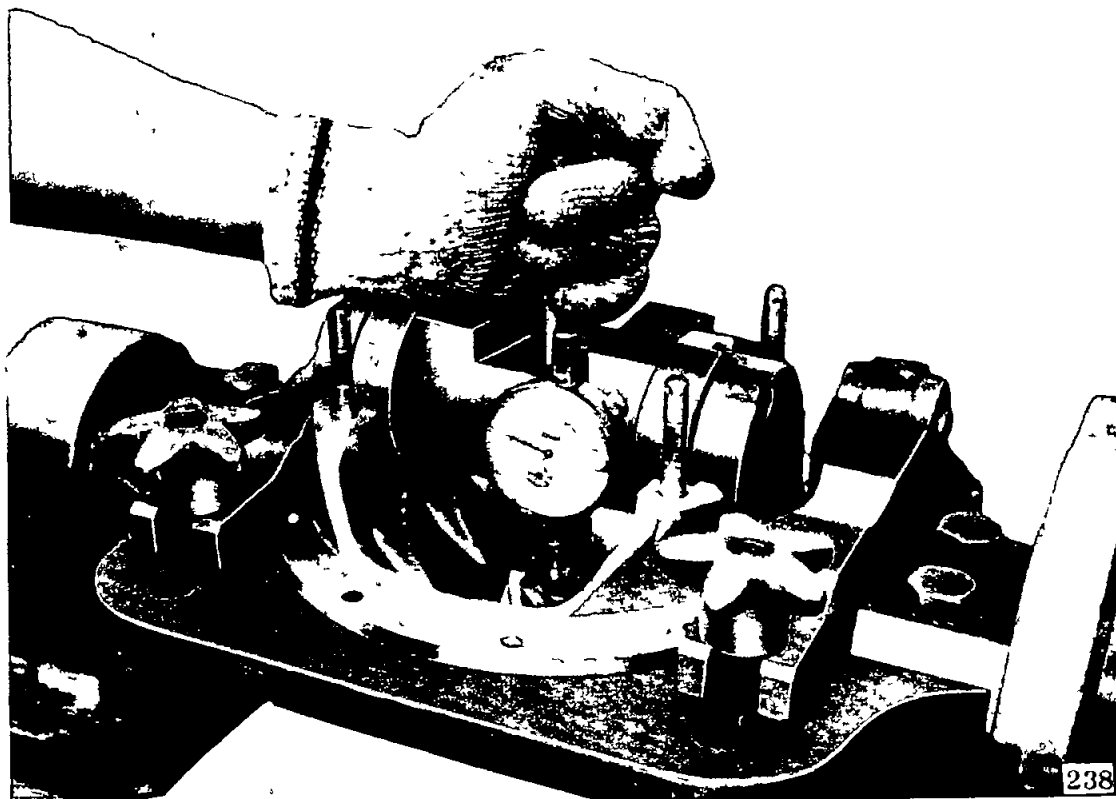


Fig. 5 Adjustment of Pinion height

Adjust to the direction of an arrow in accordance with the pinion mark

3) The thickness of drive pinion adjusting shim are arranged as following

	Part No.	Thickness	Standard Leaf Nos.	Part No.
Drive pinion adjusting shim	38153-2660	0.75 mm (0.03 in)	1	38127-25660
"	38154-2660	0.25 mm (0.01 in)	2	38128-25660
"	38155-2660	0.125 mm (0.005 in)	2	38129-25660
"	38156-2660	0.075 mm (0.003 in)	2	38130-25660

The use of the adjusting shim will be explained in the following paragraph of adjustment. Supposing the drive gear and the drive pinion were replaced as a new set and the height of drive pinion previously used was right, prepare the shim of thickness which equals to the difference of figures on the new and this pinion. Deduct the previously used shim in case it is plus, increase in case of minus and have the general idea of required thickness of the shim for assembling to prepare.

It is convenient to inspect the condition before disassembling in a way as mentioned later in the measurement of pinion height. Besides the condition of defacement on the carrier, the pinion bearing must be taken into consideration though it will be explained in detail later.

## **B) Fixing and Adjustment of Drive Pinion**

- 1) Drive pinion rear bearing outer race should be mounted in the carrier. In this case, after inserting the properly selected adjusting shim as previously mentioned between the carrier and bearing race, mount the outer race by the special tool of drive pinion front, rear bearing outer race replacer.

For adjustment of previously mentioned pinion height, the shim at the rear side of this outer race is increased or decreased, and the race also must be taken off in each time for this adjustment, therefore the tools must be handled properly to avoid such a situation as to make the bearing hole of carrier in an oval. Referring to handling method of tool, set the adaptor ring on the corn to guide the body of tool at the small hole of carrier put the rear outer race on the corn as bearing surface faces inside at the tip end of screw and put the split adaptor inside race. At the same time, supporting it by the bar, twist up the corn till the adaptor and race come to the setted position then screw up the wing nut so as the race be housed properly at the setted position.

- 2) Mount the front bearing outer race in the carrier. For mounting the front outer race, take off at first the adapter from the front end of the carrier and fix the tool at the side of stud in opposite side, tighten the screw as to be the center of ear then mount it by using adaptor as in a way of mounting the rear outer race. The race is scarcely necessary to be taken off unless damaged.
- 3) Mount the rear bearing inner race and roller to the drive pinion. By using the round adaptor attached to the drive pinion rear bearing inner race replacer which was employed at disassembling, press in the drive pinion. This might as well be done in pressing in by the use of a certain drift.

- 4) Mount the drive pinion in the carrier and adjust by measuring the position.

The pinion height must be adjusted as mentioned in the previous paragraph, by mounting temporarily the pinion in the carrier and the bearing be given a regular preload. On the other hand, the bearing of drive pinion should be newly oiled after the pinion is inserted from the inside of the carrier, the inserted end

of pinion should be locked with front bearing cone and tightened up by the pinion nut fixing with the companion flange till the regular revolving torque is required. As this is not yet at the final assembling, the bearing spacer (distance piece), bearing adjusting shim and oil seal are not mounted.

At the time of inserting the front bearing, as pushing in the inner race by pulling out the drive pinion from the rear side of the carrier. Put the rear side of the carrier downward and set the tool under it, then supporting the end surface of drive pinion, press in the bearing by using the drift. The operation would be easier by using the drive pinion front bearing inner race inserter as shown

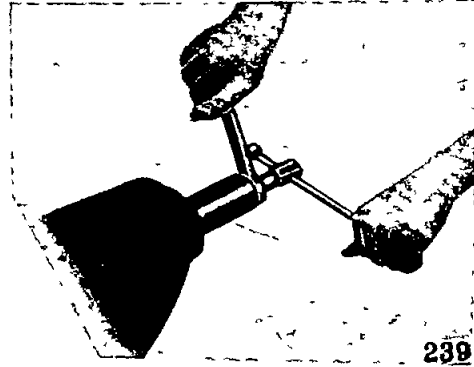


Fig. 6

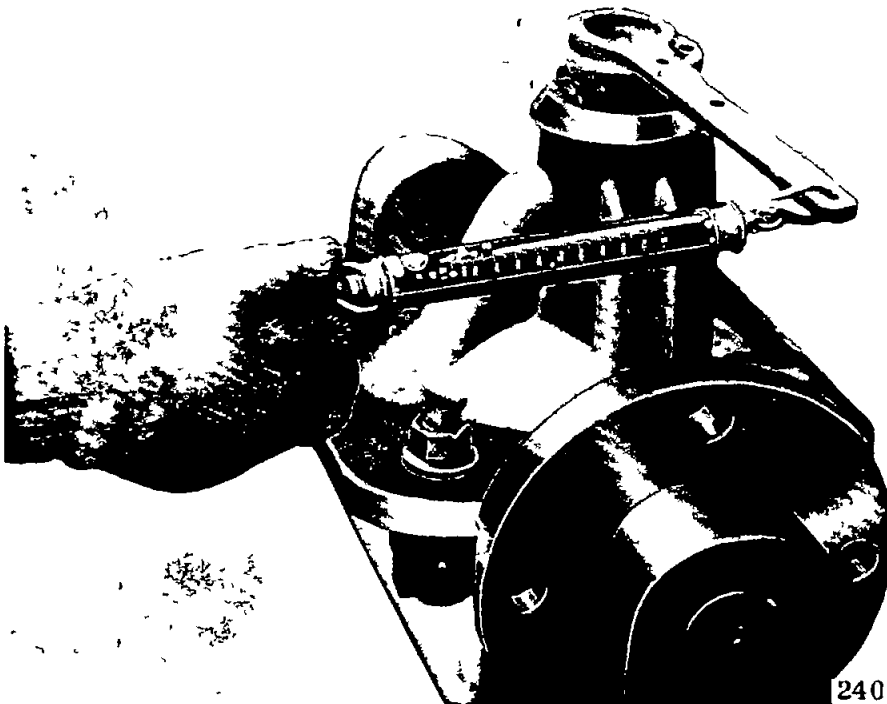


Fig. 7 Pinion Bearing Preload Gauge

Tighten up the pinion nut by turning it slowly with hands with the use of pre-load gauge as Fig 9 to the degree that support the bearing pre-load at 7-10 kg/cm

When the drive pinion is mounted in the previously mentioned condition, it is necessary to measure the height of rear surface of the pinion whether it is higher or lower than the standard. Make use of the special drive pinion arrangement gauge. The standard height of the pinion is 21 mm from the bottom of the side bearing fixed with the carrier. The fixing position can be measured by setting an arc of circle on both sides of arrangement gauge at the position of side bearing and insert the thickness gauge in the clearance between the tip of gauge bar and the pinion such as to push in by scraping of the carrier in diagonal, otherwise preload and the pinion height of the bearing would come out of order and tend to cause an unexpected trouble in future

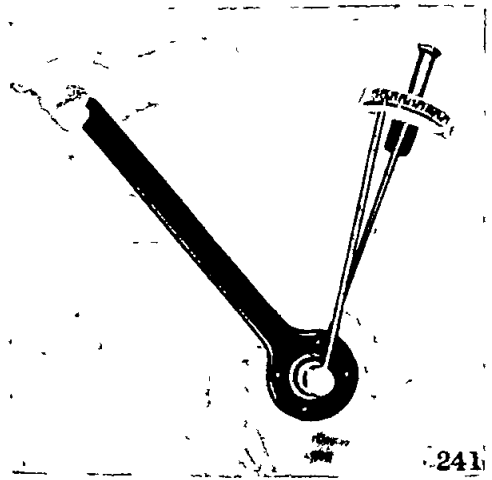
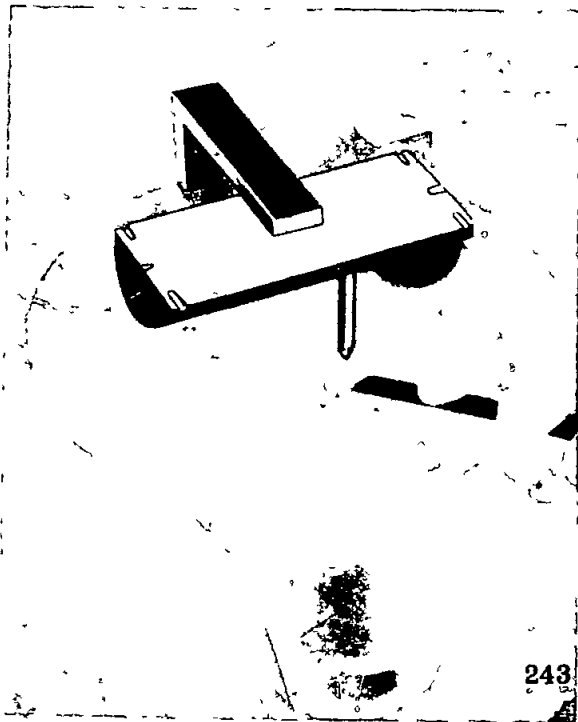


Fig. 8 Use of drive pinion bearing Pre-load Gauge

- 5) The formal adjustment of the drive pinion, bearing and preload. After the fixing position of the drive pinion is decided as mentioned in the previous paragraph, take off the pinion nut & companion flange to mount again the drive pinion bearing spacer (distance piece) and nut. Tighten up the nut Fig 8 by using the torque wrench at the regular torque of 100-120 ft /lbs (13 83-16 62 kg-cm). The preload supported by the bearing in this case is different according to the condition of the bearing adjusting shim inserted. The more of the shim inserted, much the play of pinion to the direction of axle is increased. The less of the shims inserted, the more the bearing tightened by the previously mentioned nuts and cause it to be burned if left and turned as it is. Therefore, for read-justment of the bearing preload in this case, it must be adjusted by increasing or decreasing the number of four kinds of adjusting shim as shown in the following list and measuring with the use of the drive pinion bearing pre-load gauge as Fig 7 so as to make the revolving torque of pinion at 7-10 kg/cm. If there should not be any error in the pinion with the head mark at 0 and the clearance should be sealed at 0.2 mm (0.008 in) by the feeler gauge.\*



#### Remarks

When measuring the height of the pinion head, set the semi-circular side portions of the gauge on the side bearing seats, insert a feeler gauge into the clearance between the tip of the gauge center rod and the pinion head, and adjust the pinion

The gauge rod is made 0.2 mm (8/1000 in) shorter than the standard measurement (21 mm). Therefore, adjustment is made by selecting a feeler gauge in accordance with the plus or minus valve marked on the pinion head

Fig. 9

thus pinion is regarded as at the correct position because the height of the gauge is made shorter for 0.2 mm than the standard size (21.0 mm). If it is necessary to adjust the pinion height, take off the drive pinion as well as pinion rear bearing outer race from the carrier to adjust by increasing or decreasing the number of the adjusting shim. In other words, read the mark on the head of the drive pinion, before adjusting by increasing or decreasing the number of device pinion adjusting shim to insert the feeler gauge which is deducted for the number of mark from 0.008 in in case of minus side added for the number of mark to 0.008 in increase of plus.

For instance, the mark shows  $\frac{1}{2}$ , adjust the position of drive pinion by deducting the number of shim so as to make the clearance at 0.008 in 0.002 in 0.010 in. It is necessary to give the bearing a right pre-load. At the time of pushing the outer race into the carrier, it must be done in a right way, otherwise

Specially when the old bearing is to be used again in assembling, the adjustment should be made at the lower torque than standard in accordance with the conditions of practical use so as not to give it an over pre-load.

- 6) When the former adjustment of pre-load of the bearing is completed as in the previous paragraph, inspect the pinion height again

Unless any thing wrong is found, loosen the pinion nut, take off the flange, insert the new oil seal in the rear of the carrier and formerly fix the flange, washer and pinion nut. The nut should be tightened up at the standard torque. In case the cotter pin hole fitted, the adjustment should be made not by tightening the nut, but by filling the washer.

### C) Mounting the Differential Gear Ass'y in the Carrier

- 1) Mount the complete unit of differential gear in the carrier and fix the bearing cap. There is an engraved mark on the side of cap which should be fitted with mark on the leg of bearing housing when mounting. It is important to note that the fixing part of the cap of each bearing housing is machinerly finished up.

The differential gear case is inserted by the bearing adjusting shim with the side bearing as explained and by housing in the bearing housing of carrier, the bearing must be given the regular pre-load. The screwing torque of the fixing nut of the side bearing cap is at 30-35 ft/lbs (420-490 kg-cm) and should be equally locked with fixing cotter pin.

So far, only the differential unit is mounted and the drive gear is locked with the drive pinion, therefore, the following adjustment must be made to acquire the regular side bearing pre-load & the gear backlash.

- 2) Adjustment of side bearing pre-load & backlash.

To give the right pre-load on the side bearing of differential gear case and in pressing the bearing in the differential case adjust by inserting inside the bearing adjusting shim of thickness calculated in accordance with the following method of computation.

There is a marked numeral of adjusting bases on the bearing housing of the gear carrier and differential case. The numeral is the manufacturing error in a unit of 1/1000 in against each standard measurement of A B C D in Fig. 10.

To measure the width of the side bearing on left and right, use the standard gauge (20.0 mm thickness) and dial gauge on a flat board. In this case, place the load on the bearing with the aid of weight block for about 2.5 kg to acquire the steady figures.

Calculate the error on minus side against the each standard measurement of 20.0 mm on the unit basis of 1/1000 and assume each of them as E & F. Take the left side bearing, for example. When the measured width is 19.8 mm, it is 0.2 mm (-0.008 in) against the standard measurement and the E is, by excluding the minus sign, 0.008 in.

The thickness of the shim is acquired by applying the numerals to the following method of computation

$$T_1 = A + D - C$$

$$+ 0.007 \text{ in.} + E$$

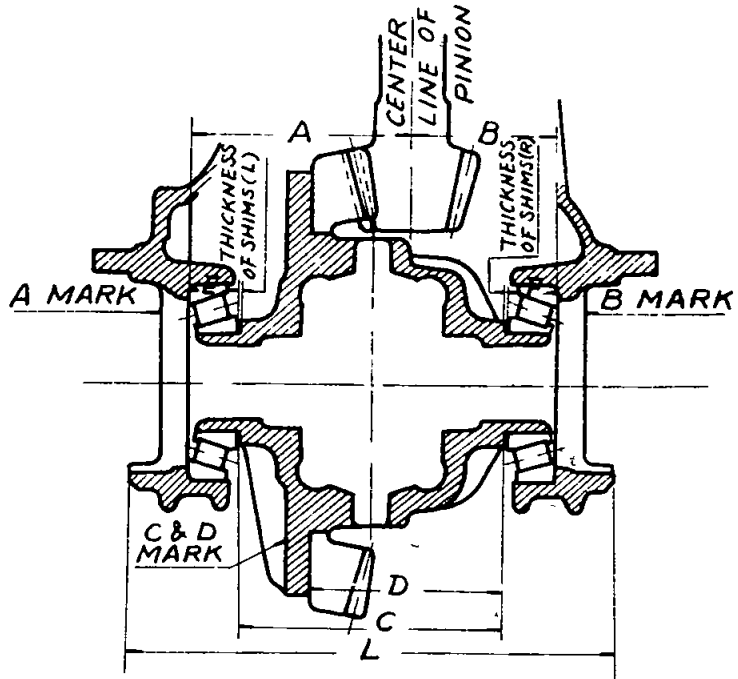
$$T_2 = B - D + 0.006$$

$$\text{in.} + F$$

Fig. 10

Thickness of shim  
on left side

Thickness of shim  
on right side



Example of calculation

Left    A = + 1  
          D = + 2  
          C = + 2  
          E = + 0.2 mm (0.008 in )

Right    B = + 2  
          D = + 3    therefore.  
          F = + 0.25 mm  
              0.010 in )

$$T_1 = A + D - C + 0.007'' + E$$

$$= 0.001'' + 0.002'' - 0.002''$$

$$+ 0.007'' + 0.008'' = 0.016''$$

Thickness of left side shim

$$T_2 = B - D + 0.006'' + F$$

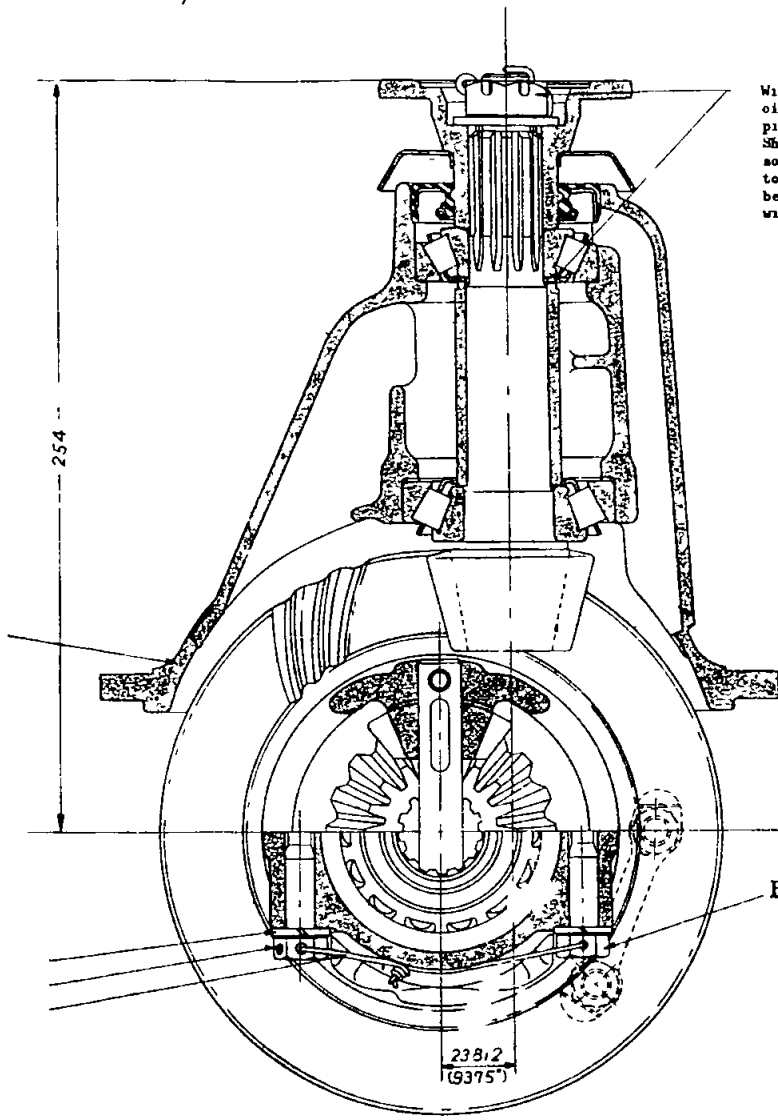
$$= 0.002'' - 0.003'' + 0.006''$$

$$+ 0.010'' = 0.015'' \text{ Thickness}$$

Thickness of right side shim

It may as well be assembled by using the shim of thickness which is in accordance with above method of computation. The left and right bearing must be well pressed in, otherwise the pre-load changes.

Measure the backlash of the drive pinion & ring gear as Fig. by using the dial indicator to make sure that it is within 0.1 mm - 0.2 mm (0.004'' - 0.008'') If it is much, move to left by taking off the right shim, and a vice versa for adjustment.



Without fitting Gear-drive-hypoid and oil seal, when tightened Nut-drive pinion with 1383 ~ 1662 kg cm, adjust Shim-adjusting-drive-pinion-bearing so as pinion-drive-hypoid friction torque is to be 7 ~ 10 kg cm When, bearing turning surface must be smooth with MP90

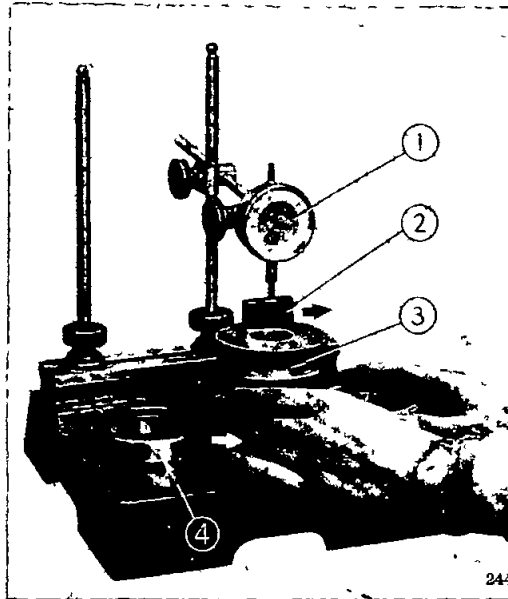
Bolt diff. bearing cap tightening torque is 415 ~ 485 Kgcm

**Fig. 11 Carrier Section**



The numeral marked by the electric pen on the side of the drive gear shows that of the recommended backlash besides the set number For example, 6-6 means the backlash of 0.006 in

- 1 Dial gauge
- 2 S. T. D. gauge (20 0 mm thickness)
3. Weight block
- 4 The bearing measured



## After the Operation

If it is necessary to use the bearing again at the time of repairing, the thickness of each shim of left & right must be reduced for 0.001"-0.003" on the basis of 80% or 60% against standard pre-load in accordance with the practical condition of use, because over pre-load is given to the bearing with the shim of thickness calculated from above method of computation

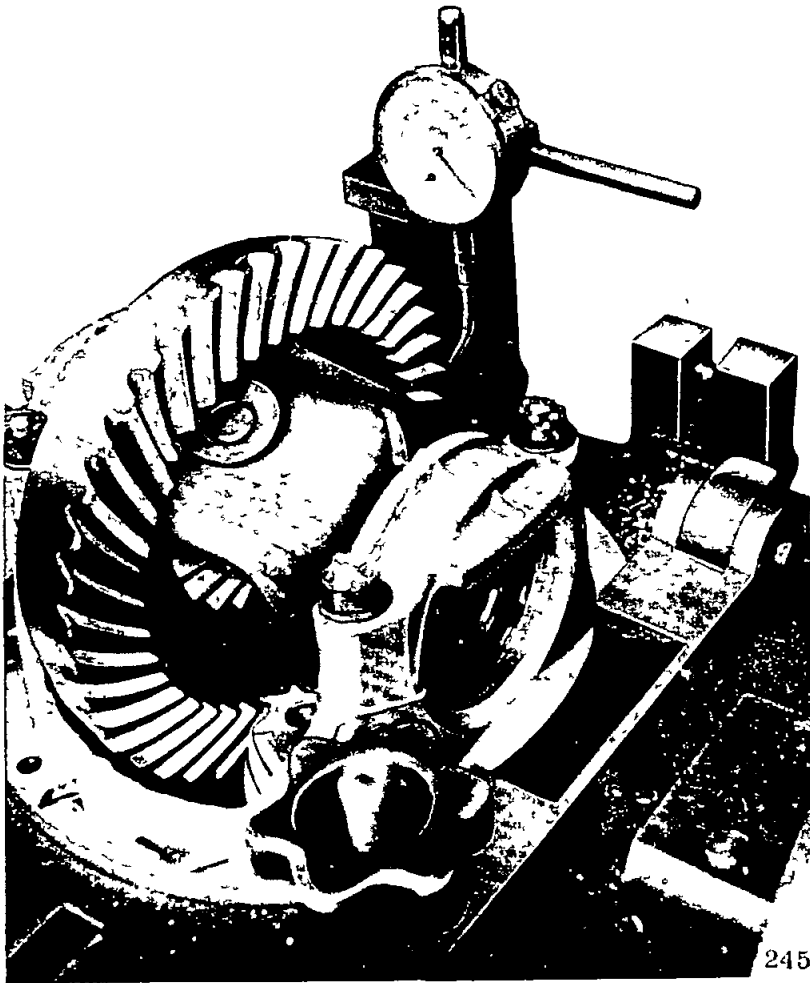


Fig. 12 Measurement of Backlash for the  
Driven Pinion & Ring Gear

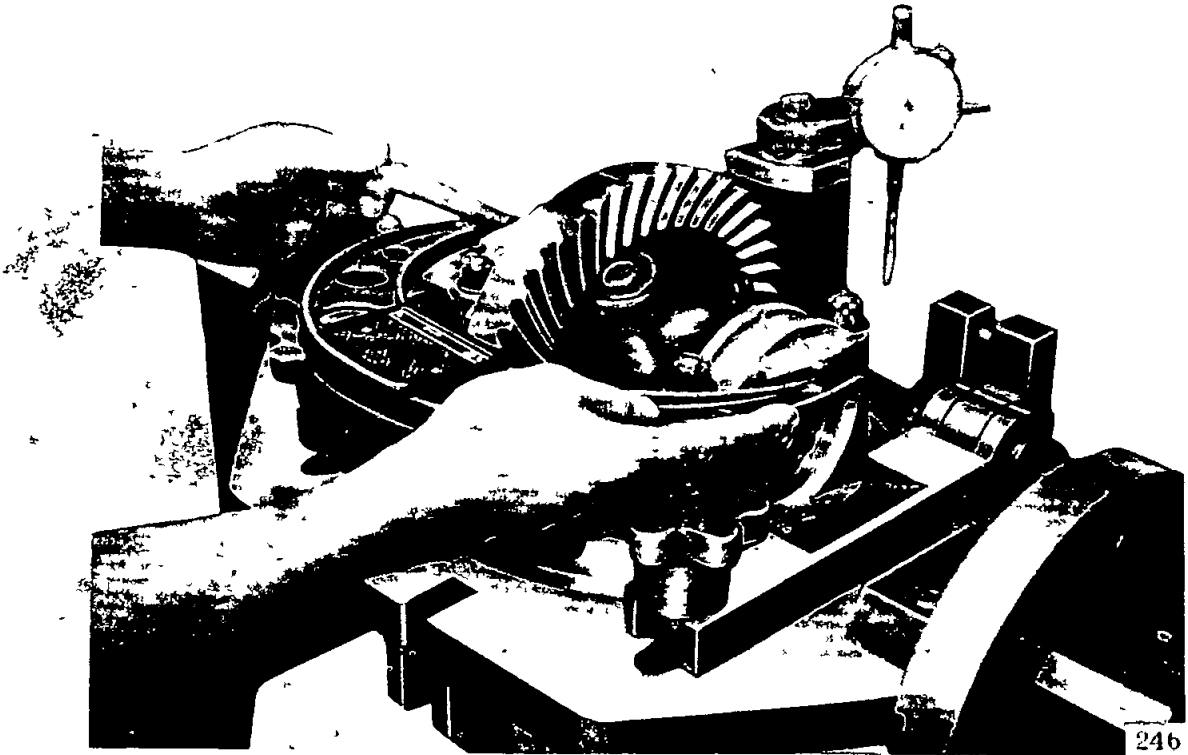
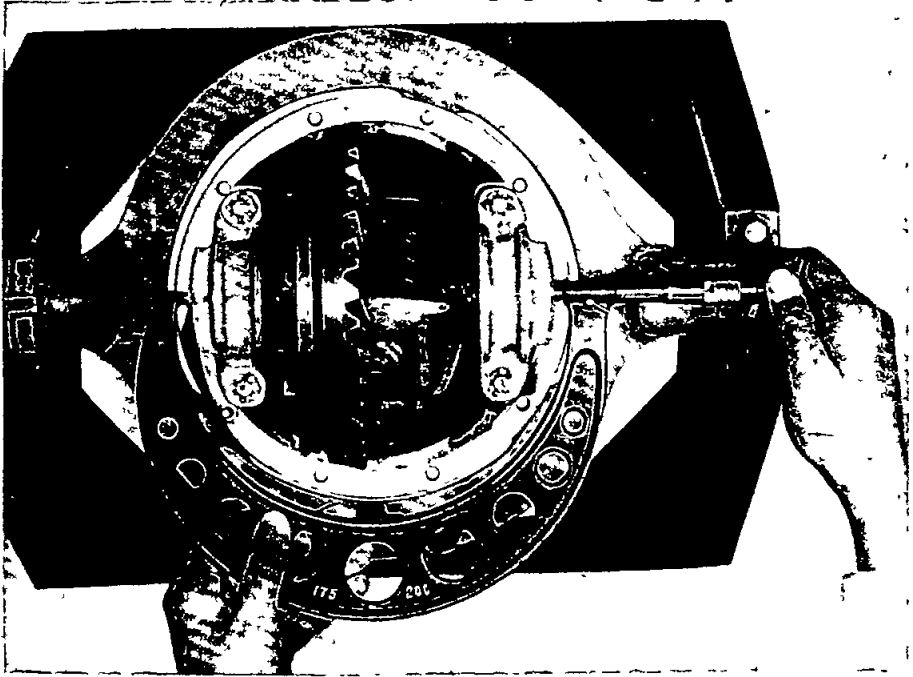
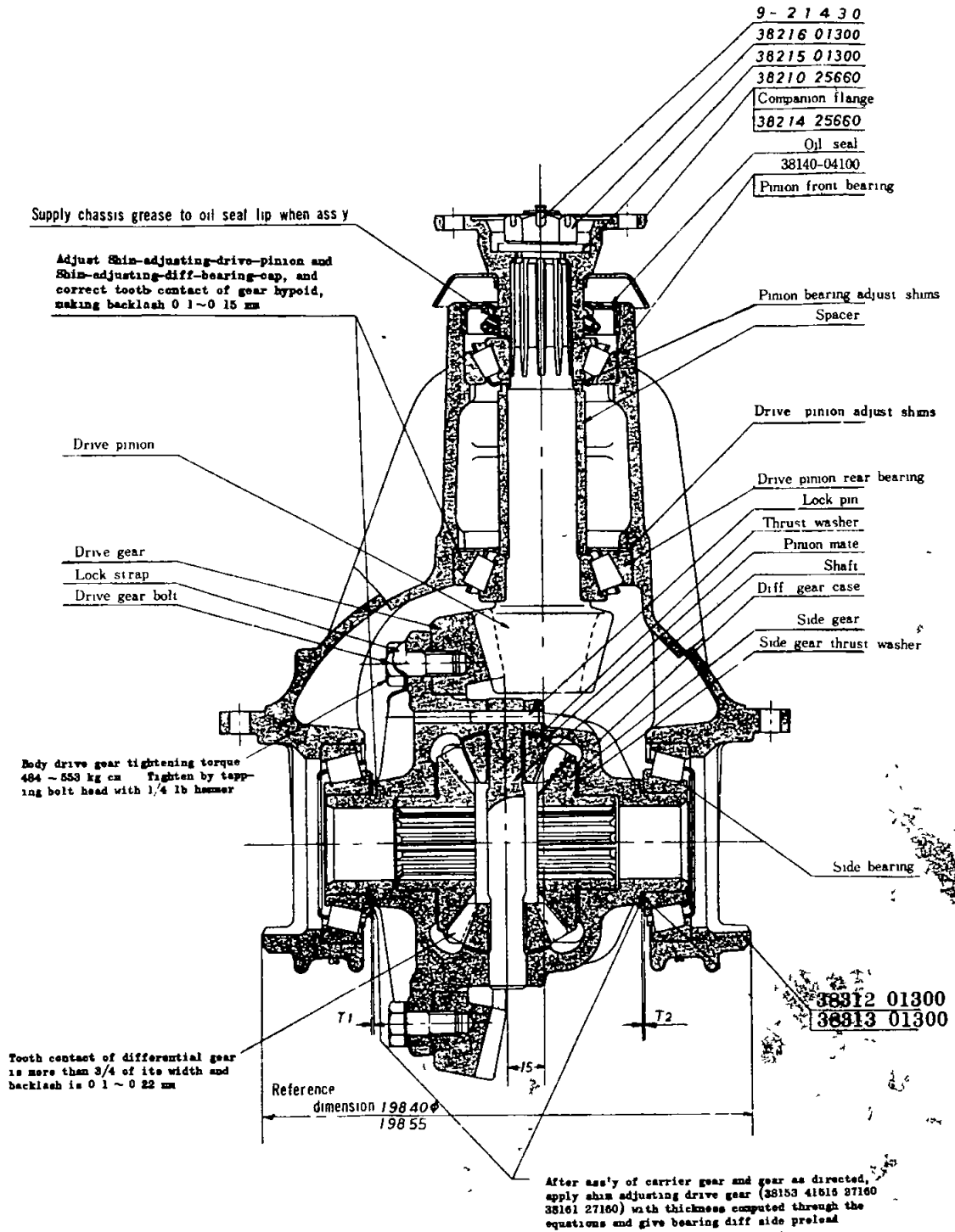


Fig. 13 Using the differential side bearing cap gauge



**Fig. 14 Differential Gear Carrier Section**

Thus the adjustment is completed. By way of precaution, measure the L measurement which is within 198.40-198.55 mm as Fig. 13. If it is insufficient, add an additional shim of 0.002 ins (0.05 mm) in left and right. In this case, the large size of micrometer, as Fig. 13 or special gauge should be employed for scaling.

The shake of the back of drive gear which has been fixed with the carrier should be measured by dial indicator to confirm that it is within 0.1-0.2 mm.

## Mounting the Gear Carrier Ass'y on the Rear Axle Housing

Interior of the axle housing should be cleaned well.

The carrier packing should also be replaced with new one.

Mount the gear carrier ass'y without mistaking its upper side with down side and through 10 studs, then fix with the lock washer & nut. The nut must be tightened in a diagonal line so as not to cause the oil leaks.

When it is mounted on the vehicle, feed the gear oil immediately. The oil of the designated hypoid gear oil No. 90 should be feed. Feed the oil till it comes up to the down side of the feeding hole.

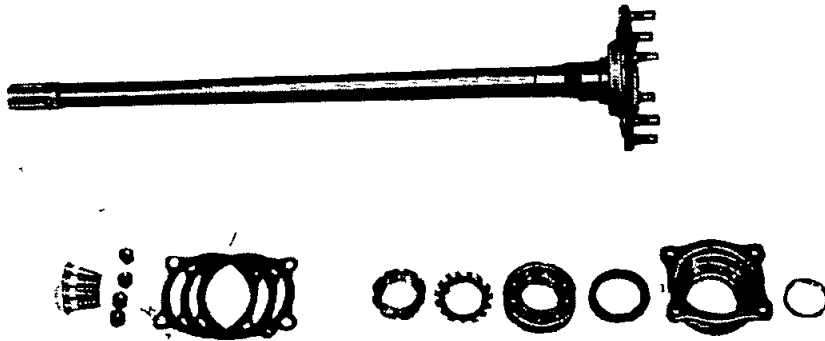


Fig. 14

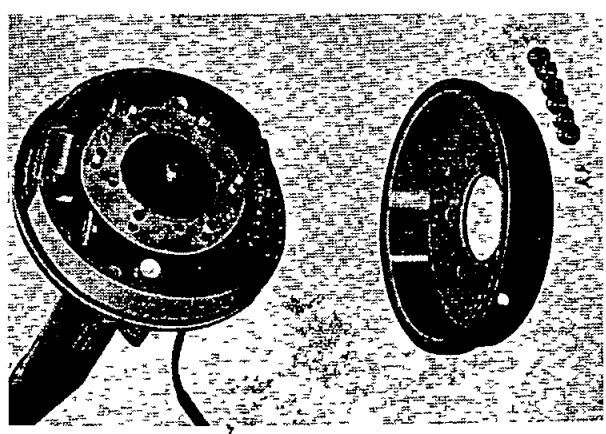
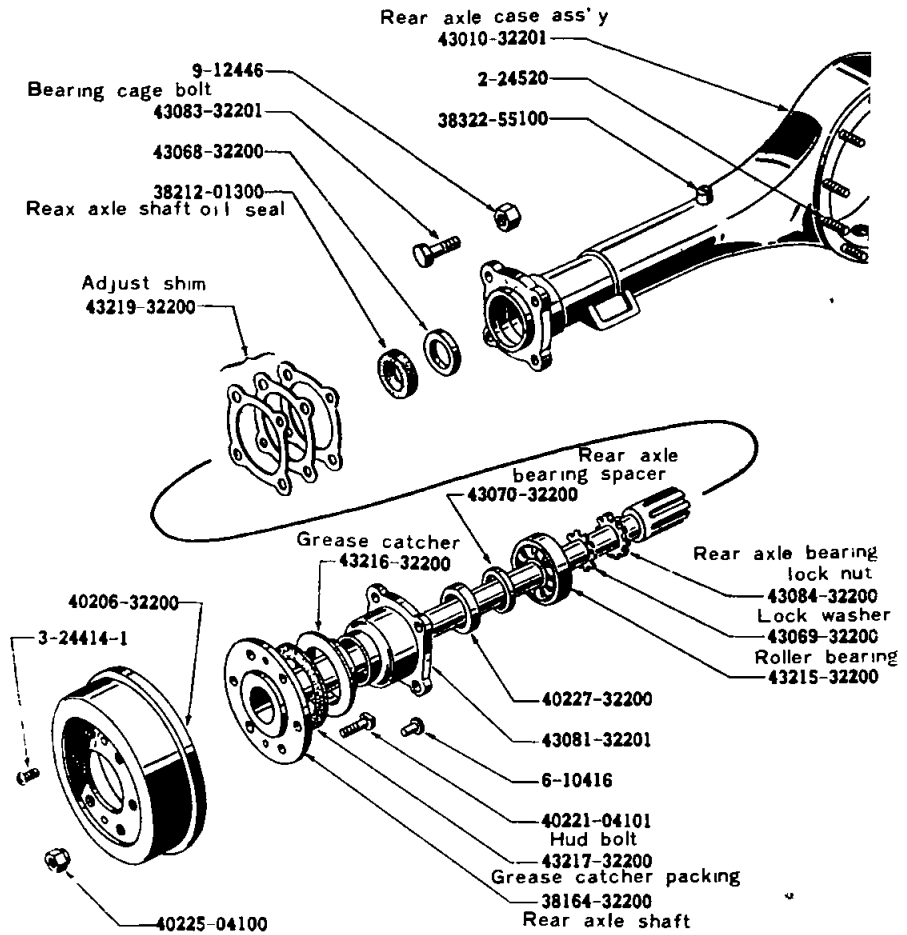
When replacing the differential axle shaft do not forget the adjust shim between the end of the axle flange and the shaft with the brake disc assembly so as to keep the end play of the axle shafts.

## Axle Shaft Removal

Jack up the axle on the blocks. Unscrew and remove the brake drum using a screw driver.

If the brake linings should hold the drum when the hand brake is released, slack off the brake shoe adjuster a few notches.

Take off the fix-bolts of the brake disc and remove the axle shaft assembly as shown Fig. Tap out with swing hammer holding the wheel stud bolts with



**Fig. 15 Rear Axle Shaft**

the rear axle shaft. Draw out the shaft and disc assembly by gripping it outside of the brake disc.

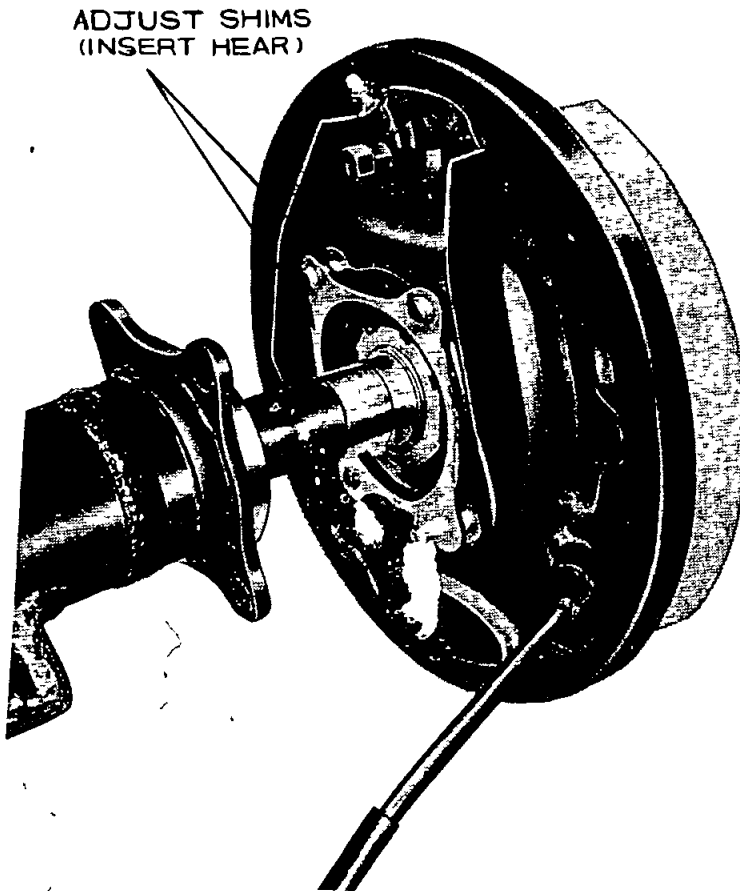


Fig. 16 Assembly for Axle Tube

Referring to Fig 17 assemble to the axle tube with the axle shaft with brake disc assembly (Brake disc, Grease catcher packing, Grease catcher, Bearing cage, Grease seal, Spacer taper roller bearing, Lock washer, and Bearing lock nut) In this case, the shaft must be given a regular end play, which is the end play of direction to the spline of shaft by the thickness of adjusting shims inserted at the time of assembling

In adjustment for this end play, select the adjusting shims for one side (Left or Right) at the first

Insert selected shims between the axle tube and the shaft assembly. Fit the end play of axle shaft 0.85-1.10 mm

Secondary, attach the other side of axle shaft assembly and adjust end play 0.05-0.10 mm by selecting adjust shims.

## **THE INSPECTION WHEN THE CAR STOPS**

1) Operating the side brake, and setting the revolving of axle shaft, the gear backlash and the defacement of the spline in the housing can be found by inspecting the motion of the propeller shaft as moving it to left and right

Specially in case of the drive pinion comes out and in, the pinion bearing is worn out or the adjustment is necessary

2) Another inspection should be carried in a way by jacking up one of the wheels and spin it back and forth

3) Holding the tire of the wheels jacked up and spin and move to every direction When the shock is felt, inspect the degree of tightness and adjust it

4) Inspect and confirm the volume and quality of the oil in the housing

## **Inspection in Motion**

1) In case of giving the high metallic noise when speeding up, the backlash is at the least or too much at the drive gear and the drive pinion

2) Giving any abnormal noise in speeding up or slowing down, the drive pinion bearing is worn out or damaged

3) It is the bearing that gives the constant humming noise at high speed and the gear that makes a periodic nose at low speed In case there is any damage of the gear, it must be immediately disassembled and repaired because if it is used as it is, the broken gear cause to breake the other gear and another and so forth, finally to the big accident



# BRAKE

## GENERAL DATA

Type	operated by foot	Four wheel braking by oil pressure
	operated by hand	Mechanical braking for rear wheels
Inner dia of master cylinder		22.23 mm. (7/8 in )
Inner dia of wheel cylinder		Front wheel                  Rear wheel
		19 05 mm                  19 05 mm
Residual pressure of brake oil		0.5-0.8 kg/sq cm.

## BRAKE DRUM

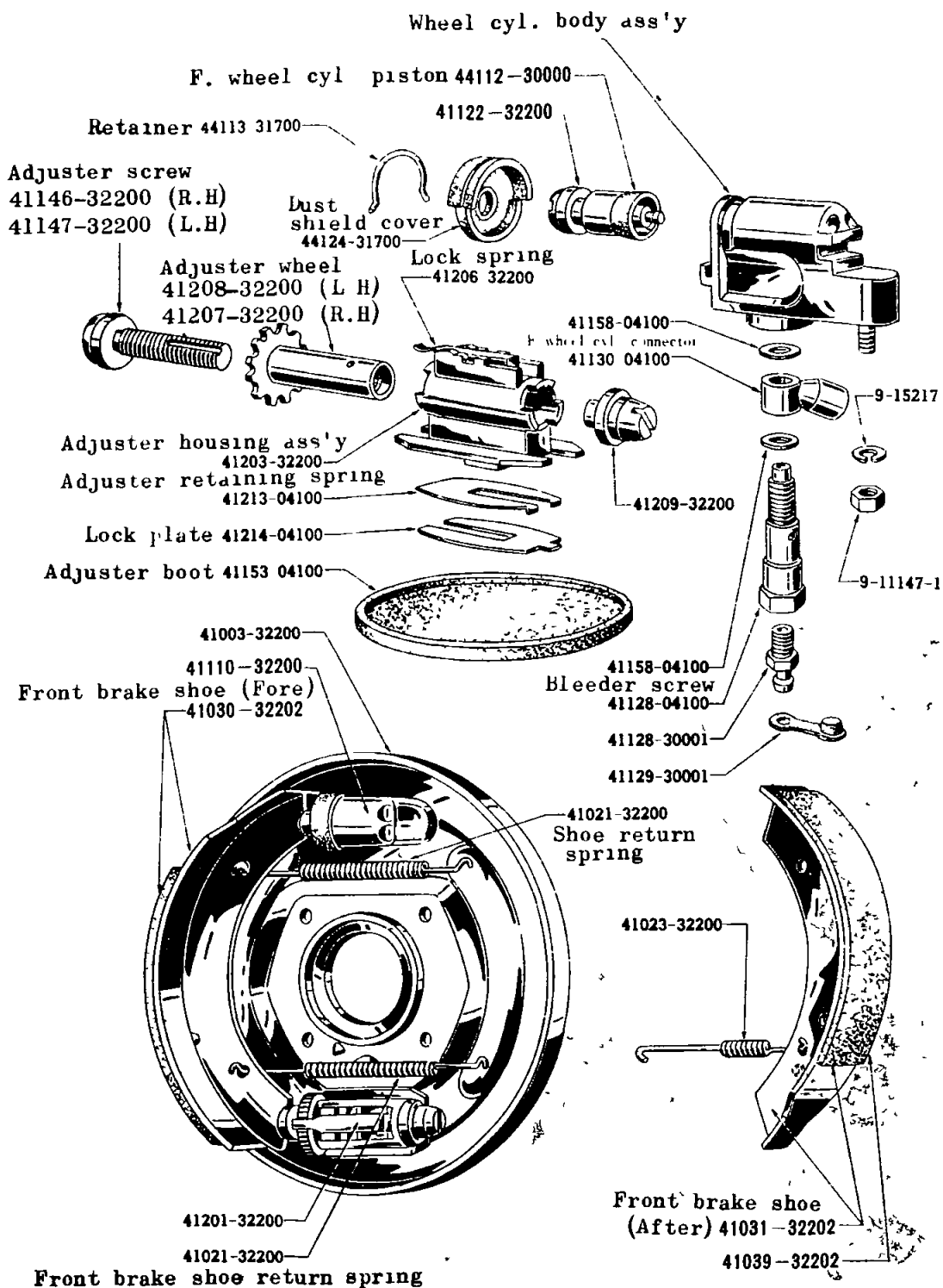
Inner dia of drum (both front & rear)	254 mm (10 in.)
Degree of real circle of drum	Less than 0 05 mm (0.002 in )
Amendment limit of dittoed degree	0 20 mm (0 008 in )
Allowable limit of inner dia of drum	0.80 x 2 mm (0 032 in x 2)

## BRAKE SHOE

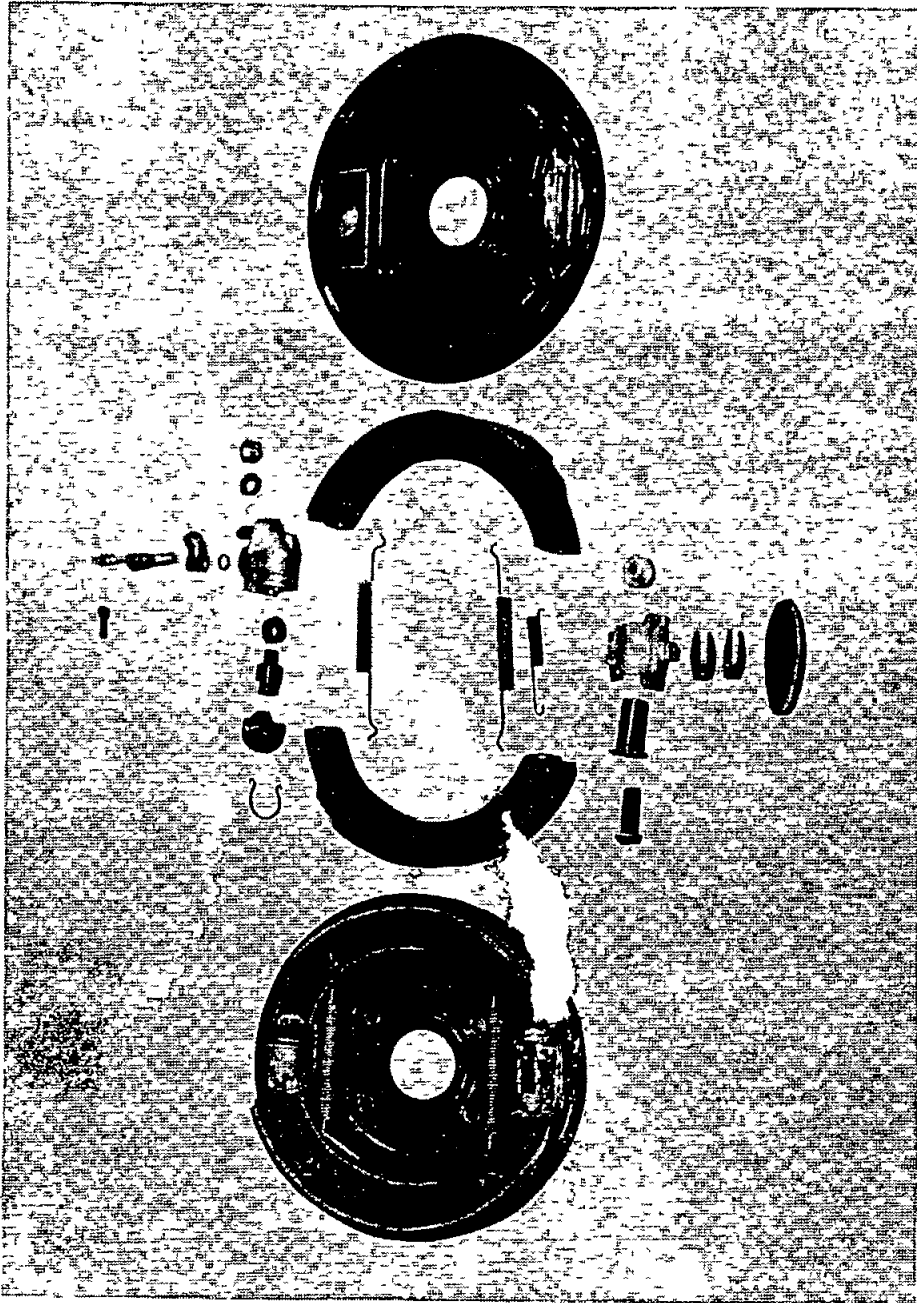
Lining dimension (both front & rear wheel)	
Length x width x thickness	244 mm x 45 mm x 4 5 mm
Lining area (per brake shoe)	110 sq cm.
Adjustment of shoe clearance (Front & Rear brake)	Fasten adjusting gear notch completely and then make 12 turnings back
Play for pedal	10-14 mm

The brakes on all four wheels are hydraulically operated by foot pedal application, directly coupled to a master cylinder in which the hydraulic pressure of the brake operating fluid is originated. A supply tank case integrally with the master cylinder provides a reservoir by which the fluid is replenished, and a pipe line consisting of tube, flexible hose and union, inter connected the master cylinder and the wheel cylinders.

The pressure generated in the master cylinder by application with the foot pedal is transmitted with equal and undiminished force to all wheel cylinders simultaneously. This moves the pistons outwards, which in turn expand the brake shoes thus producing automatic equalization, and efficiency in direct proportion to the effort supplied at the pedal. When the pedal is released the brake shoe springs return the shoes which then return the



**Component of Front Brake**



wheel cylinder pistons, and therefore the fluid back into the pipe lines and master cylinder.

An independent mechanical linkage actuated by a hand brake, mounted drivers seat side (left or right side), operates the rear wheels by mechanical expanders attached to the rear wheel cylinder bodies

## FRONT BRAKES

The front brakes are operated by each one wheel cylinder.

Each wheel cylinder consists of a body containing, spring, spring seats, pistons, piston cups, cylinder cover lock wheel cylinder cover and adjust screw

The shoes are allowed to slide and centralise during the actual braking operation which distributes the braking force qually over the lining area ensuring high effeciency and even lining wear

Adjustment for the brake shoes is by means the teeth of the gear typed covers connecting with the adjusting screws and each adjusting screw for brake shoes

The brake shoes rest on the dimples formed in the back plate and are held in position by one return spring which connecting with the hole of shoes

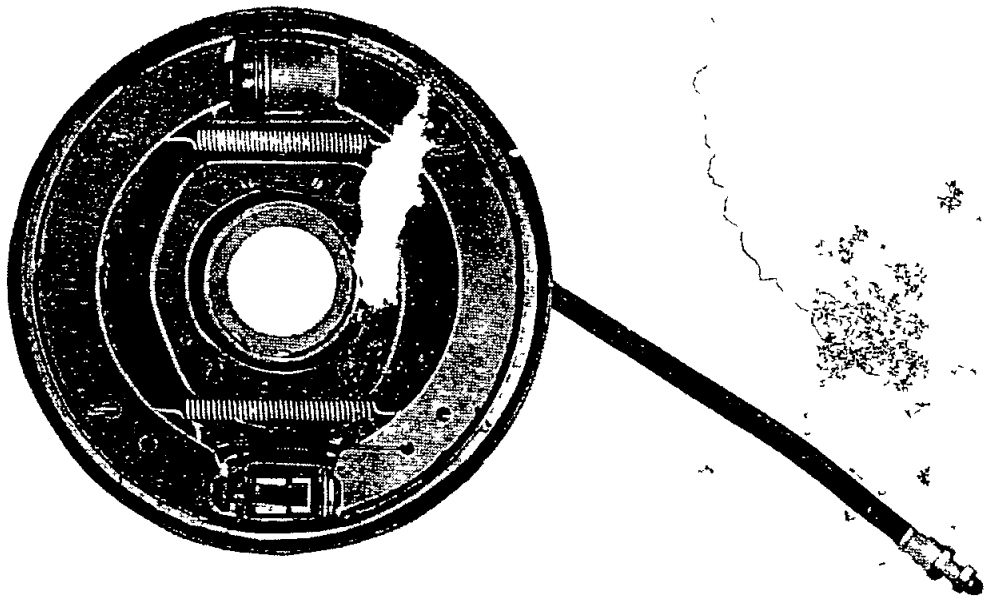
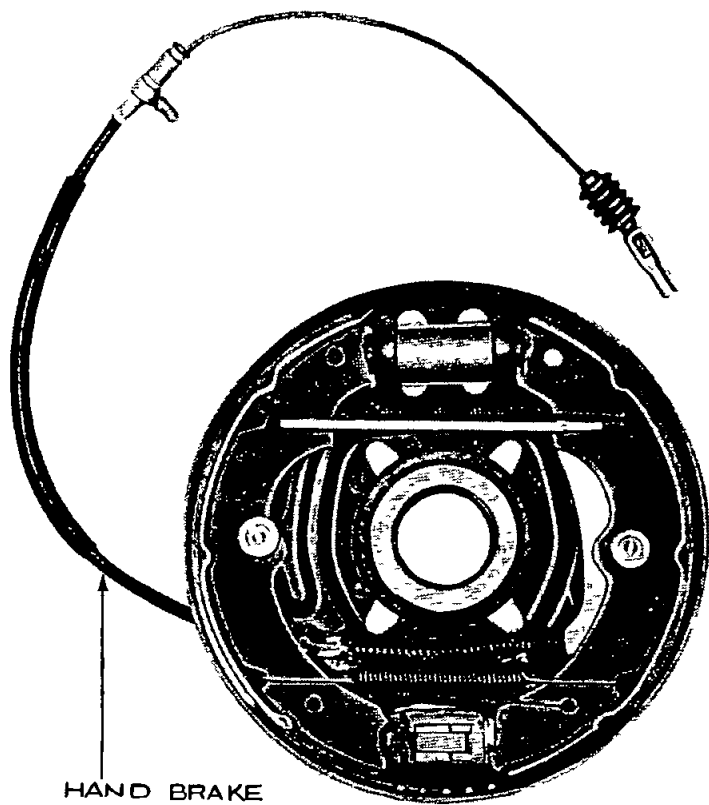


Fig 1-

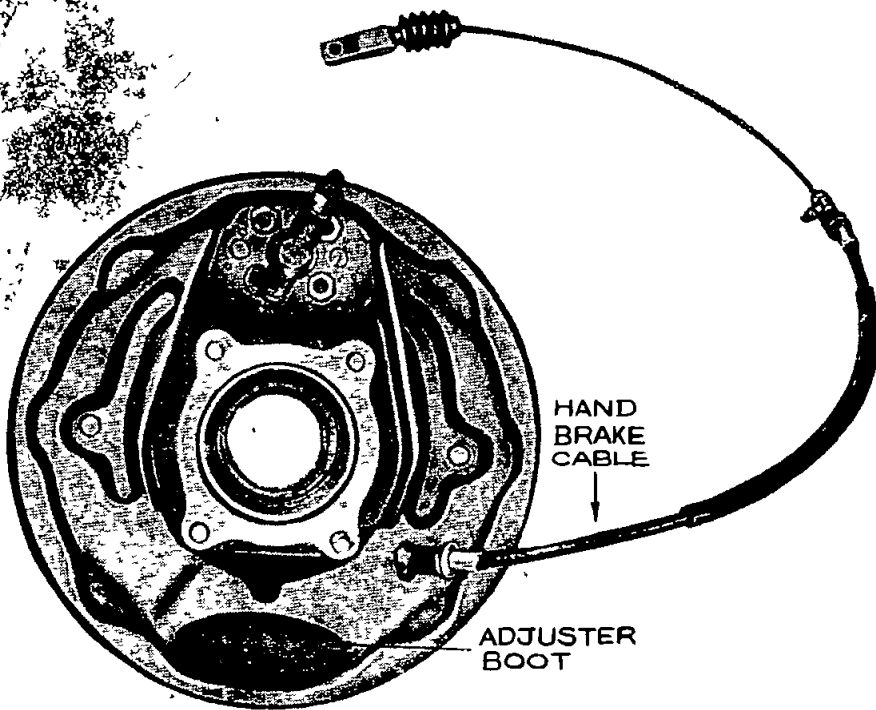
## REAR BRAKES

The rear brake shoes are not fixed but are allowed to slide and centralise with the same effect as in the front brakes. They are hydraulically operated by wheel cylinder and independent hand brake mechnism



HAND BRAKE  
CABLE

BRAKE DRUM SIDE



HAND  
BRAKE  
CABLE

ADJUSTER  
BOOT

BRAKE DISC BACK

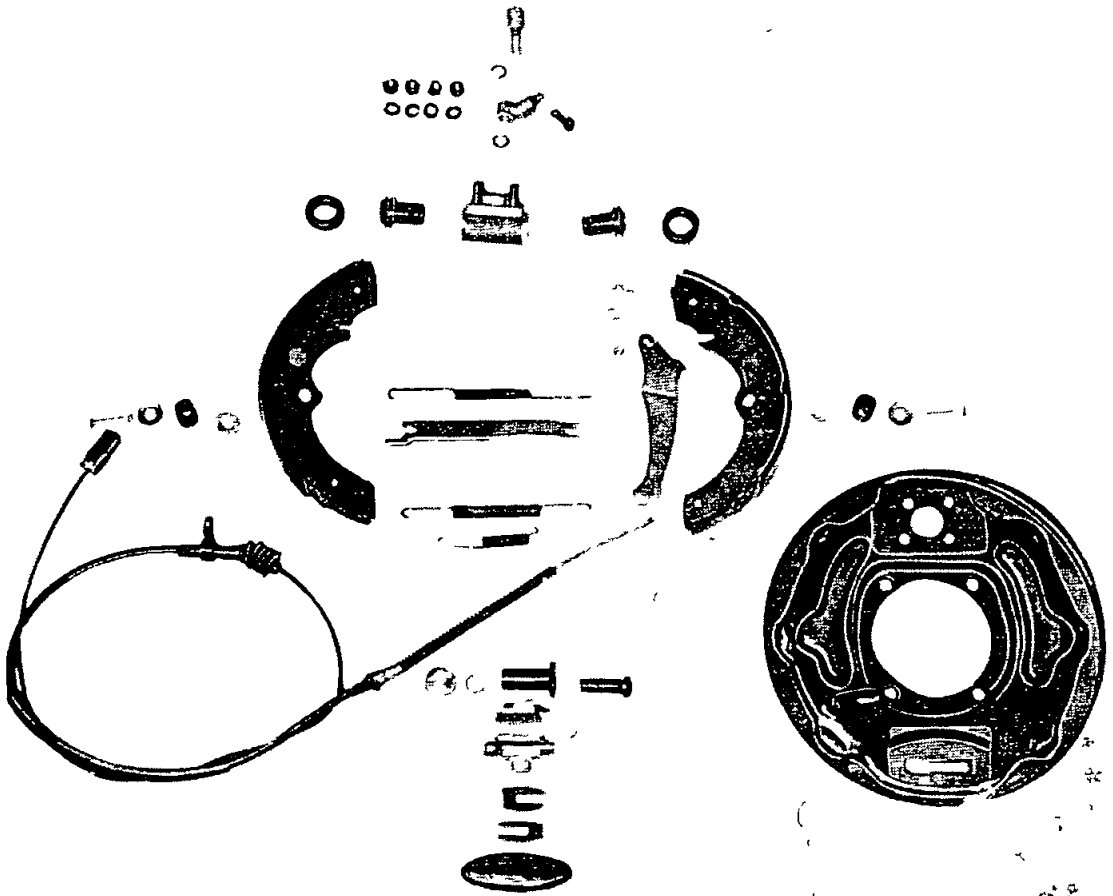
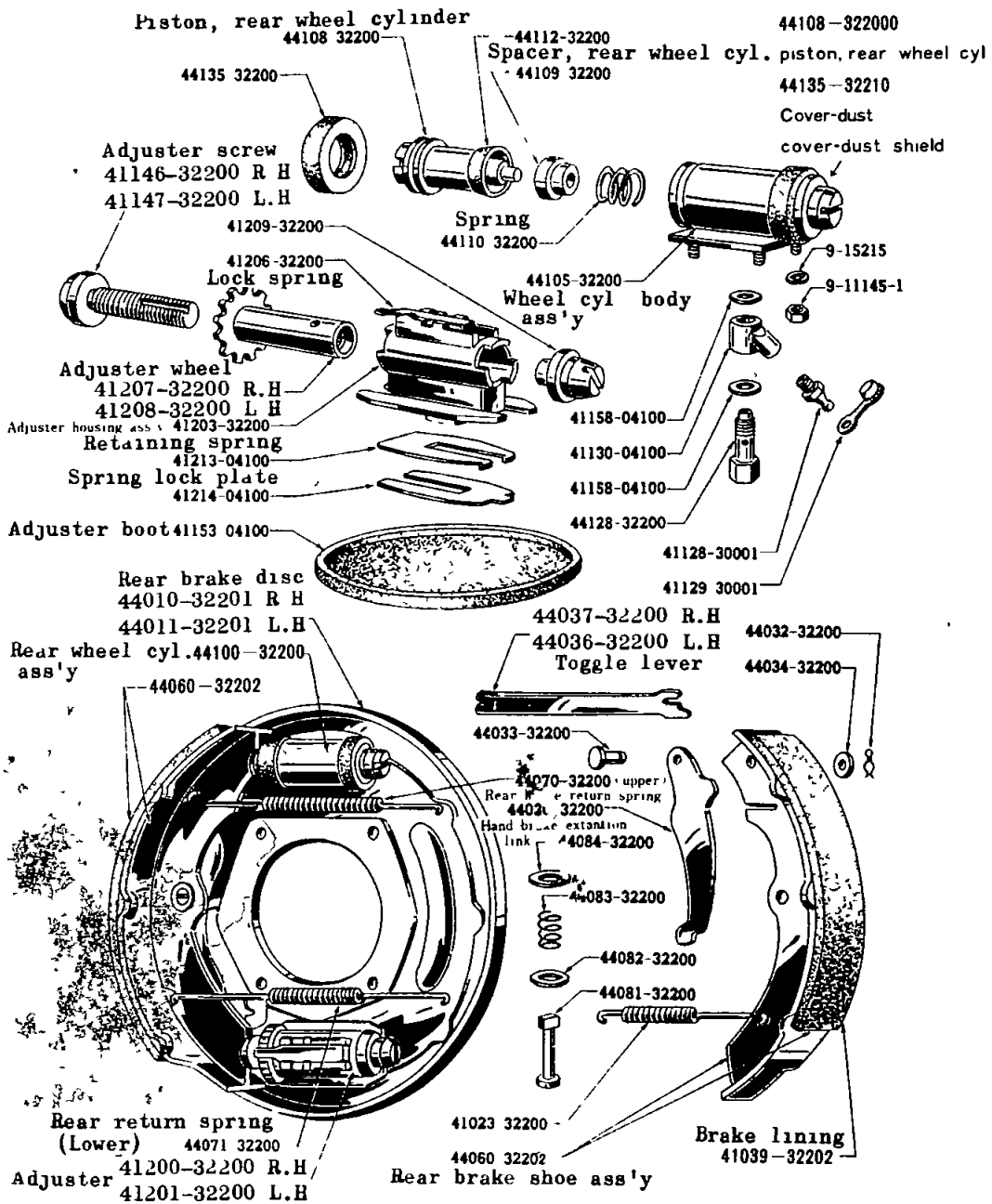


Fig. 2

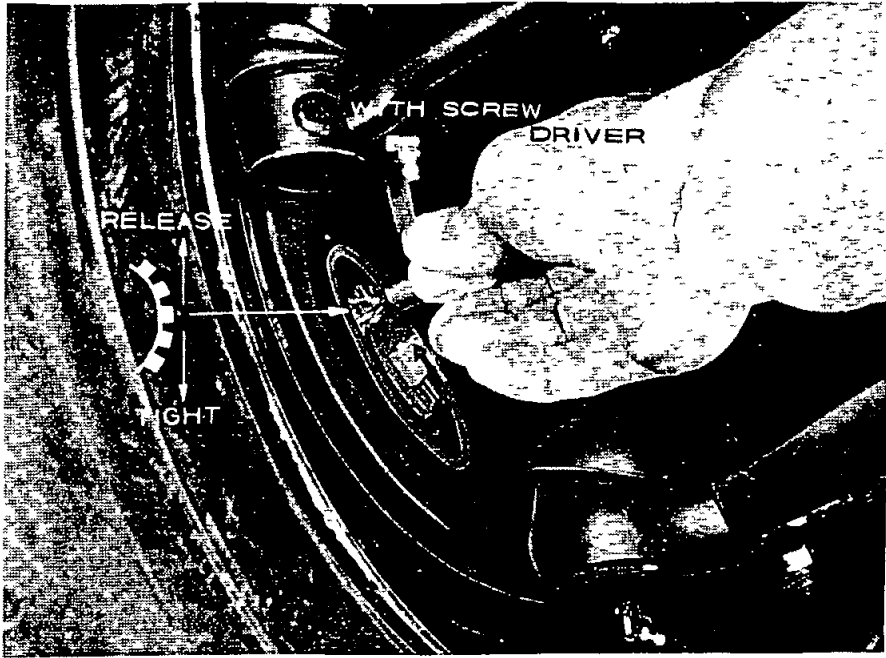
## HAND BRAKE

The hand brake operates on the rear wheels only and is applied by a pull-up type of lever situated along-side the driver's seat. The cable from the control is attached to the toggle lever connected with the rear brake disc. The hand brake linkage is set when leaving the works and should not require any attention under normal maintenance. Only when a complete overhaul is necessary should the hand brake linkage require resetting.

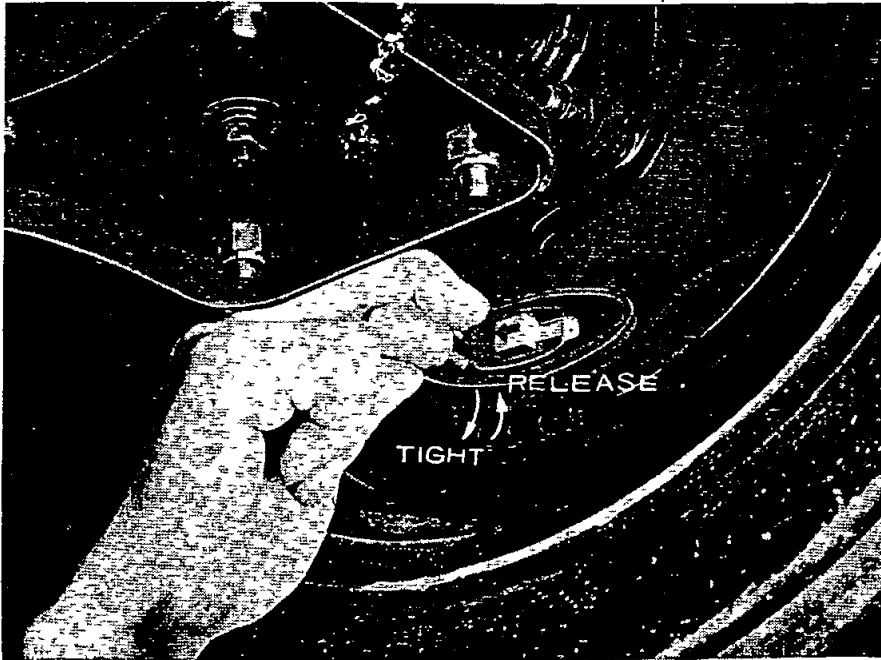
When this is correct the rear shoes should be locked to the drums, the hand brake control just slightly applied and the wire rope set with the slackness just removed, by means of a nut at the center rod of the equalizer drag link.



**Componets of Rear Brake**



Front brake adjustment



Rear brake adjustment



## ADJUSTING BRAKES

Raise the truck and place stand jacks front and rear so that all four wheels rotate freely

Disconnect the parking brake cables at the cross shaft lever  
This precaution should be taken to eliminate the possibility of brake shoe drag due to mis-adjusted parking brakes

Remove the adjuster boot and insert a screw driver through adjusting hole and engage the teeth on the wheel

Turn the adjuster wheel down upward direction until the shoe becomes locked on the brake drum, then turn it up (approximately 12 notches) until the wheel turns lightly

## MASTER CYLINDER

This consists of an alloy body with a polished, finished bore, and reservoir with cap

The inner assembly is made of the push rod, stopper plate ring, piston, secondary cap, return spring, inlet valve and check valve seat.

The open end of the cylinder is protected by a rubber boot as shown Fig. 1. Desassembling the Brake Master cylinder

Disconnect the pressure pipe union from the cylinder and remove the securing bolts, then the master cylinder and fluid reservoir may be withdrawn complete from the car. Remove the filler cap and drain out fluid. Pull back the rubber boot and remove the stopper ring with a pair of long-nosed pliers. The push rod assembly can then be removed. When the push rod has been removed the piston with the secondary cap will be exposed, therefore remove the piston assembly complete.

The assembly can be separated by taking out other small parts. Examine all parts, especially the rubber primary cap, for wear or distortion and replace with new parts where necessary

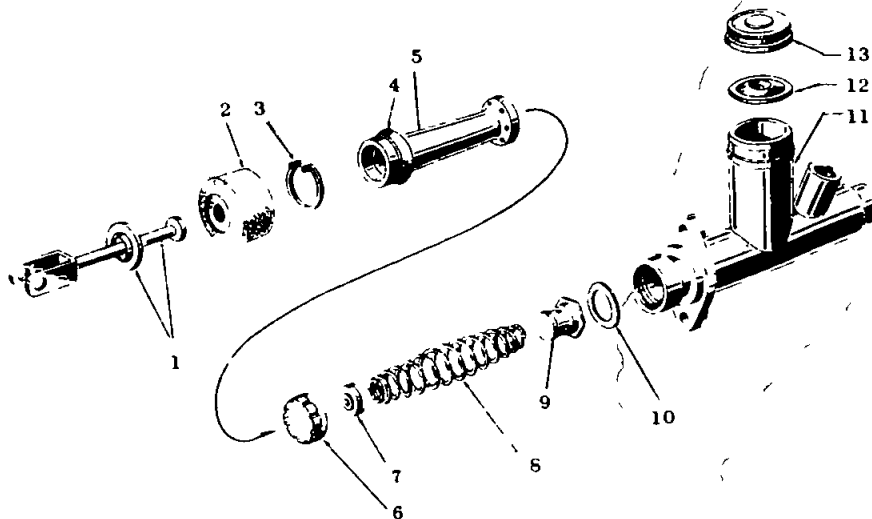


Fig. 3 Components of Brake master cylinder

- |                                |                                |
|--------------------------------|--------------------------------|
| 1. Push rod assembly           | 8. Return spring               |
| 2. Master cylinder rubber boot | 9. Let out valve assembly      |
| 3. Stopper plate ring          | 10. Check valve seat           |
| 4. Piston secondary cup        | 11. Brake master cylinder body |
| 5. Master cylinder piston      | 12. Filler cap gasket          |
| 6. Piston primary cup          | 13. Filler cap                 |
| 7. Return spring seat          |                                |

## Bleeding the Hydraulic System

Bleeding is necessary any time a portion of the hydraulic system has been disconnected or if the level of the brake fluid has been allowed to fall so low that air has entered the master cylinder. With all the hydraulic connections secure and the supply tank topped up with the fluid, remove the cap from the bleed valve and fit the bleed tube over the bleed valve, immersing the free end of the tube in a clean jar containing a little brake fluid.

Unscrew the bleed valve cap about three-quarters of a turn and then operate the brake pedal with a slow full stroke until the fluid entering the jar is completely free of air bubbles. Then, during a downstroke of the brake pedal, tighten the bleed screw cap sufficiently to seat, remove bleed tube.

This process must now be repeated for each of the other wheel cylinder

Always keep a careful check on the supply tank during bleeding since it is most important that a full level is maintained

Should air reach the master cylinder from the supply tank, the whole of the bleeding operation must be repeated

After bleeding, top up the supply tank to its correct level of approximately three-quarters full. Never use fluid that has been bleed from a brake system for topping up the supply tank, as this brake fluid may be to some extent aereated. Such fluid must be allowed to stand for at least one day before it is used again. This will allow the air bubbles in the fluid time to disperse. Great cleanliness is essential when dealing with any part of the hydraulic system, and especially so where the brake fluid is concerned. Dirty fluid must never be added to the system

