SERVICE MANUAL

1954-1960

Jeep®

UTILITY VEHICLES

MODELS

L6-226	4WD	F4-134	4WD
L6-226	4x4	F4-134	4x4
L6-226	4x2	F4-134	4x2

WILLYS SALES CORPORATION
WILLYS-OVERLAND EXPORT CORPORATION

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'JEEP' UTILITY WAGON



'JEEP' 4WD TRUCK

FOREWORD

This manual is provided for the guidance of all automotive service men, vehicle owners and service salesmen who repair, maintain or adjust Jeep Utility Vehicles. The information herein was prepared from the service man's viewpoint to give him accurate and concise data he may need to service the entire vehicle. The information is not elementary as it is intended for automotive service men who are familiar with automotive construction and repair in general. It is not intended, nor would it be possible in such limited space, to cover every possible repair that he may encounter. All specifications are in accord with Engineering Specifications and should be adhered to in all work on the vehicle.

The manual sections follow logical division into major components of the vehicles. The first page of each section has a detailed index of the contents of that section. Subject matter covers all models included in this manual unless an exception for a particular model is specifically mentioned.

Proper maintenance, adjustment and repair is a sound investment which pays dividends in trouble-free driving, longer vehicle life and lower repair bills in the future. If maintenance, adjustments or repairs are omitted, improperly performed, or not performed at the correct time, larger repair bills are sure to result at a later date. Follow closely the procedures given in this manual to assure trouble-free driving, maximum vehicle life, and a minimum of expense in the future.

Vehicle Description

This manual covers all Jeep "Utility Vehicle" models currently being produced. Significant changes made in each model since they were first produced are included in the manual. A description of each model follows. General specifications for each model are listed on page 4. Detailed specifications covering major vehicle units are listed at the end of each section of the manual.

L6-226 4WD — This is a 4-wheel-drive truck with a cab and either a pickup or platform stake body. It has a six-cylinder, L-head, engine.

L6-226 4x4 — This is a 4-wheel-drive vehicle with either a Utility Wagon or Utility Delivery body. It has a six-cylinder, L-head, engine.

L6-226 4x2 — This is a 2-wheel-drive vehicle with either a Utility Wagon or Utility Delivery body. It has a six-cylinder, L-head, engine. It was formerly designated as Model 6-226 2x4.

F4-134 4WD — This is a 4-wheel-drive truck with a cab and either a pickup or platform stake body. It has a four-cylinder, F-head, engine. It was formerly designated as Model 475 4WD.

F4-134 4x4 — This is a 4-wheel-drive vehicle with either a Utility Wagon or a Utility Delivery body. It has a four-cylinder, F-head, engine. It was formerly designated as Model 4 x 475.

F4-134 4x2 — This is a 2-wheel-drive vehicle with either a Utility Wagon or a Utility Delivery body. It has a four-cylinder, F-head, engine. It was formerly designated as Model 475 and Model 2 x 475.

LUBRICATION SPECIFICATIONS

Model L6-226 4WD

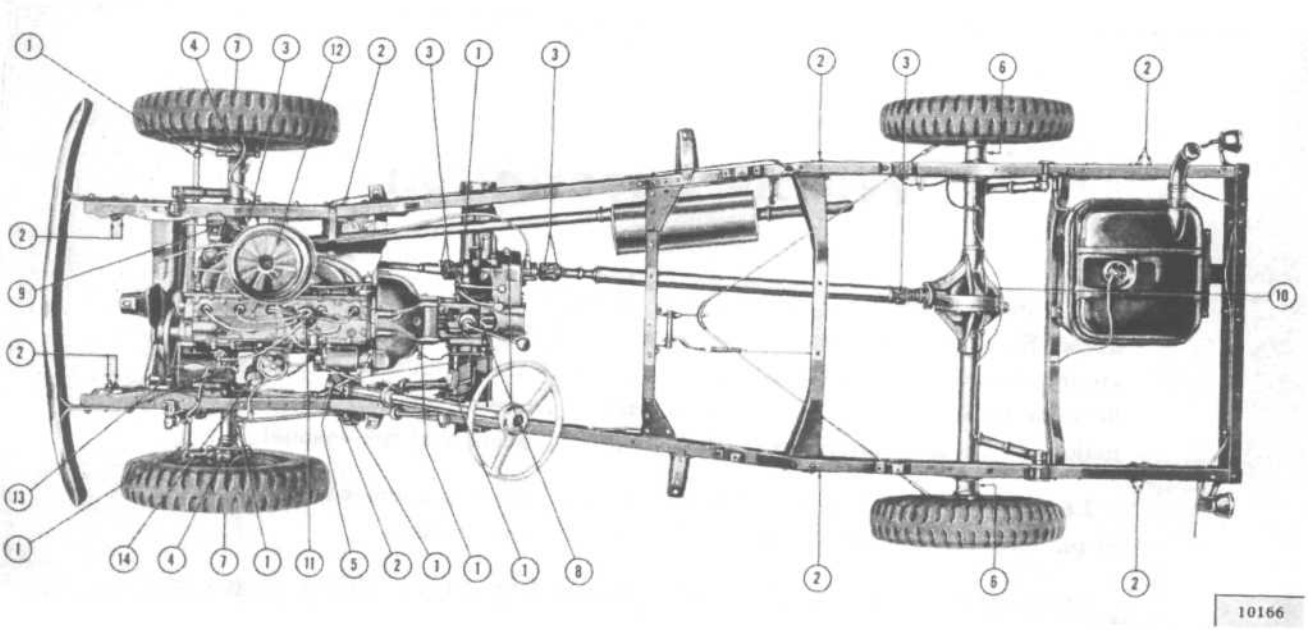


FIG. 3—LUBRICATION CHART — MODEL L6-226 4WD

Chart No.	ITEM TO BE LUBRICATED	FREQUENCY* 1000 miles = 1.600 km.	QUANTITY U.S. Imperial Metric	LUBRICANT TYPE	LUBRICANT GRADE Summer	LUBRICANT GRADE Winter
1.	Chassis Bearings	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
2.	Spring Shackle Bushings Spring Pivot Bolt Bushings	With lube fittings: Each 1000 miles Without lube fittings: No lubrication	As required	Chassis Lubricant	No. 1	No. 0
3.	Universal Joints Propeller Shaft	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
4.	Front Axle Shaft	Check each 1000 miles Change each 12,000 miles [19.200 km.]	As required	Chassis Lubricant	No. 1	No. 0
5.	Steering Gear	Check each 1000 miles	As required	GL-4	SAE 90	SAE 90
6.	Rear Wheels	Sparingly each 1000 miles	As required	Wheel Bearing Lubricant	No. 2	No. 2
7.	Front Wheels	Disassemble to lubricate each 6000 miles [9.600 km.]	As required	Wheel Bearing Lubricant	No. 2	No. 2
8.	Transmission and Transfer Case	Check each 1000 miles Change each 10,000 miles	6 pts. 5 pts. 2,8 ltrs.	GL-4	SAE 90	SAE 80
9. 10.	Differentials Front Rear	Check each 1000 miles Change each 10,000 miles	2 ½ pts. 2 pts. 1,2 ltrs. 3 pts. 2 ¼ pts. 1,3 ltrs.	GL-4 GL-4**	SAE 90 SAE 90	SAE 90 SAE 90
11.	Distributor Oiler Wick Pivot Cam	Each 1000 miles Each 1000 miles Each 1000 miles Each 1000 miles	Several Drops One drop One drop Sparingly	Engine Oil Engine Oil Engine Oil Grease	Same as engine Same as engine Same as engine Soft	
12.	Air Cleaner	Each 2000 miles	1 ¼ pt. 1 pt. 0,6 ltrs.	Engine Oil	Same as engine	
13.	Generator	Each 1000 miles	2 to 4 drops	Engine Oil	Same as engine	
14.	Engine	Change each 2000 miles	5***qts. 4 ¼ qts. 4,7 ltrs.			

Above 90°F. [32°C.]	Not lower than 32°F. [0°C.]	As low as 10°F. [-12°C.]	As low as -10°F. [-23°C.]	Lower than -10°F. [-23°C.]
use SAE 30 or 10W-30	use SAE 20, 20W, 10W-30, or 10W-20	use SAE 20W, 10W-30, or 10W-20	use SAE 10W, 10W-30, or 10W-20	use SAE 5W or 5W-20

*For frequency of lubrication under field or industrial use, see Par. B-38.
**For Powr-Lok differential use only Willys Powr-Lok Differential Oil, Part No. 94557.
***When oil filter is changed at the same time, add one quart [1 ltr.].

LUBRICATION SPECIFICATIONS

Model L6-226 4x4

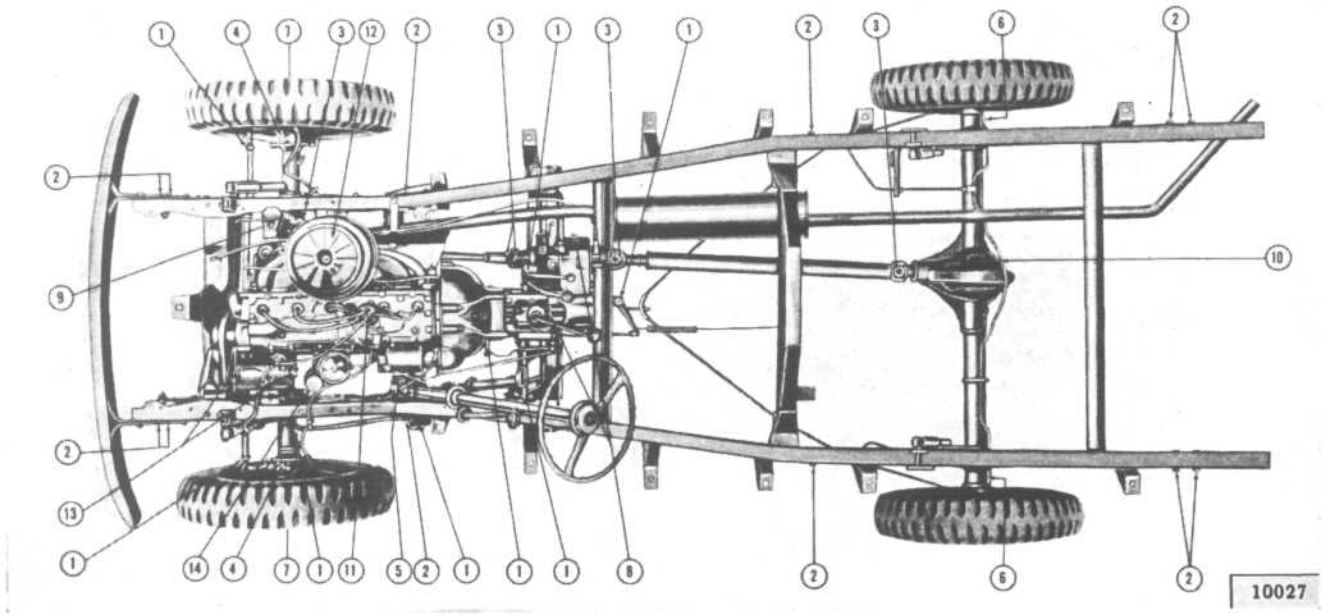


FIG. 4—LUBRICATION CHART — MODEL L6-226 4x4

Chart No.	ITEM TO BE LUBRICATED	FREQUENCY* 1000 miles = 1.600 km.	QUANTITY U.S. Imperial Metric	LUBRICANT TYPE	LUBRICANT GRADE Summer	Winter
1.	Chassis Bearings	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
2.	Spring Shackle Bushings Spring Pivot Bolt Bushings	With lube fittings: Each 1000 miles Without lube fittings: No lubrication	As required	Chassis Lubricant	No. 1	No. 0
	Universal Joints					
3.	Propeller Shaft	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
4.	Front Axle Shaft	Check each 1000 miles Change each 12,000 miles [19.200 km.]	As required	Chassis Lubricant	No. 1	No. 0
5.	Steering Gear	Check each 1000 miles	As required	GL-4	SAE 90	SAE 90
6.	Rear Wheels	Sparingly each 1000 miles	As required	Wheel Bearing Lubricant	No. 2	No. 2
7.	Front Wheels	Disassemble to lubricate each 6000 miles [9.600 km.]	As required	Wheel Bearing Lubricant	No. 2	No. 2
8.	Transmission and Transfer Case	Check each 1000 miles Change each 10,000 miles	6 pts. 5 pts. 2,8 ltrs.	GL-4	SAE 90	SAE 80
	Differentials					
9.	Front	Check each 1000 miles	2 ½ pts. 2 pts. 1,2 ltrs.	GL-4	SAE 90	SAE 90
10.	Rear	Change each 10,000 miles	3 pts. 2 ¼ pts. 1,3 ltrs.	GL-4**	SAE 90	SAE 90
11.	Distributor					
	Oiler	Each 1000 miles	Several Drops	Engine Oil	Same as engine	
	Wick	Each 1000 miles	One drop	Engine Oil	Same as engine	
	Pivot	Each 1000 miles	One drop	Engine Oil	Same as engine	
	Cam	Each 1000 miles	Sparingly	Grease	Soft	
12.	Air Cleaner	Each 2000 miles	1 ¼ pt. 1 pt. 0,6 ltrs.	Engine Oil	Same as engine	
13.	Generator	Each 1000 miles	2 to 4 drops	Engine Oil	Same as engine	
14.	Engine	Change each 2000 miles	5*** qts. 4 ¼ qts. 4,7 ltrs.			

Above 90°F. [32°C.]	Not lower than 32°F. [0°C.]	As low as 10°F. [-12°C.]	As low as -10°F. [-23°C.]	Lower than -10°F. [-23°C.]
use SAE 30 or 10W-30	use SAE 20, 20W, 10W-30, or 10W-20	use SAE 20W, 10W-30, or 10W-20	use SAE 10W, 10W-30, or 10W-20	use SAE 5W or 5W-20

*For frequency of lubrication under field or industrial use, see Par. B-38.
**For Powr-Lok differential use only Willys Powr-Lok Differential Oil, Part No. 94557.
***When oil filter is changed at the same time, add one quart [1 ltr.].

LUBRICATION SPECIFICATIONS

Model L6-226 4x2

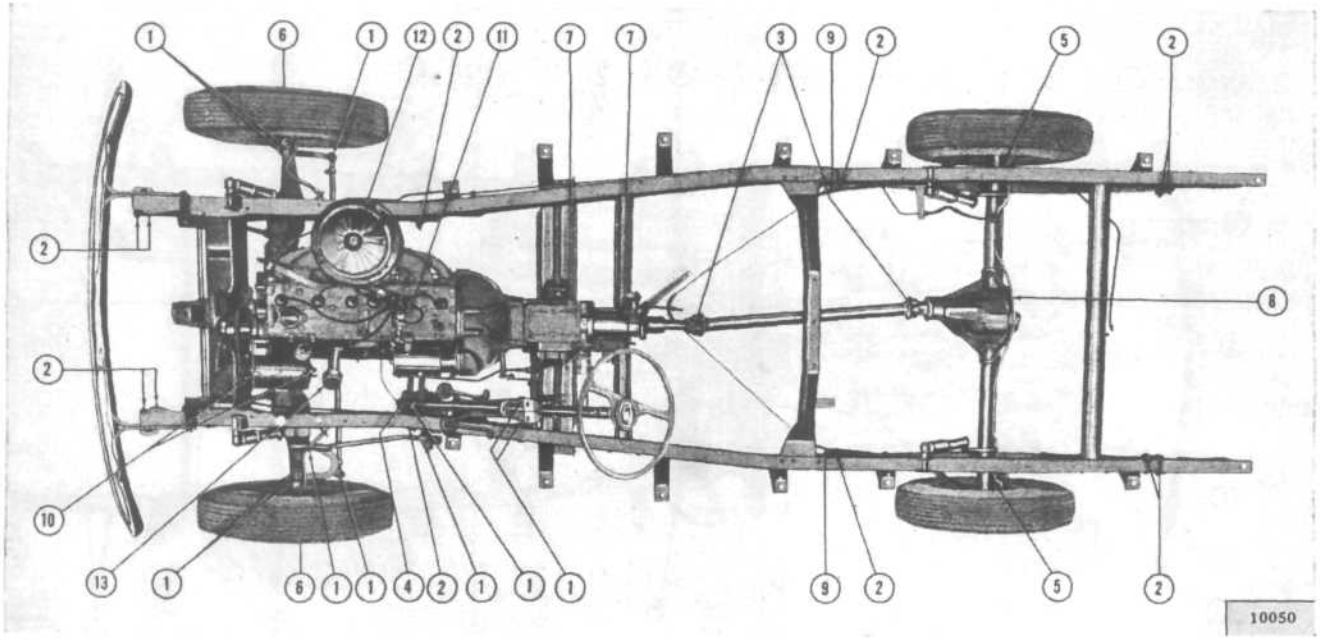


FIG. 5—LUBRICATION CHART — MODEL L6-226 4x2

Chart No.	ITEM TO BE LUBRICATED	FREQUENCY 1000 miles = 1.600 km.	QUANTITY U.S. Imperial Metric	LUBRICANT TYPE	LUBRICANT GRADE Summer	LUBRICANT GRADE Winter
1.	Chassis Bearings	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
2.	Spring Shackle Bushings Spring Pivot Bolt Bushings	With lube fittings: Each 1000 miles Without lube fittings: No lubrication	As required	Chassis Lubricant	No. 1	No. 0
3.	Universal Joints	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
4.	Steering Gear	Check each 1000 miles	As required	GL-4	SAE 90	SAE 90
5.	Rear Wheels	Sparingly each 1000 miles	As required	Wheel Bearing Lubricant	No. 2	No. 2
6.	Front Wheels	Disassemble to lubricate each 10,000 miles	As required	Wheel Bearing Lubricant	No. 2	No. 2
7.	Transmission Overdrive	Check each 1000 miles Change each 10,000 miles	2 ½ pts. 2 pts. 1,2 ltrs. 1 pt. ⅜ pt. 0,5 ltrs.	GL-4 GL-4	SAE 90 SAE 90	SAE 80 SAE 80
8.	Differential	Check each 1000 miles Change each 10,000 miles	2 pts. 1¾ pts. 1,0 ltrs.	GL-4*	SAE 90	SAE 90
9.	Hand Brake Cable	Disassemble to lubricate each 10,000 miles	As required	Graphite Grease	Light	
10.	Generator	Each 1000 miles	2-4 drops	Engine Oil	Same as engine	
11.	Distributor Oiler Wick Pivot Cam	 Each 1000 miles Each 1000 miles Each 1000 miles Each 1000 miles	 Several drops One drop One drop Sparingly	 Engine Oil Engine Oil Engine Oil Grease	 Same as engine Same as engine Same as engine Soft	
12.	Air Cleaner	Change each 2000 miles	1 ¼ pts. 1 pt. 0,6 ltrs.	Engine Oil	Same as engine	
13.	Engine	Change each 2000 miles	5** qts. 4¼ qts. 4,7 ltrs.			

Above 90°F. [32°C.] use SAE 30 or 10W-30	Not lower than 32°F. [0°C.] use SAE 20, 20W, 10W-30, or 10W-20	As low as 10°F. [-12°C.] use SAE 20W, 10W-30, or 10W-20	As low as -10°F. [-23°C.] use SAE 10W, 10W-30, or 10W-20	Lower than -10°F. [-23°C.] use SAE 5W or 5W-20

*For Powr-Lok differential use only Willys Powr-Lok Differential Oil, Part No. 94557.
**When oil filter is changed at the same time, add one quart [1 ltr.].

LUBRICATION SPECIFICATIONS
Model F4-134 4WD

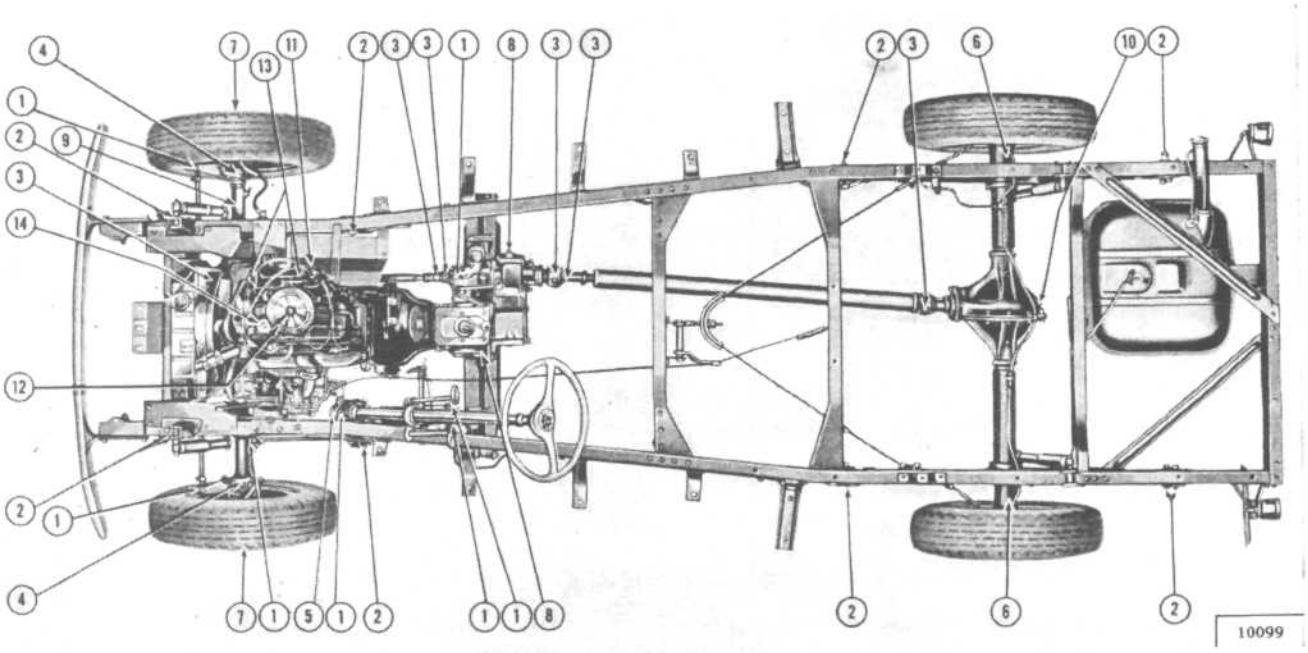


FIG. 6—LUBRICATION CHART — MODEL F4-134 4WD

Chart No.	ITEM TO BE LUBRICATED	FREQUENCY* 1000 miles = 1,600 km.	QUANTITY U.S. Imperial Metric	LUBRICANT TYPE	LUBRICANT GRADE Summer	LUBRICANT GRADE Winter
1.	Chassis Bearings	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
2.	Spring Shackle Bushings Spring Pivot Bolt Bushings	With lube fittings: Each 1000 miles Without lube fittings: No lubrication	As required	Chassis Lubricant	No. 1	No. 0
	Universal Joints					
3.	Propeller Shaft	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
4.	Front Axle Shaft	Check each 1000 miles Change each 12,000 miles [19.200 km.]	As required	Chassis Lubricant	No. 1	No. 0
5.	Steering Gear	Check each 1000 miles	As required	GL-4	SAE 90	SAE 90
6.	Rear Wheels	Sparingly each 1000 miles	As required	Wheel Bearing Lubricant	No. 2	No. 2
7.	Front Wheels	Disassemble to lubricate each 6000 miles [9.600 km.]	As required	Wheel Bearing Lubricant	No. 2	No. 2
8.	Transmission and Transfer Case	Check each 1000 miles Change each 10,000 miles	6 ½ pts. 5 ½ pts. 3,7 ltrs.	GL-4	SAE 90	SAE 80
	Differentials					
9.	Front	Check each 1000 miles Change each 10,000 miles	2 ½ pts. 2 pts. 1,2 ltrs. 3 pts. 2 ¼ pts. 1,3 ltrs.	GL-4 GL-4**	SAE 90 SAE 90	SAE 90 SAE 90
10.	Rear					
11.	Distributor					
	Oiler	Each 1000 miles	Several Drops	Engine Oil	Same as engine	
	Wick	Each 1000 miles	One drop	Engine Oil	Same as engine	
	Pivot	Each 1000 miles	One drop	Engine Oil	Same as engine	
	Cam	Each 1000 miles	Sparingly	Grease	Soft	
12.	Air Cleaner	Each 2000 miles	1 ¼ pt. 1 pt. 0,6 ltrs.	Engine Oil	Same as engine	
13.	Generator	Each 1000 miles	2 to 4 drops	Engine Oil	Same as engine	
14.	Engine	Change each 2000 miles	4***qts. 3 ¼ qts. 3,8 ltrs.			

Above 90°F. [32°C.]	Not lower than 32°F. [0°C.]	As low as 10°F. [–12°C.]	As low as –10°F. [–23°C.]	Lower than –10°F. [–23°C.]
use SAE 30 or 10W-30	use SAE 20, 20W, 10W-30, or 10W-20	use SAE 20W, 10W-30, or 10W-20	use SAE 10W, 10W-30, or 10W-20	use SAE 5W or 5W-20

*For frequency of lubrication under field or industrial use, see Par. B-38.
**For Powr-Lok differential use only Willys Powr-Lok Differential Oil, Part No. 94557.
***When oil filter is changed at the same time, add one quart [1 ltr.].

F4-134 4WD

LUBRICATION SPECIFICATIONS

Model F4-134 4x4

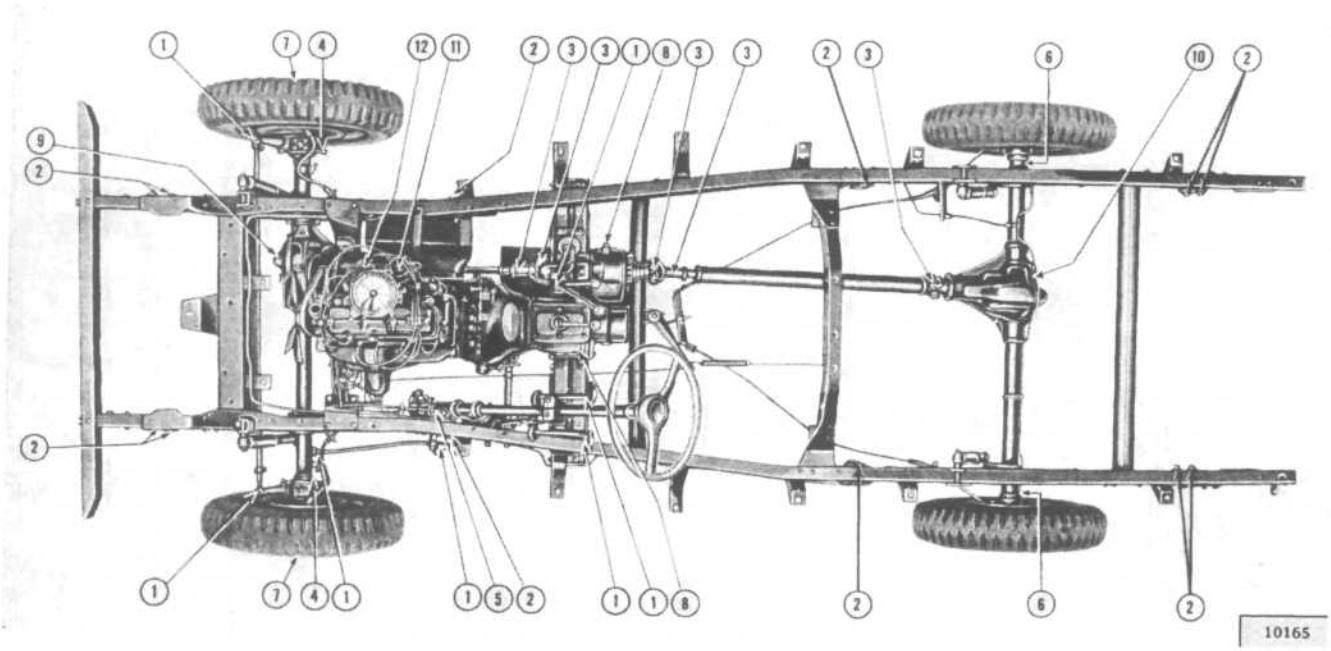


FIG. 7—LUBRICATION CHART — MODEL F4-134 4x4

Chart No.	ITEM TO BE LUBRICATED	FREQUENCY* 1000 miles = 1.600 km.	QUANTITY U.S. Imperial Metric	LUBRICANT TYPE	LUBRICANT GRADE Summer	LUBRICANT GRADE Winter
1.	Chassis Bearings	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
2.	Spring Shackle Bushings Spring Pivot Bolt Bushings	With lube fittings: Each 1000 miles Without lube fittings: No lubrication	As required	Chassis Lubricant	No. 1	No. 0
	Universal Joints					
3.	Propeller Shaft	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
4.	Front Axle Shaft	Check each 1000 miles Change each 12,000 miles [19.200 km.]	As required	Chassis Lubricant	No. 1	No. 0
5.	Steering Gear	Check each 1000 miles	As required	GL-4	SAE 90	SAE 90
6.	Rear Wheels	Sparingly each 1000 miles	As required	Wheel Bearing Lubricant	No. 2	No. 2
7.	Front Wheels	Disassemble to lubricate each 6000 miles [9.600 km.]	As required	Wheel Bearing Lubricant	No. 2	No. 2
8.	Transmission and Transfer Case	Check each 1000 miles Change each 10,000 miles	6 ½ pts. 5 ½ pts. 3,7 ltrs.	GL-4	SAE 90	SAE 80
	Differentials					
9.	Front	Check each 1000 miles Change each 10,000 miles	2 ½ pts. 2 pts. 1,2 ltrs. 3 pts. 2 ¼ pts. 1,3 ltrs.	GL-4 GL-4**	SAE 90 SAE 90	SAE 90 SAE 90
10.	Rear					
11.	Distributor					
	Oiler	Each 1000 miles	Several Drops	Engine Oil	Same as engine	
	Wick	Each 1000 miles	One drop	Engine Oil	Same as engine	
	Pivot	Each 1000 miles	One drop	Engine Oil	Same as engine	
	Cam	Each 1000 miles	Sparingly	Grease	Soft	
12.	Air Cleaner	Each 2000 miles	1 ¼ pt. 1 pt. 0,6 ltrs.	Engine Oil	Same as engine	
	Generator	Each 1000 miles	2 to 4 drops	Engine Oil	Same as engine	
	Engine	Change each 2000 miles	4*** qts. 3 ½ qts. 3,8 ltrs.			

Above 90°F. [32°C.] use SAE 30 or 10W-30	Not lower than 32°F [0°C.] use SAE 20, 20W, 10W-30, or 10W-20	As low as 10°F. [-12°C.] use SAE 20W, 10W-30, or 10W-20	As low as -10°F. [-23°C.] use SAE 10W, 10W-30, or 10W-20	Lower than -10°F. [-23°C.] use SAE 5W or 5W-20

*For frequency of lubrication under field or industrial use, see Par. B-38.
**For Powr-Lok differential use only Willys Powr-Lok Differential Oil, Part No. 94557.
***When oil filter is changed at the same time, add one quart [1 ltr.].

LUBRICATION SPECIFICATIONS

Model F4-134 4x2

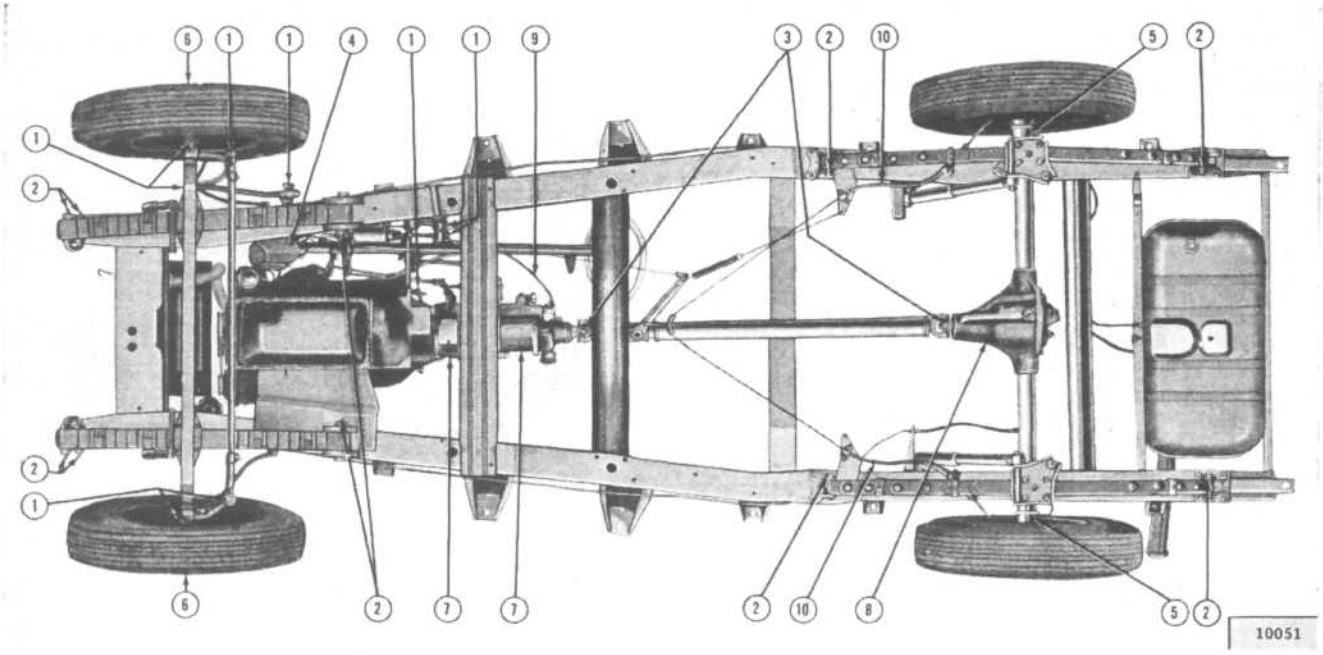


FIG. 8—LUBRICATION CHART — MODEL F4-134 4x2

Chart No.	ITEM TO BE LUBRICATED	FREQUENCY 1000 miles = 1.600 km.	QUANTITY U.S. Imperial Metric	LUBRICANT TYPE	LUBRICANT GRADE Summer	LUBRICANT GRADE Winter
1.	Chassis Bearings	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
2.	Spring Shackle Bushings Spring Pivot Bolt Bushings	With lube fittings: Each 1000 miles Without lube fittings: No lubrication	As required	Chassis Lubricant	No. 1	No. 0
3.	Universal Joints	Each 1000 miles	As required	Chassis Lubricant	No. 1	No. 0
4.	Steering Gear	Check each 1000 miles	As required	GL-4	SAE 90	SAE 90
5.	Rear Wheels	Sparingly each 1000 miles	As required	Wheel Bearing Lubricant	No. 2	No. 2
6.	Front Wheels	Disassemble to lubricate each 10,000 miles	As required	Wheel Bearing Lubricant	No. 2	No. 2
7.	Transmission Overdrive	Check each 1000 miles Change each 10,000 miles	1 ½ pts. 1 ¼ pts. 0,8 ltrs. ¾ pt. ⅝ pt. 0,4 ltrs.	GL-4 GL-4	SAE 90 SAE 90	SAE 80 SAE 80
8.	Differential	Check each 1000 miles Change each 10,000 miles	2 pts. 1 ¾ pts. 1,0 ltrs.	GL-4*	SAE 90	SAE 90
9.	Speedometer Cable	Disassemble to lubricate each 12,000 miles [19.200 km.]	As required	Graphite Grease	Light	
9.	Hand Brake Cable	Disassemble to lubricate each 10,000 miles	As required	Graphite Grease	Light	
	Generator	Each 1000 miles	2-4 drops	Engine Oil	Same as engine	
	Distributor Oiler Wick Pivot Cam	 Each 1000 miles Each 1000 miles Each 1000 miles Each 1000 miles	 Several drops One drop One drop Sparingly	 Engine Oil Engine Oil Engine Oil Grease	 Same as engine Same as engine Same as engine Soft	
	Air Cleaner	Change each 2000 miles	1 ¼ pts. 1 pt. 0,6 ltrs.	Engine Oil	Same as engine	
	Engine	Change each 2000 miles	4** qts. 3 ⅓ qts. 3,8 ltrs.			

Above 90°F. [32°C.]	Not lower than 32°F. [0°C.]	As low as 10°F. [-12°C.]	As low as -10°F. [-23°C.]	Lower than -10°F. [-23°C.]
use SAE 30 or 10W-30	use SAE 20, 20W, 10W-30, or 10W-20	use SAE 20W, 10W-30, or 10W-20	use SAE 10W, 10W-30, or 10W-20	use SAE 5W or 5W-20

*For Powr-Lok differential use only Willys Powr-Lok Differential Oil, Part No. 94557.
**When oil filter is changed at the same time, add one quart [1 ltr.].

F4-134 4X2

B-4. Engine Lubricating System

The engine is pressure lubricated by a gear type oil pump driven by a spiral gear on the camshaft. Oil is drawn through a floating, screened intake to prevent the accumulation of any sediment or water that might accumulate in the oil pan. Engine lubrication is shown in Figs. 1 and 2. Maximum oil pressure in the system is limited by an oil pressure relief valve located on the oil pump of the F4-134 engine and in the cylinder block of the L6-226 engine. See Par. D-122 and E-20.

B-5. DETAIL LUBRICATION REQUIREMENTS

B-6. Initial Lubrication

When a new vehicle is placed in service or an engine is overhauled, the engine oil should be changed after the first 500 miles [800 km.] of operation and again after an additional 1500 miles [2.400 km.]. The oil filter should be cleaned and the element replaced after the first 2000 miles [3.200 km.] of operation. For all other vehicle lubrication, follow the instructions given in the remainder of this section of this manual.

During the run-in period, until the piston rings have become seated, oil consumption in the engine is usually greater than that considered normal for proper lubrication. As much as 4000 miles [6.400 km.] of operation may be required to properly seat the rings and decrease oil consumption to normal. Do not overfill the crankcase as excess oil will be rapidly dissipated. Under no conditions should an oil heavier than SAE 20W be used during the summer or SAE 10W during the winter for the first 500 miles [800 km.] when an engine is new or has been rebuilt.

B-7. Engine Crankcase

The oil in the crankcase should be changed after each 2000 miles [3.200 km.] of service or more often should inspection show contamination or thinning of the oil. Should either of these conditions exist, an inspection should be made to determine and correct the cause.

B-8. Lubrication Fittings

Each 1000 miles [1.600 km.] clean each lubrication fitting indicated by No. 1 on Lubrication Charts and use a pressure gun to lubricate. Be sure that the grease channels are open to provide complete lubrication of bearing surfaces. In extreme cases it may be necessary to clear plugged channels.

B-9. Spring Shackles and Pivot Bolts

All spring shackles and spring pivot bolts are shown as No. 2 on the Lubrication Charts, but some of these points will not have lubrication fittings. Where there is no lubrication fitting at one of these points, indicating a silent bloc bushing has been installed, that point is not to be lubricated. Where there are lubrication fittings at the spring shackles or pivot bolts lubricate at each fitting with a pressure gun every 1000 miles [1.600 km.].

B-10. Propeller Shaft Universal Joints

Every 1000 miles [1.600 km.] lubricate the Spicer propeller shaft universal joints and slip joints with proper lubricant. Use a hand gun to avoid damaging the seals.

On all vehicles using Universal Products joints, disassemble and repack each 20,000 miles [32.000 km.] with not more than 1 oz. [28 gm.] of lubricant in each joint.

B-11. Front Axle Shaft Universal Joints and King Pin Bearings

All 4-wheel drive front axle shaft universal joints and the front axle king pin bearings are enclosed in the steering knuckle housings. Check the lubricant level in the housings each 1000 miles [1.600 km.] to maintain it at fill plug level. Once each year or at each 12,000 miles [19.200 km.] remove the shafts. Thoroughly clean the universal joints and housings and refill the housings with universal joint or chassis lubricant. Use No. 1 for summer and No. 0 for winter.

B-12. Steering Gear

Check the lubricant level in the steering gear housing at each 1000 miles [1.600 km.] to be sure that the lubricant is at fill plug opening level. Should lubricant be required, fill the housing slowly with a hand compressor. Do not overlook replacing the fill plug.

B-13. Front Wheel Bearings

Seasonally or at each 6000 miles]9.600 km.] remove the front wheels and repack the bearings with wheel bearing grease. Work the grease into the cage holding the rollers.

B-14. Rear Wheel Bearings

The rear wheel bearings are equipped with lubrication fittings with a vent opening through the housings above each fitting as shown in Fig. 294. Use a hand compressor and wheel bearing grease, forcing the grease through each lubrication fitting until it flows from the vent. Vent should be kept clear of obstruction or grease will back up into the brakes. Do not add grease after it flows from the vent for it may be forced through the wheel keyway onto the outside of the wheel and possibly onto the brake linings.

B-15. Transmission

Check the transmission lubricant level at each regular 1000-mile lubrication and add lubricant to the level of the fill plug hole.

Drain and refill the transmission each 10,000 miles [16.000 km.]. To drain the oil from the transmission case, unscrew the drain plug in the lower right side of the case. Replace the drain plug and remove the fill plug in the right side of the case. Pour in lubricant to the level of the fill plug hole and replace the fill plug.

On those model L6-226 4x2 vehicles equipped with a conventional transmission, there is a second fill plug located in the side of the long rear bearing retainer. Check the fluid level in the rear bearing retainer whenever the transmission housing is checked. Add GL4 lubricant as required.

For those models equipped with transmission overdrive, see Par. B-17.

B-16. Transfer Case

Drilled passages are provided for oil circulation between transmission and transfer case housings on all 4-wheel-drive vehicles. All transfer cases should be serviced separately even though the lubricant circulates to the transmission.

Lubricate the transfer case in the same manner and use the same lubricants as outlined above for the transmission.

B-17. Overdrive

On those vehicles equipped with an overdrive, use GL4 lubricant grade SAE 90 in summer and SAE 80 in winter in both transmission and overdrive units. If these grades cannot be obtained, use SAE 40 engine oil.

The overdrive case drain plug is located in the lower rear part of the case and the filler hole on the right hand side. The overdrive case should be filled first with oil, then fill the transmission because the lubricant passes between the two units. The overdrive should be checked for lubricant level every 1000 miles [1.600 km.].

B-18. Overdrive Control

If so equipped, once each year disconnect the overdrive control cable from the overdrive and pull the cable from the conduit to lubricate the conduit with light graphite grease.

B-19. Front and Rear Axle Differentials

Check the level in each unit every 1000 miles [1.600 km.] to be sure that they are filled to the level of the fill plug openings. Drain and refill the housings every 10,000 miles [16,000 km.]. Do not mix different types of lubricants. Use only flushing oil or light engine oil to clean out the housings. Do not use water, steam, kerosene, or gasoline for flushing.

B-20. Powr-Lok Nonslip Differential

Some vehicles may be equipped with the Powr-Lok nonslip differential as optional equipment. This unit can be identified by a brass tag stamped with the letter **T** under one of the differential cover bolt heads. The Powr-Lok differential requires a special lubricant and ordinary multipurpose gear lubricants *must not* be used. Use only Willys Powr-Lok Differential Oil, Part No. 94557, furnished in pint cans.

Powr-Lok differential may be cleaned only by disassembling the unit and wiping with clean rags. Do not flush the Powr-Lok unit.

B-21. Distributor

The distributor shaft is lubricated through an oiler mounted on the side of the housing. Place three or four drops of light engine oil in the oiler each 1000 miles [1.600 km.]. Also place one drop of light engine oil on the wick located on the top of the shaft, which is made accessible by removing the rotor arm. Sparingly apply soft grease to the breaker arm cam. Place a drop of oil on the breaker arm pivot.

B-22. Generator

Oilers are provided at each end of the generator. Place two to four drops of light engine oil in each oiler every 1000 miles [1.600 km.].

B-23. Oil Filter

After the initial change specified in Par. B-6, clean the oil filter and replace the element at each 6000 miles [9.600 km.] of normal vehicle use. Oil filter servicing should be performed at the same time as one of the regular engine oil changes. At that time be sure to add one quart to the engine oil change requirement.

B-24. Oil Bath Air Cleaner

These vehicles are equipped with an oil bath type air cleaner. This type cleaner thoroughly removes all dust from the air before it enters the carburetor. For efficient operation, the cleaner must be serviced at regular intervals. Service the unit according to conditions of vehicle operation. For regular highway travel service the cleaner at each engine oil change. To service the air cleaner, unscrew the eye bolt on the oil cup clamp and remove the oil cup. Scrape all dirt from inside the oil cup and clean the inside surface with cleaning solution. Refill with new oil of the same viscosity as is recommended for the engine crankcase to the oil level bead and install the cup securely to the cleaner body with the attaching clamp.

When using the vehicle regularly in extremely dusty conditions, the cleaner should be serviced daily. Also, the air cleaner body (less oil cup) should be removed from the vehicle and cleaned at weekly intervals or oftener.

To do this, loosen hose clamp, and remove hose from the cleaner.

Detach breather hose from the fitting on the cleaner. Remove the two wing screws and lift cleaner from vehicle. Agitate the cleaner body thoroughly in cleaning solution to clean the filtering element. Dry element with air hose but do not re-oil.

Install the cleaner body in the vehicle with the two wing screws and attach hoses securely.

Carefully check the hose clamps and fittings on the breather hoses at frequent intervals. Loose connections will affect proper operation of the crankcase ventilating system.

B-25. Speedometer Cable

Remove the speedometer drive shaft from the tube once each year, clean it thoroughly, and coat it with a good quality light graphite grease.

B-26. Flexible Controls — Choke, Hand Brake

Periodically oil the exterior surfaces of the flexible control conduits with penetrating oil. This will usually maintain smooth operation with minimum wear. Should the hand brake control cable require additional lubrication, remove it from the conduit and coat it with light graphite grease.

B-27. Brake Master Cylinder

Check the fluid level in the brake master cylinder every 1000 miles [1.600 km.]. Wipe clean the top of the filler cap and also the housing area around it. Replenish the brake fluid to a level ½″ [1,3 cm.] below the top of the fill hole. Use only heavy-duty brake fluid conforming to specification SAE-70-R1. Be sure to handle the brake fluid in clean dispensers and containers that will not introduce even the slightest amount of other liquids. Replace and tighten the filler cap.

B-28. Clutch Linkage

Lubricate all friction points of the clutch linkage every 1000 miles [1.600 km.]. Use the same grade of engine oil as used for the engine. Failure to lubri-

cate these points will result in premature wear; the links will wear and the holes in the mating parts will become elongated.

B-29. Windshield Wiper

On those models where the windshield wiper blades are operated through pulleys and cables, once a year coat the cables with light grease and oil the pulley bearings with engine oil.

On those models where the wiper blades are operated by rigid arms, regularly lubricate all pivot points of the assembly with engine oil.

B-30. Body

Often attention is not given to the proper lubrication of the body hardware. However, when this is done it should be called to the owner's attention to avoid soiled clothing. A few drops of oil should be placed on the door, tail gate and hood hinges. Use greaseless lubricant on the door dovetails and striker plates. Put a little oil on the door check hinge pins. The hood catch, hand brake ratchet, cowl ventilator control, and hood and tail gate props should be oiled for easy operation. Whenever necessary, the door glass regulator mechanism should be lubricated sparingly. An occasional application of penetrating oil on the outside of the hood lock, choke and starter control conduits will keep the controls operating freely.

B-31. Power Take-Off and Pulley Drive

Check the lubrication level each time the vehicle is lubricated to be sure that the housings are filled to fill opening levels. Should the units be used often, drain and refill the housings each 300 hours of operation.

B-32. Power Take-Off Propeller Shaft Universal Joints

For average use the original factory lubrication will last the life of the vehicle. Should the power take-off be used often, however, for long periods of time, disassemble and repack the joints once each year. When repacking, guard against overfilling for hydraulic action may damage the boots. The capacity of each joint is one fluid ounce.

B-33. Centrifugal Governor

Check the oil level in the governor housings at each vehicle lubrication. Use the same seasonal grade oil as is used in the engine and change oil at each engine oil change. Do not fill the housing above the plug opening. Keep the vent in the fill plug open at all times.

B-34. PARTS REQUIRING NO LUBRICATION

B-35. Water Pump Bearing, Clutch Release Bearing

The water pump and clutch release bearings are prelubricated for life when manufactured and cannot be relubricated.

B-36. Starting Motor Bearings

The starting motor bearings are lubricated at assembly to last between normal rebuild periods.

B-37. Springs

The vehicle springs should not be lubricated. At assembly the leaves are coated with a long lasting special lubricant which is designed to last the life of the springs. Spraying with the usual mixture of oil and kerosene has a tendency to wash this lubricant from between the leaves, making it necessary to relubricate often to eliminate squeaking.

B-38. LUBRICATION REQUIREMENTS FOR OFF-HIGHWAY OPERATION

Adequate lubrication becomes increasingly important when vehicles are used in off-highway operation. Under these conditions all operating parts of both the engine and chassis are subjected to unusual pressures. At the same time such operation is usually under abnormal dust and dirt conditions making additional precautions necessary. The importance of correct lubrication for the conditions of operation cannot be overestimated.

B-39. Engine Oil

Use only a nationally advertised brand of MS grade oil. No definite change interval can be recommended because of the great variety of uses and conditions of use. It is important, however, that the oil in a new or rebuilt engine be changed at the first eight or ten hours of operation and for heavy, dusty work every fifty hours thereafter. Watch the condition of the oil closely and should it become contaminated, change it immediately.

B-40. Chassis Lubrication

The period of lubrication depends entirely upon the type of work being done. Using the specified interval of 1000 miles [1.600 km.] recommended for highway travel as a guide, lubricate at safe intervals required for the type of operation being done. Under the extremely dusty conditions lubricate these points daily. Be sure to force enough lubricant into each fitting to force out the old lubricant which might be contaminated with grit and which would cause rapid wear if allowed to remain. Do not place lubricant on the various ball and socket joints or pivot points of the lift linkage as dirt will accumulate to form an abrasive mixture. It is best to simply wipe these parts clean with a cloth.

B-41. Oil Filter

Dismantle and clean the filter and replace the element at the end of the first 100 hours of service. Element replacement at each 150 hours of additional service should provide satisfactory filtering. However, under extreme conditions this may not be true. The condition of the oil will indicate the condition of the filter element. Should the oil quickly become discolored and show evidence of contamination, change the element without delay.

B-42. Air Cleaner

The care of the air cleaner is extremely important at all times. When operation is under dusty conditions, clean and refill the cleaner reservoir to the full mark daily and under extreme conditions twice daily. When servicing the unit, use a suitable tool

to dislodge dirt clinging to the bottom and sides of the intake passage within the body of the cleaner.

B-43. Front Axle Shaft Universal Joint

The front axle steering knuckle pivot pins (king pins) are supported in housings at each end of the front axle which also enclose the front axle shaft universal joints. Maintain the lubricant level in the housings even with the filler plug openings at all times. For off-highway use remove the universal joints twice yearly, thoroughly clean both the housings and joints with a suitable solvent, and refill the housings to the fill plug opening levels with the correct lubricant as shown in the Lubrication Charts.

B-44. Transmission and Transfer Case

The combined capacity of the two housings is small for economy, making it important that the lubricant be changed at regular intervals. For off-highway use drain both housings every 300 hours of operation and refill to the fill plug opening levels.

B-45. Front and Rear Differentials

Because of the higher pressures developed in the axle assemblies with heavy-duty operation drain, flush, and refill the differential assemblies each 300 hours of operation. Use only flushing oil or light engine oil to clean out the housings (except Powr-Lok differentials).

ENGINE TUNE-UP

Contents

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Fuel Pump	C-9
TROUBLE SHOOTING	C-13
Fuel System	C-14
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C-1. ENGINE TUNE-UP

To secure best performance and dependability, the engine should have a periodic tune-up each 6000 miles [9.600 km.] or at the end of each 500 hours of off-the-road use. To secure the best results, it is recommended that a definite regular procedure be followed as outlined in Fig. 9. It is essential that the carburetor receive attention at the last of this sequence as it is impossible to satisfactorily adjust the carburetor until other units are correctly adjusted.

C-2. Check Battery

This includes cleaning the battery terminals and cable connectors. If corrosion has formed on the terminals, use a strong solution of baking soda and water to remove it. Tighten the terminal screws to assure good connections. Check the negative ground cable connection, particularly making sure of a good ground connection. Check each cell with a hydrometer. A variation of 25 points between the cells indicates that the battery requires attention. As a further check, a capacity test may be taken which is made by placing a 150-ampere load on the battery for 15 seconds. The voltage drop for the battery should not be more than 1½ volts with a 6-volt battery or 3 volts with a 12-volt battery. Be sure the engine ground strap connection, Fig. 10, is tight and clean.

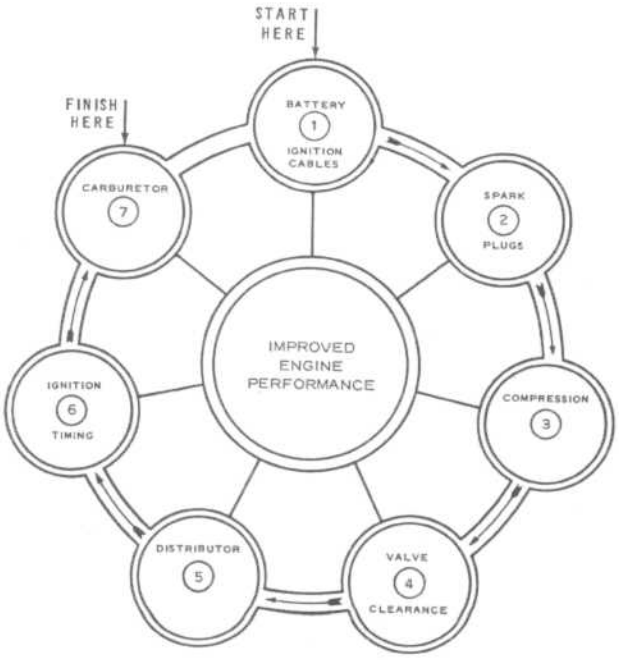


FIG. 9—ENGINE TUNE-UP CYCLE

C-3. Remove and Clean Spark Plugs

Adjust the electrode gaps to .030" [0,762 mm.] by bending the outer electrode mounted in the plug shell. Use a wire gauge to measure the gap.

C-4. Check Engine Compression

See Par. C-24.

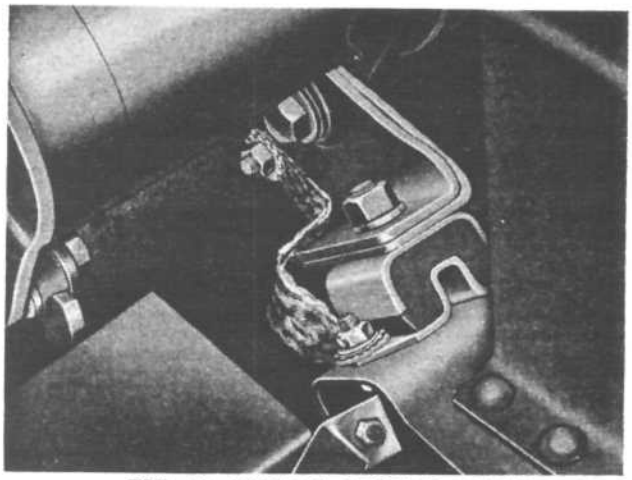


FIG. 10—ENGINE GROUND STRAP

C-5. Check Valve Tappet Clearances

Before making this check, use a torque wrench to tighten the cylinder head bolts to recommended torque. See Par. D-111f and E-6. If the cylinder head is improperly tightened, incorrect valve adjustment will be made. The exhaust valves are equipped with ball bearing rotors built into the lower spring retainers as shown in Fig. 11. Adjustment of all valve tappets are to be made with the engine cold.

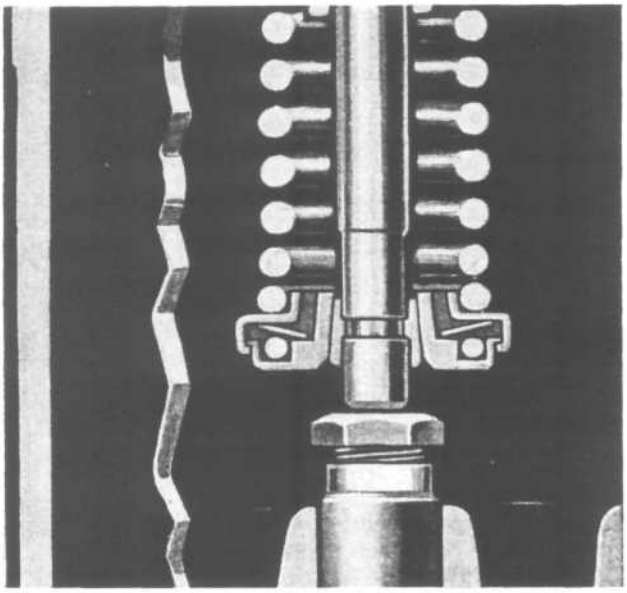


FIG. 11—VALVE WITH BEARING TYPE ROTATOR

a. F4-134 engine. Adjust the intake valves to .018″ [0,457 mm.] clearance and the exhaust valves to .016″ [0,406 mm.] clearance.

b. L6-226 engine. Adjust both the intake and exhaust valves to .014″ [0,356 mm.] clearance. See paragraph D-16 for information on access to the valve chamber. Following is the recommended order for adjusting tappets at room temperature. Tappets are numbered consecutively starting from the front of the engine.

TAPPET ADJUSTMENT SEQUENCE

With Valves No. 1 and 3 fully raised — Adjust Tappets No. 10 and 12
With Valves No. 8 and 9 fully raised — Adjust Tappets No. 4 and 5
With Valves No. 2 and 6 fully raised — Adjust Tappets No. 7 and 11
With Valves No. 10 and 12 fully raised — Adjust Tappets No. 1 and 3
With Valves No. 4 and 5 fully raised — Adjust Tappets No. 8 and 9
With Valves No. 7 and 11 fully raised — Adjust Tappets No. 2 and 6

C-6. Check Distributor

Remove the cap to clean it thoroughly and inspect it for cracks and carbon. Check the shaft for excessive side play. If more than .005″ [0,127 mm.] it will be necessary to install new bushings. Check the distributor point spring tension which must be between 17 and 20 ounces [482 a 567 gr.]. Be sure that the distributor points are clean and make full, square contact. If not correctly aligned, bend the stationary contact bracket slightly to provide alignment. Adjust the points to provide .020″ [0,508 mm.] gap. This is accomplished by loosening lock screw Fig. 12 No. 7 and turning adjusting eccentric screw No. 8 until correct clearance is secured. Be sure that the fiber block on the breaker arm is resting against the highest point on the cam when the adjustment is made and recheck the gap after locking the adjustment. Apply a thin film of cam lubricant to the cam to minimize fiber block wear. Check the condenser ground and lead connections.

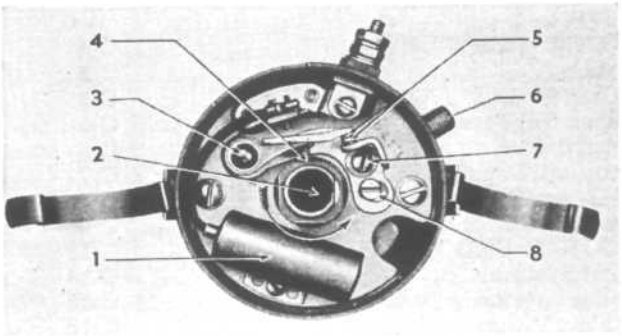


FIG. 12—DISTRIBUTOR

1—Condenser
2—Lubricating Wick
3—Breaker Arm Pivot
4—Breaker Cam
5—Distributor Points
6—Oiler
7—Adjustment Lock Screw
8—Adjustment Screw

C-7. Check Ignition Timing

This may best be accomplished with a neon timing light. In the absence of a timing light, remove No. 1 spark plug and turn the engine over until No. 1 piston is on compression stroke as determined by air being forced out through the spark plug opening. Turn the engine slowly until the 5° mark on the timing gear cover is in alignment with the notch on the crankshaft pulley as shown in Fig. 13 for the F4-134 engine, or the 5° mark on the vibration damper is in alignment with the timing pointer as shown in Fig. 14 for the L6-226 engine. When the piston is so positioned, the timing is correctly set if the distributor rotor arm points to No. 1 terminal in the distributor cap and the distributor points are just ready to break. Timing may be altered by loosening the distributor mounting clamp and turning the distributor assembly. Turn it clockwise to advance the timing and counterclockwise to retard it. Do not overtighten the mounting clamp screw.

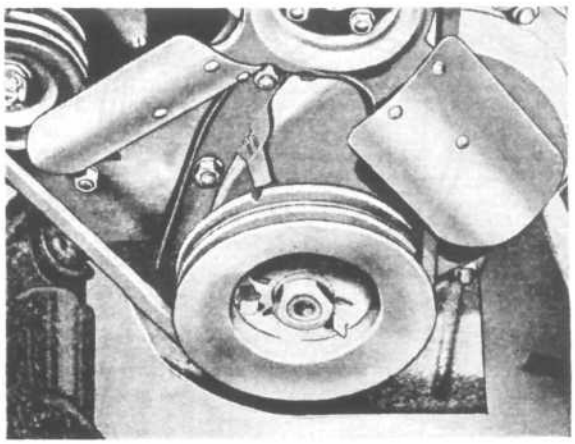


FIG. 13—F4-134 ENGINE TIMING MARKS

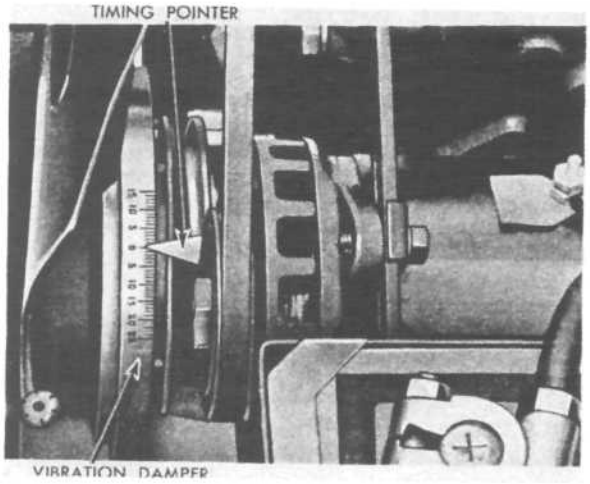


FIG. 14—L6-226 ENGINE TIMING MARKS

C-8. Check Fuel System Including Air Cleaner

Clean the fuel filtering screen and the fuel pump bowl. Check all fuel line connections to guard against leakage. To service the oil bath air cleaner, remove the oil cup, clean it thoroughly, and refill to the indicated oil level. Tighten all connections and check for leaks in the air tube.

C-9. Check Fuel and Vacuum Pump

Fuel pump pressure is important for low pressure will seriously affect engine operation and too high pressure will cause high fuel consumption and possibly carburetor flooding. Should there be any doubt of normal operation, check the pressure with a gauge as shown in Fig. 15. The minimum and maximum allowable pressures are for the F4-134 engine 2½ to 3¾ lbs. [0,176 a 0,264 kg./cm²] and for the L6-226 engine 3½ to 5½ lbs. [0,246 a 0,386 kg./cm²].

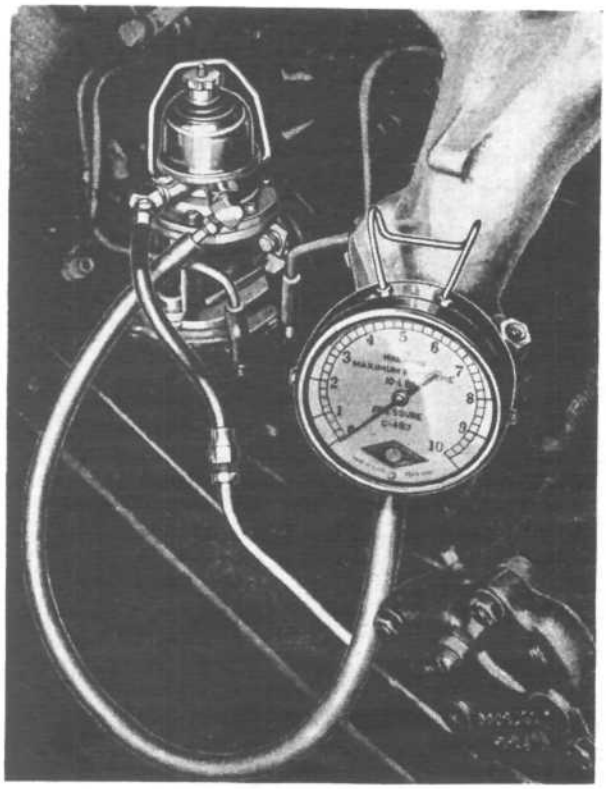


FIG. 15—FUEL PUMP PRESSURE

C-10. Check Carburetor
C-11. Set Engine Idle Speed

Start the engine and allow it to run until operating temperature is reached. Set the engine idle speed with adjusting screw Fig. 16, No. 1 to provide the standard idle of 600 rpm. for the F4-134 engine and 550 rpm. for the L6-226 engine. Adjust low speed adjusting screw No. 2 to provide smooth idle.

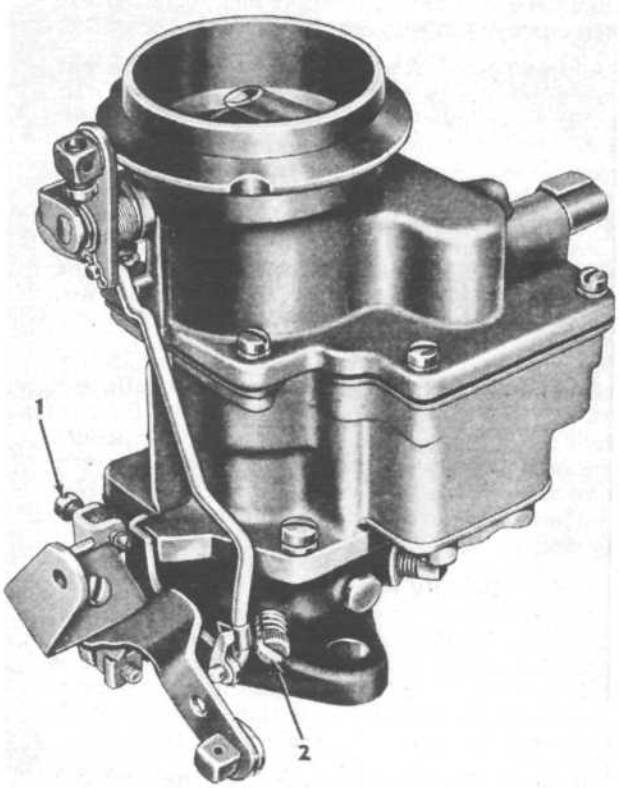


FIG. 16—CARBURETOR ADJUSTMENTS

C-12. Test Vehicle

Test the vehicle thoroughly under normal and extreme driving conditions. Adjust the spark timing to the point where faint "ping" can be heard under full-throttle, low-speed conditions. If the tune-up sequence has been carefully followed, and the carburetor overhauled, but performance is still not satisfactory, the reason must be isolated by following the trouble-shooting procedures which follow.

C-13. TROUBLE SHOOTING
C-14. FUEL SYSTEM
C-15. Carburetor

Investigate for flooding or vapor lock before checking fuel system components. Flooding, or enriching the fuel-air mixture, can be caused by a dirty air cleaner and this unit should be checked first in such

cases and serviced if necessary. This condition can also be caused by the choke being connected so that it will not open fully. The lever should be connected to the choke rod in the fully open position with the choke control pushed all the way in. Incorrect float level, poorly seating float valve, and other carburetor conditions may be responsible, and the carburetor should then be checked (see Fuel Section).

C-16. Fuel Pump

a. Pressure Test — Test for pressure as described in paragraph C-9 above. If the pressure is low the fuel line may be clogged or restricted. Disconnect the tank line at the flexible tube, put the end of the flexible tube in a can of gasoline and retest. If the pressure is still too low, repair or replace the pump.

b. Volume Test — A pump may build up sufficient pressure but fail to produce sufficient volume. To test this, turn down the carburetor line fitting and, with the tank line connected, pump out a couple of strokes to be sure the pump is primed. Using a half pint milk bottle or similar measure, pump a half pint [¼ ltr.] of fuel by cranking the engine with the starter. Count the strokes necessary to fill the measure. If it requires more than 20 strokes, the fuel pump is inefficient, the tank line is leaking air, or the fuel supply is restricted.

c. Vacuum Test — If volume is insufficient it may be caused by a fault in the pump or by insufficient supply to the pump. To test the pump further, disconnect the tank line and connect a vacuum gauge in its place. Crank the engine and observe the vacuum reading. If this is less than 8″ [20,3 cm.] of mercury [Hg] the pump is at fault. If 10″ [25,4 cm.] or more, check out the fuel line.

C-17. Fuel Supply from Tank

a. Faulty Tank Vent — Occasionally a stuck fuel tank filler cap vacuum relief valve is mistaken for a fuel line obstruction. If the pump vacuum is satisfactory but the volume insufficient, remove the tank filler cap and repeat the volume test. If the volume is satisfactory, replace the cap.

b. Air Leak (Tank to Pump) — If the fuel line is leaking air, this may be determined by disconnecting it at the tank and connecting a vacuum gauge at that end. Connect the tank line at the pump, making sure the joint is tight and crank the engine as in Par. C-16c. If the vacuum gauge reads lower than it did when the pump was tested, the line probably has an air leak. If the vacuum is the same the trouble is due to a restriction in the line.

c. Restrictions — Disconnect the line at the pump and blow air under high pressure through it. This will frequently dislodge dirt, etc., in the line. If air goes through freely, and there is no evidence of the line being dented or flattened anywhere along its length, the line may be considered clear and the restriction is probably in the tank. Apply air pressure to the fuel line fitting on the tank, with the filler cap removed. This will usually dislodge any obstruction from the fuel pickup line inside the tank. If necessary, a soft wire may be pushed into this fitting to clear the pickup.

C-18. IGNITION SYSTEM

C-19. Spark Plugs

Clean and gap spark plugs as described in Par. C-3. Inspect them for excessive burning and erosion of electrodes, blistering of porcelain at the firing tip, black deposits, or fouling. These conditions indicate that the plugs have not been operating at the correct temperature (see descriptions below). NOTE: Abnormal operating conditions, such as prolonged idling, just before checking the plugs may produce false indications.

a. Too Hot — After fairly short service at an excessive operating temperature the tip of the insulator will show dark spots and blisters. As high-temperature operation is continued, the whole insulator nose will discolor, showing fused and blistered deposits near the electrode, as well as considerable erosion and burning of the electrodes. After extreme service, the porcelain itself may be fused, cracked, and blistered at the tip. The electrodes will show extreme erosion and burning and possibly even surface cracking. NOTE: If such cracking appears on certain plugs after fairly short service it may be caused by water leaks in the associated cylinders.

b. Too Cold — In the early stages, cold plug operation will result in a dull black "sooting" of the plug. This condition frequently is found in new cars during the break-in period and is no indication of trouble in this case. As the condition progresses, black deposits of oil and carbon build up on the base of the shell and on the insulator until, in extreme cases, the space between insulator and shell may be almost completely filled. Excessive electrode erosion will seldom be found in cases of cold plug operation. These indications can be produced by the use of an excessively rich air-fuel mixture and the carburetor should be checked if this condition is suspected. Fouling will also be caused by leaking rings or intake valve guides that permit excessive oil to reach the combustion chambers. The use of a hotter plug will help burn away some of this fouling but the mechanical condition of the engine should be corrected.

c. Normal — In normal temperature operation the plug will accumulate grayish-tan to reddish-brown deposits with fairly uniform discoloration of the insulator nose and slight, localized electrode erosion. If the insulator shows any blotches, blisters, irregular discoloration, etc., look for hot-plug symptoms. Too hot or too cold plug operation may be caused by the use of plugs of other than the specified heat rating but, if the plugs are as specified, a hotter or colder plug may be desirable. However, under or over-heating is usually caused by factors outside of the spark plugs themselves and the cause should be determined before changing plugs. The design of the engine calls for plugs equivalent to the Champion J-8 (as installed in production) though any factor that consistently affects engine operating temperature may cause this requirement to change. Overheating may be caused by insufficient tightening of the plug in the head, which interferes with the flow of heat away

from the firing tip. If this is the case, the plug gasket will show very little flattening. Over-tightening, conversely, will produce too easy a heat flow path and result in cold plug operation. This will be evidenced by an excessively flattened and deformed gasket. Prevailing temperatures, condition of cooling system, and air-fuel mixture can affect the engine operating temperature and should be taken into consideration.

C-20. Distributor

Remove the distributor cap and inspect for cracks, carbon runners, corrosion, or excessive burning of the spark plug contacts inside the cap. Inspect the rotor for the same conditions. If these are found, replace the cap and/or rotor. If not, proceed with the trouble shooting procedure. If flaws in cap and rotor are invisible they will show up in testing the secondary circuit (Par. C-23). Check the points for burning and build-up of metal. If build-up does not exceed 1/64" [0,4 mm.] file or grind the points clean, bend into perfect closing alignment if necessary, and gap to 0.020" [0,508 mm.]. Any further trouble in the distributor will show up in trouble shooting the primary circuit.

C-21. Primary Circuit

For a quick check of the primary circuit, measure the voltage at the coil primary terminals under cranking conditions. If the voltage is less than 4½ volts with 6-volt battery or 9 volts with 12-volt battery make the following tests:

NOTE: With the ignition switch on and the points open, voltage across the points should be near maximum. If there is no voltage at all there is a break in the circuit, possibly in the coil primary winding.

a. Check the level and specific gravity of the battery electrolyte. Fill and charge the battery as necessary. If the battery is not satisfactory, install a new, fully charged battery for completion of the primary circuit tests.

b. Check the starter for excessive voltage drop and check the starter itself for excessive draw as described in the Electrical Section.

c. If the battery and the starter circuit are satisfactory but the coil primary voltage while cranking is less than 4½ volts with 6-volt battery or 9 volts with 12-volt battery the trouble will be found in the ignition primary circuit. To check the circuit, turn the ignition on, turn the engine until the points are closed, and measure the voltage drop across each portion of the circuit with a voltmeter in the positions indicated.

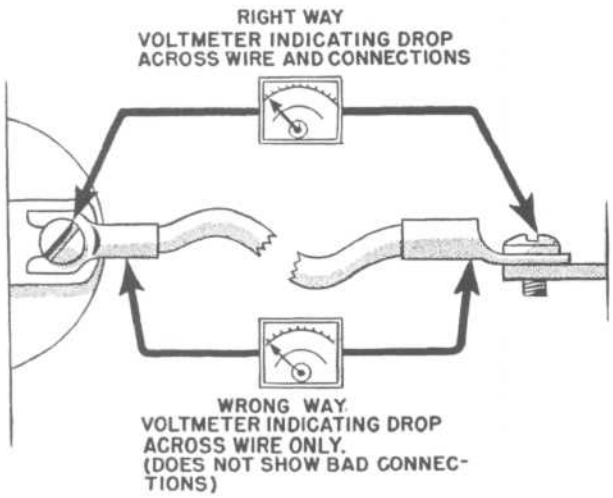


FIG. 17—VOLTAGE DROP TEST

C-22. Voltage Drops

NOTE: Most voltage drops will be found at the connections of wires to terminals as dirt, oxidation, etc., will frequently cause excessive resistance at these points. Measure voltage drops in wires as shown in Fig. 17 to take this into account.

a. Connect the voltmeter from the battery cable terminal on the starter solenoid to the battery terminal of the coil primary. If voltmeter reads more than 0.2 volt:

1.) Connect voltmeter from the solenoid terminal (above) to the battery terminal of the ignition switch. If the voltmeter reads more than 0.05 volt, check and clean the connections at solenoid, light switch, and ignition switch. If not:
2.) Connect voltmeter from battery terminal to ignition terminal on ignition switch. If the voltage drop is more than 0.1 volt, repair or replace the switch. If not:
3.) Connect voltmeter from the ignition terminal of the ignition switch to the battery terminal of the coil primary. If the voltmeter reads more than 0.05 volts, clean and tighten the connections and check again. If not satisfactory, replace the wire.

b. Connect the voltmeter from the distributor primary terminal on the coil to the coil terminal on the distributor. Voltage drop should not exceed 0.05 volt. Clean and tighten connections if necessary.

c. Connect the voltmeter from the coil terminal on the distributor to a clean bare spot, free from paint, on the distributor body. The reading should be less than 0.05 volts. If more, it indicates excessive resistance through the points or in the distributor internal connections. Clean and align the points and make sure the breaker arm connection to the primary terminal, as well as the stationary contact point mounting in the body, are clean and tight. Open the points and check the voltmeter. It should read close to peak voltage. Low voltage indicates that a circuit through the distributor exists, while the points are open, i.e. a short. Disconnect the condenser lead and open the points; a jump to full voltage indicates a short in the condenser. If not, overhaul the distributor (see Electrical Section).

d. With the points closed, connect the voltmeter from a clean, paint-free spot on the distributor body to the negative post of the battery. The voltage drop should be practically zero, a hardly readable deflection on the meter. If not:

1.) Check for voltage drop in the battery ground cable. Clean the battery post, cable terminals, and contact surface on bell housing, or on body if a noticeable deflection of the meter occurs.
2.) Check for voltage drop between the distributor body and a clean, paint-free spot on the engine block. Remove the distributor and clean the mounting surfaces of body and block if any voltage drop is indicated.

C-23. Secondary Circuit

If satisfactory ignition is not obtained with correct point gap and tension, satisfactory condenser, sufficient primary voltage, and correctly cleaned, gapped, and installed spark plugs, the secondary circuit should be investigated.

a. Coil Testing — Bring the coil up to operating temperature using the coil heat feature of the coil tester if available. Refer to the coil tester manufacturer's instructions for specific hook-ups for making the following tests:

1.) Connect the positive lead of the tester to the battery terminal of the coil primary winding, connect the tester ground lead to the coil tower, and measure the resistance of the secondary winding. This should not be more than 20,000 ohms. If it is, a fault in the secondary winding is indicated.
2.) Check for a grounded secondary by touching the tester ground lead to the coil cover. Resistance should be over 100,000 ohms. If not, the secondary is grounded to the cover.
3.) If the secondary winding is satisfactory measure the primary current draw in accordance with the specifications of the test equipment manufacturer.

b. Secondary Circuit Insulation — With the coil primary in the circuit with the breaker unit of the tester as outlined for the primary current draw test (above), connect a long high-tension test lead to the coil tower. Check the secondary circuit for leakage as follows:

NOTE: In the following tests a slight sparking and meter deflection will usually be seen just as contact is made. This is caused by capacitance and does not indicate defective insulation.

1.) Distributor Cap — Remove the coil lead from the cap and touch the test lead to the center contact inside the cap. If the meter reading drops when the contact is touched, or if sparking is seen, a leakage path is present between the center contact and one of the plug towers. This leakage path will be in the form of a crack or carbon track in the cap. Disconnect the spark plug wires from cap one at a time and test each plug contact with the high voltage lead, with all other plug wires connected. Any sparking or meter drop indicates that a leakage path exists between that particular contact and an adjacent one. Testing the adjacent contacts will determine which pair is at fault.
2.) Distributor Rotor — Touch the test lead to the spring contact in the center of the distributor rotor. Any leakage in the rotor insulation, between the contact and the shaft, will cause a drop in the meter reading and usually sparking will be seen.
3.) Spark Plug Wires — Disconnect the spark plug wires from the plugs and test the plug terminal of each. The meter reading should not drop below the open secondary value (value before making contact). If it does, or if a large spark occurs when the test lead and the plug wire are separated, there is a break in the insulation on that wire.
4.) Coil Tower Insulation — Remove the high tension test lead from the coil tower and touch the ground lead of the coil tester to several points around the base of the tower. Any sparking or deflection of the meter indicates a leakage path in the tower insulation.

C-24. USE OF VACUUM AND COMPRESSION GAUGES

Mechanical conditions such as wear, maladjustment, etc., which detract from engine performance can frequently be isolated through interpretation of vacuum and compression gauge readings. Since these conditions seldom occur separately, but usually in groups, as the result of general wear, the tests are not foolproof. However, through the process of elimination plus application of common sense, a reasonably accurate analysis can be made if these readings are observed carefully and checked against the interpretations below.

C-25. Vacuum Gauge

Disconnect the vacuum line fitting from the head, just below the carburetor, and install the proper adapter. Connect the vacuum gauge to the adapter and start the engine. Connect a tachometer from the distributor primary terminal to ground and set the engine speed at 600 rpm. Observe the vacuum reading.

a. Steady from 18″ to 21″ [46 a 53 cm.] of mercury [Hg] — This is a normal reading indicating that valve and spark timing, valve seating and piston ring sealing are all in good shape.

b. Steady but Below Normal — This indicates a condition common to all cylinders, such as a leak at the carburetor gasket, late ignition or valve timing, or uniform piston ring and bore wear.

c. Slow Fluctuation or Drifting — This indicates that the idle mixture is incorrect and the cause should be looked for in the fuel system.

d. Steady Regular Pulsation — This is caused by a condition affecting one or more cylinders, but not all, and indicates a leaky valve, gasket blow-by, restricted intake port, or an electrical miss.

e. Intermittent Pulsation — This is caused by an occasional malfunction such as a sticking valve (all valves may be erratic in operation if the valve springs are weak), an electrical miss (caused by insufficient distributor point tension or low coil voltage coupled with inconsistent spark plug gaps or fouled plugs) or dirt in the fuel system finding its way into passages of critical size or valve seats in the carburetor.

f. Normal at Start But Quickly Falls Off (With Engine Running at 2000 rpm.). This indicates exhaust back pressure caused by a restriction in the exhaust system.

C-26. Compression Gauge

Before a compression test, loosen the spark plugs one or two turns to break loose any carbon deposits on the bases of the plugs. Start the engine and accelerate to 1000 rpm. to blow out this carbon. If this is not done the carbon is apt to be caught on the valve seat surfaces and cause incorrect com-

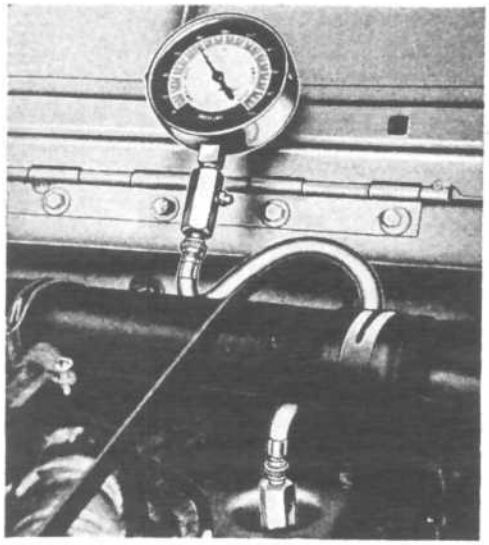


FIG. 18—COMPRESSION AND VACUUM GAUGE

pression readings. Remove all the plugs and take compression readings at each cylinder while cranking the engine with the starter. Allow only four compression strokes at each cylinder and record the first and last readings. Interpret the recorded pressures as follows:

a. Pressure quickly comes up to specified pressure and is uniform between cylinders within 10 psi. [0,7 kg./cm²]. This indicates that the engine is normal with satisfactory seating of rings and valves, correct valve timing, and gaskets are sealing correctly. Specified pressure for the L6-226 engine is 125 to 140 psi. [8,8 a 9,8 kg-cm²] and for the F4-134 engine 120 to 130 psi. [8,4 a 9,1 kg-cm²].

b. Pressure low on first stroke, builds up to less than normal — This indicates compression leakage due to rings or valves. To determine which is responsible, pour about ½ oz. [14 gm.] of engine oil into each cylinder, allow a few minutes for the oil to leak down to and past the rings, and test compression again: If compression pressures improve over the first test the loss of compression is due to wear of piston rings and bores. If compression pressures do not improve, the trouble is due to poor valve seating. NOTE: If this condition is noticed on two adjacent cylinders, but is not general, it probably is caused by a gasket leak between those cylinders. Inspect the plugs from these cylinders for fouling or surface cracking of electrodes. If these conditions are present, gasket leakage is probable (see Spark Plugs, Par. C-19).

c. Pressures higher than normal — This indicates that carbon deposits in the combustion chamber have reduced the size of the chamber enough to give the effect of a raised compression ratio. This will usually cause pinging under load that cannot be satisfactorily corrected by timing. The carbon must be cleaned out of the engine (See Par. C-34) to correct this trouble.

C-27. MECHANICAL FACTORS AFFECTING DISTRIBUTOR TIMING

Difficulty in obtaining correct timing or irregularity of spark advance characteristics can be caused by the mechan cal factors affecting the distributor described in paragraphs C-28 thru C-31.

C-28. Incorrect Installation of Oil Pump

The relationship of the oil pump driven gear to the driven gear on the camshaft is critical because it determines the relationship between distributor rotor position and piston position. If the gears are meshed one tooth away from the correct position the distributor will be advanced or retarded 36°. With No. 1 piston at top dead center the distributor rotor should point downward and forward at about five o'clock. If it does not, remove and correctly install the oil pump as instructed in Sections D and E.

C-29. Excess Gear Lash

If the gear lash in the oil pump and distributor drive is excessive, the distributor timing and advance will be erratic. Due to the right-angle helical gear drive this lash consists of the combined effects of rotational lash and end play in both gears. Check timing gear lash and crankshaft and camshaft end play as described under the proper Engine Section.

C-30. Distributor Internal Faults

Erratic timing and advance may be caused by such distributor internal troubles as excess bearing clearance, worn cam, excess play or improper spring tension in the advance mechanism, etc. See Electrical Section for distributor test and rebuild procedures.

C-31. Timing Pointer Setting Incorrect

Model L6-226 Engines

If satisfactory engine performance is not realized after carefully tuning the engine, the position of the timing pointer in relation to vibration damper calibration should be checked and corrected if necessary. This may be done with the cylinder head either removed (Par. C-32) or installed (Par. C-33).

C-32. With Cylinder Head Removed

Mount and adjust a dial indicator so the top end of travel of No. 1 piston registers 0° on the indicator. Turn the crankshaft slowly clockwise until the needle on the indicator just starts to move from 0°; then mark the vibration damper at the resulting pointer indication. Turn the crankshaft counterclockwise until the indicator again starts to move after reaching the 0° indicator reading; mark the vibration damper at this second resulting pointer indication. Move the crankshaft until the pointer is exactly halfway between the two marks just scribed. The pointer should now point directly to the zero mark on the vibration damper. If not, without allowing the crankshaft to move, bend the pointer until it does point to zero.

C-33. With Cylinder Head Installed

Remove the spark plugs and crank the engine until No. 1 piston is near top dead center (compression stroke). Then fill No. 1 cylinder with enough oil to bring the level to the bottom of the spark

plug hole. Turn the crankshaft slowly until the oil just starts to recede from its highest level; mark the vibration damper at the resulting pointer indication. Turn the crankshaft counterclockwise until the oil again starts to recede after reaching the maximum level; mark the vibration damper at this second pointer indication. Move the crankshaft until the pointer is exactly halfway between the two marks just scribed. The pointer should now point directly to the zero mark on the vibration damper. If not, without allowing the crankshaft to move, bend the pointer until it does point to zero. Draw as much oil from the cylinder as possible with a suitable suction gun, then turn the engine a few revolutions with the starter to further clear the cylinder of oil. Oil removal must be thorough before the spark plugs are replaced, or engine damage may result when the first attempt is made to start the engine. Replace spark plugs.

C-34. Reconditioning Valves

When compression and vacuum readings indicate that the valves are not seating properly they should be reconditioned as instructed in the proper Engine Section. Valve guides and springs should also be checked and replaced if necessary when this is done.

C-35. Valve Timing

Valve timing may be off due to improper installation of, or excessive wear in the timing gears, excess crankshaft or camshaft end play, and incorrect valve tappet clearance adjustment.

a. Improper timing gear installation — The meshing of the timing gears (or sprockets and chain) is critical because it determines the timing of the valves in relation to the positions of the pistons. Occasionally an engine will be found which has been disassembled and improperly reassembled, and the timing gears will not be properly meshed. A displacement of one tooth from the correct position will advance or retard the valve timing 7½°. If compression and vacuum readings are consistently low and no other causes can be found, check the timing gears. Correct timing gear installation is covered in the proper Engine Section.

b. Excessive wear in camshaft drive — Excess wear in the timing gears creates backlash which tends to retard the valve timing. Excessive end play in the crankshaft or camshaft will add to this backlash because the timing gears are helical rather than spur gears. To check the gears for wear, or for correcting crankshaft and camshaft end play, see the proper Engine Section.

c. Improper tappet clearance adjustments — Since the tappet clearance must be taken up by rotation of the cam before the valve can begin opening, improper clearance will affect the valve timing seriously. Too little clearance will advance the valve opening and delay closing and, in the extreme case, prevent the valve from seating properly. Too much clearance, on the other hand, will delay opening and advance closing, reducing both the time the valve is open and the size of the opening. Correct tappet adjustment procedure is discussed in the proper Engine Section.

C-36. Pistons, Rings, Bores, Etc.

If the vacuum and compression readings, and the age of the engine, indicate that the seal between pistons and cylinder bores is no longer effective within satisfactory limits the engine should be overhauled. See the proper Engine Section for instructions on piston and bore reconditioning.

C-37. Pre-ignition

Pre-ignition is caused by deposits in combustion chambers and on spark plug insulators. These deposits result from stop-and-go driving with low engine speeds or from excessive idling.

Spark plug fouling is the formation of these deposits on spark plug insulators. Failure of the spark plugs becomes evident as poor acceleration, engine roughness, and reduced vehicle top speed. Clean fouled spark plugs.

Carbon ping, carbon rattle, and deposit-induced pre-ignition are produced by carbon deposits in the combustion chambers. Carbon ping is usually audible during acceleration and can be reduced or eliminated by retarding ignition timing or removal of carbon. Carbon deposit rattle is audible upon deceleration and can be mistaken for a bearing knock or tappet maladjustment. It can be eliminated by removal of carbon.

Deposit induced pre-ignition occurs when the carbon deposits in the combustion chambers continue to glow after the power and exhaust cycles have been completed and is sometimes audible as carbon ping. Although the audible effects can sometimes be eliminated by use of fuels with greater antiknock qualities, the inaudible effects, such as engine roughness, may still remain. Unless deposit induced pre-ignition is eliminated by removal of carbon, serious damage, such as burned pistons, can result.

The possibility of pre-ignition problems occurring can be eliminated or reduced by use of the following suggestions:

a. Check carburetor and set float and metering rod to specifications.

b. Adjust idle mixture to smoothest engine operation; then set engine idle to specified rpm.

c. Torque spark plugs to specifications.

d. Use hotter plugs if vehicle is used for slow driving.

e. Use heavy-duty or detergent oil.

f. Subject the vehicle to moderate-to-high-speed highway driving.

SERVICE DIAGNOSIS

Poor Fuel Economy

Ignition Timing Slow or Spark Advance Stuck
Carburetor Float High
Accelerator Pump Not Properly Adjusted
High Fuel Pump Pressure
Fuel Leakage
Leaky Fuel Pump Diaphragm
Loose Engine Mounting Causing High Fuel Level in Carburetor
Low Compression
Valves Sticking
Spark Plugs Bad
Spark Plug Cables Bad
Weak Coil or Condenser
Improper Valve Tappet Clearance
Carburetor Air Cleaner Dirty
High Oil Level in Air Cleaner
Dragging Brakes
Front Wheels Out of Alignment
Tires Improperly Inflated
Inaccurate Odometer
Faulty Fuel Tank Cap
Clogged Muffler or Bent Exhaust Pipe

Lack of Power

Low Compression
Ignition System (Timing Late)
Improper Functioning Carburetor or Fuel Pump
Fuel Lines Clogged
Air Cleaner Restricted
Engine Temperature High
Improper Tappet Clearance
Sticking Valves
Valve Timing Late
Leaky Gaskets
Muffler Clogged
Bent Exhaust Pipe

Low Compression

Leaky Valves
Poor Piston Ring Seal
Sticking Valves
Valve Spring Weak or Broken
Cylinder Scored or Worn
Tappet Clearance Incorrect
Piston Clearance too Large
Leaky Cylinder Head Gasket

Burned Valves and Seats

Sticking Valves or too Loose in Guides
Improper Timing
Excessive Carbon Around Valve Head and Seat
Overheating
Valve Spring Weak or Broken
Valve Tappet Sticking
Valve Tappet Clearance Incorrect
Clogged Exhaust System

Valves Sticking

Warped Valve
Improper Tappet Clearance
Carbonized or Scored Valve Stems
Insufficient Clearance Valve Stem to Guide

Valves Sticking—Continued

Weak or Broken Valve Spring
Valve Spring Cocked
Contaminated Oil

Overheating

Inoperative Cooling System
Thermostat Inoperative
Improper Ignition Timing
Improper Valve Timing
Excessive Carbon Accumulation
Fan Belt too Loose
Clogged Muffler or Bent Exhaust Pipe
Oil System Failure
Scored or Leaky Piston Rings

Popping-Spitting-Detonation

Improper Ignition
Improper Carburetion
Excessive Carbon Deposit in Combustion Chambers
Poor Valve Seating
Sticking Valves
Broken Valve Spring
Tappets Adjusted too Close
Spark Plug Electrodes Burned
Water or Dirt in Fuel
Clogged Lines
Improper Valve Timing

Excessive Oil Consumption

Piston Rings Stuck in Grooves, Worn or Broken
Piston Rings Improperly Fitted or Weak
Piston Ring Oil Return Holes Clogged
Excessive Clearance, Main and Connecting Rod Bearings
Oil Leaks at Gaskets or Oil Seals
Excessive Clearance, Valve Stem to Valve Guide (Intake)
Cylinder Bores Scored, Out-of-Round or Tapered
Too Much Clearance, Piston to Cylinder Bore
Misaligned Connecting Rods
High Road Speeds or Temperature
Crankcase Ventilator Not Operating

Bearing Failure

Crankshaft Bearing Journal Out-of-Round
Crankshaft Bearing Journal Rough
Lack of Oil
Oil Leakage
Dirty Oil
Low Oil Pressure or Oil Pump Failure
Drilled Passages in Crankcase or Crankshaft Clogged
Oil Screen Dirty
Connecting Rod Bent

L6-226 ENGINE

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D-1. GENERAL

The Willys engine Model L6-226, shown in Fig. 19, is used in Models L6-226 4WD, L6-226 4x4, and L6-226 4x2. It is a six-cylinder L-head engine of 226.2 cubic inch displacement and develops 105 brake horsepower at 3600 rpm.

As a result of normal mass-production methods and in common with other engine manufacturers some engines are manufactured with oversized cylinder bores and/or undersize crankshaft journals. For L6-226 engines, such deviations are indicated by a code letter suffix to the engine serial number as follows:

A — .010″ [0,254 mm.] undersize main and connecting rod bearings.

N — .020″ [0,508 mm.] oversize pistons.

AN — Combination of A and N.

This engine is equipped with a fully counterbalanced crankshaft supported by four main bearings. Crankshaft end play is controlled by thrust flanges provided on the rear main bearing.

The cylinder block and crankcase are cast integrally, forming a rigidly reinforced unit. Special reinforcing at the tappet chamber, the oil pan mounting surface and at other important areas increases the strength of the block. The main bearing caps are large in size to assure rigid support of the main bearings and crankshaft. Cup-type core hole plugs in the cylinder block decrease the possibility of coolant leakage at these points.

The engine is pressure lubricated. An oil pump, driven from the camshaft, forces the lubricant through the drilled passages in the crankshaft to efficiently lubricate the main and connecting rod bearings. Lubricant is also force fed to the camshaft bearings, tappets, timing gear chain and gears. Cylinder walls and piston pins are lubricated from spurt holes in the connecting rods.

The engine is provided with full length water jackets. The areas around the valves, cylinders and throughout the cylinder head are provided with passages, through which the coolant is circulated by a belt-driven pump. Circulation of the coolant is controlled by a thermostat in the cylinder head water outlet elbow on the cylinder head.

ENGINE REPAIR

D-2. Engine Supports

The engine is supported at its front end by two rubber insulators attached to the frame side rail brackets. It is supported at the rear at the transmission by two rubber insulators attached to the rear engine support cross member. This cross member is bolted to the frame side rails so that it can be dropped when removing the transmission.

The rubber insulators should be checked for separation and wear by jacking the power plant away from the frame, near the supports, while watching the action of the insulators. Vibration cannot be effectively controlled by separated or worn insulators and they should be replaced if faulty.

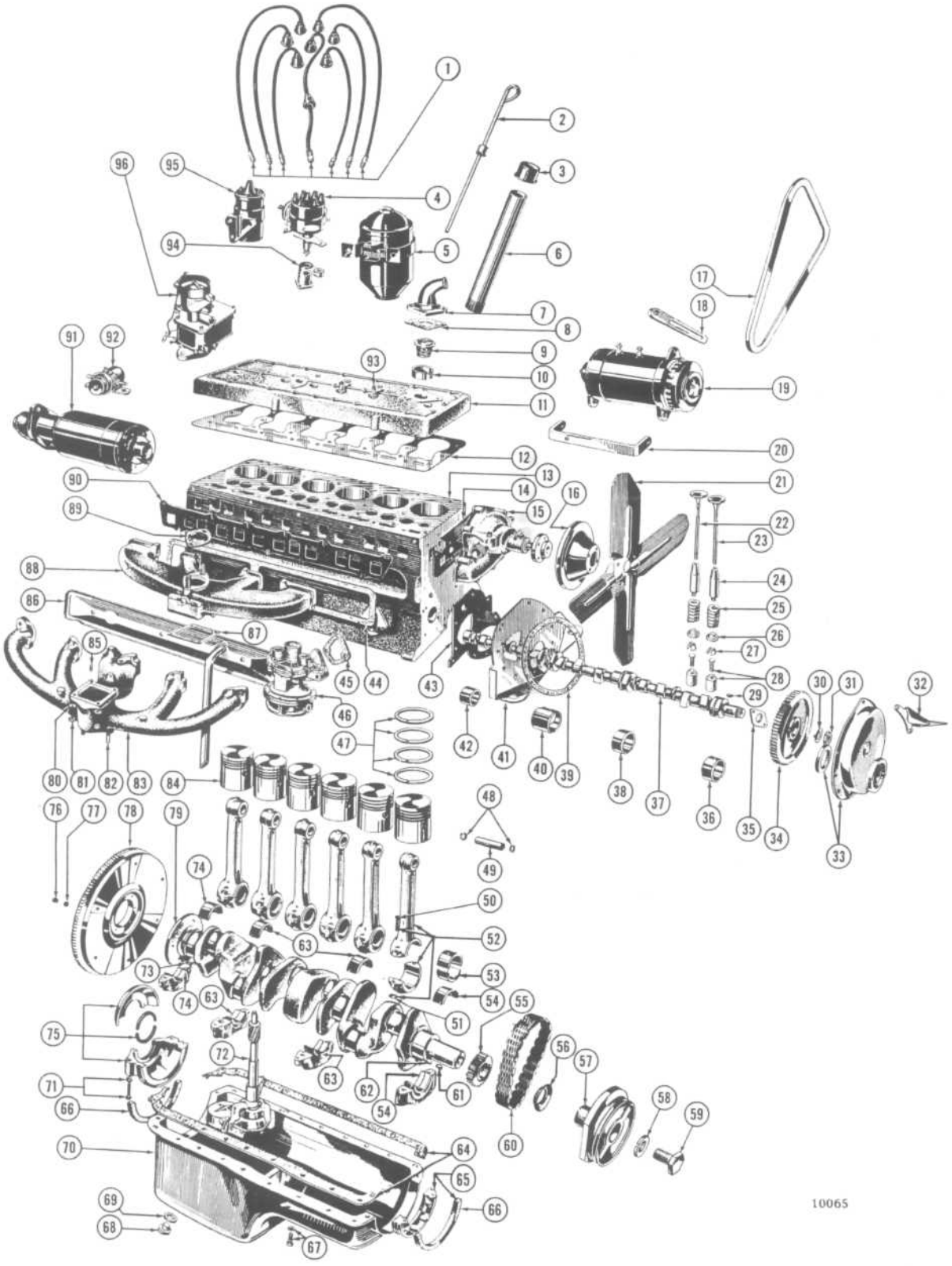


FIG. 19—L6-226 ENGINE

LEGEND FOR FIG. 19

1—Spark Plug Cables
2—Oil Level Indicator
3—Oil Filler Cap
4—Distributor
5—Oil Filter
6—Oil Filler Tube
7—Water Outlet Elbow
8—Gasket
9—Thermostat
10—Adapter Ring
11—Cylinder Head
12—Gasket
13—Cylinder Block
14—Gasket
15—Water Pump
16—Water Pump Pulley
17—Generator Belt
18—Adjusting Strap
19—Generator
20—Support Bracket
21—Fan
22—Exhaust Valve
23—Intake Valve
24—Valve Guide
25—Valve Spring
26—Valve Spring Retainer
27—Retainer Lock
28—Tappet Assembly
29—Key
30—Lock Plate
31—Nut
32—Timing Pointer
33—Timing Chain Cover Assembly
34—Sprocket
35—Thrust Plate
36—Front Bushing
37—Camshaft
38—Front Intermediate Bushing
39—Gasket
40—Rear Intermediate Bushing
41—Front Engine Plate
42—Rear Bushing
43—Gasket
44—Gasket
45—Gasket
46—Fuel Pump
47—Piston Rings
48—Retaining Ring
49—Piston Pin
50—Bolt
51—Nut
52—Connecting Rod Assembly
53—Connecting Rod Bearing
54—No. 1 Crankshaft Bearing
55—Crankshaft Sprocket
56—Oil Slinger
57—Vibration Damper
58—Washer
59—Bolt
60—Timing Chain
61—Key
62—Key
63—No. 2 and No. 3 Crankshaft Bearings
64—Gasket
65—Front Filler Block
66—Gasket
67—Bolt and Lockwasher
68—Drain Plug
69—Gasket
70—Oil Pan
71—Screw and Lockwasher
72—Oil Pump
73—Bolt
74—No. 4 Crankshaft Bearing
75—Oil Seal, Filler Block, and Guard
76—Nut
77—Lockwasher
78—Flywheel
79—Crankshaft
80—Washer
81—Nut
82—Stud
83—Exhaust Manifold
84—Piston
85—Stud
86—Valve Chamber Cover
87—Gasket
88—Intake Manifold
89—Insulator Gasket
90—Gasket
91—Starting Motor
92—Solenoid
93—Spark Plug
94—Distributor Adapter
95—Ignition Coil
96—Carburetor

D-3. Engine Ground Strap

To assure an effective ground to the chassis electrical circuits, a ground strap bridges the left front engine support to the chassis. The connections of this strap must be kept clean and tight for proper operation of lights, generator regulator, etc.

D-4. Engine Removal

a. Drain the radiator and block. Drains at bottom of radiator and left side of block.
b. Remove the hood from the hood hinges; also remove the radiator stay bars.
c. Remove both the upper and lower radiator hoses and the heater hoses, if so equipped.
d. Remove the fan.
e. Remove the radiator and shroud attaching screws and remove the radiator and shroud.
f. Disconnect the negative ground cable of the battery.
g. Disconnect wires from:
Temperature Sender
Oil Pressure Sender
Starter
Generator
Coil
Secondary at distributor
h. Remove the air cleaner. Do not spill oil.
i. Disconnect accelerator pedal linkage from bellcrank.
j. Disconnect vacuum line from wiper motor.
k. Disconnect fuel line from fuel pump and plug.
l. Disconnect engine ground strap at front engine support.
m. Disconnect clutch linkage.
n. Disconnect exhaust pipe at manifold.
o. Disconnect front engine supports.
p. Attach a lifting sling to the head bolts and to a chain hoist or floor crane. Take up all slack.
q. Remove bolts from bell housing to rear engine plate.
r. Raise the engine slowly while at the same time pull it forward until the clutch clears the bell housing and dash panel.

D-5. ENGINE DISASSEMBLY

Engine disassembly is presented in the sequence to be followed when the engine is to be completely overhauled on an engine stand after removal from the vehicle. Most of the operations of the procedure are also applicable separately with the engine in the vehicle, provided that wherever necessary the part of the engine to be worked on is first made accessible by removal of engine accessories or other engine parts.

When the disassembly operations are performed with the engine out of the vehicle, it is assumed, in this procedure, that all of the accessories have been removed prior to starting the disassembly and the oil has been drained.

In addition to the instructions covering operations for disassembling the engine out of the vehicle, special instructions are given to cover different operations required when disassembly is done with the engine installed.

Engine disassembly is covered in Par. D-6 through D-30.

D-6. Remove Manifold

Remove the nuts, plain washers, and retainers that attach the intake and exhaust manifold assembly to the cylinder block. Remove the manifolds and gasket from the cylinder block.

D-7. Remove Water Pump

Remove the bolts and lock washers that attach the water pump to the cylinder block. Remove the water pump.

D-8. Remove Water Outlet Elbow

Remove the nuts and lock washers that attach the water outlet elbow to the cylinder head and lift the elbow and thermostat assembly from the cylinder head.

D-9. Remove Cylinder Head

Remove the cylinder head bolts and remove the cylinder head from the cylinder block. Remove and discard the cylinder head gasket. Rotate the engine

in the stand to the upside down position at this time if the operations are being performed out of the vehicle.

D-10. Remove Oil Pan

Remove the bolts and lock washers that attach the oil pan to the cylinder block and remove the oil pan and gaskets. Discard the gaskets.

D-11. Remount the Engine

If the engine disassembly is to be performed using an engine stand, attach the engine stand brackets to the cylinder block oil pan flange to permit removal of the engine end plates or flywheel housing. Remove the mounting brackets that were attached to the end plates.

When the engine disassembly is being performed with the engine in the vehicle, suitable support must be provided to raise the engine, after the front engine mounting attaching nuts and washers are removed.

D-12. Remove Clutch

Remove four of the bolts and lock washers that attach the clutch assembly to the flywheel, leaving two opposed bolts to be backed out alternately until the clutch spring pressure is relieved. Then, support the clutch assembly with one hand while removing the two remaining bolts. Remove the clutch assembly. For information on disassembly, inspection, repair, and assembly of the clutch, refer to "Clutch" section. Instructions for removing the clutch when the engine is in the vehicle are also given in "Clutch" section.

D-13. Remove Flywheel

Remove the nuts and lock washers attaching the flywheel to the crankshaft flange. Use a pry bar between the flywheel and the housing and carefully loosen the flywheel from the crankshaft flange. Remove the flywheel. If the flywheel is to be removed with the engine in the vehicle, the transmission and clutch must first be removed as detailed in "Clutch" section.

D-14. Remove Oil Pump

Remove the lock wire from the rear intermediate main bearing bolts. Remove the nut and lock washer that attach the oil pump to the bearing cap. Lift the oil pump out of the bearing cap. Rotate the engine to the vertical position, front end facing up, if the operations are being performed with the engine out of the vehicle.

D-15. Remove Piston and Connecting Rod Assemblies

To prevent breaking the piston lands, the ridge at the top of each cylinder bore must be removed before attempting to remove the pistons. To remove the ridge, use a cylinder ridge reamer as shown in Fig. 20. For proper use of the reamer, follow the instructions furnished by the manufacturer. The portion of metal removed from the bore should not extend more than $\frac{1}{64}$ inch [0,396 mm.] below the ridge.

Remove the self-locking nuts that attach the connecting rod bearing cap to one of the connecting

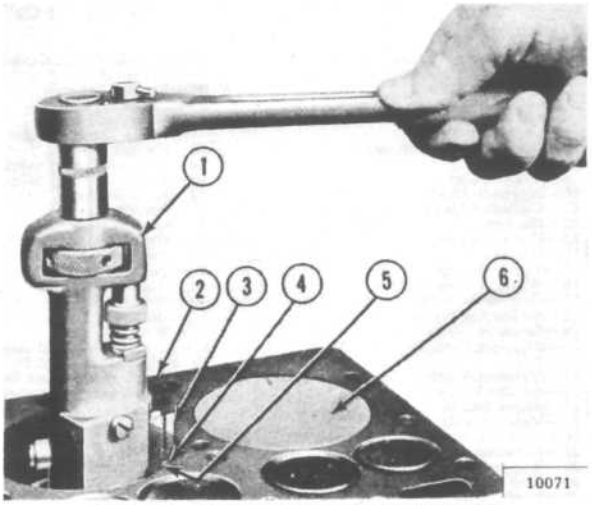


FIG. 20—REMOVING RIDGE FROM CYLINDER BORE

1—Ridge Reamer
2—Cylinder Block
3—Cutting Blade
4—Stop Screw
5—Stop Screw Lock Nut
6—Piston

rods. Remove the bearing cap. Push the connecting rod and piston assembly out of the cylinder block with the handle end of a hammer until the piston rings are free from the cylinder bore (Fig. 21). Remove the piston and connecting rod assembly from the top of the cylinder block. Reassemble the connecting rod bearing cap with the bearings in place, to the rod from which it was removed. Rotate the crankshaft and follow the same procedure until all the piston and connecting rod assemblies are removed.

Pistons and connecting rod assemblies may be removed for repair with the engine in the vehicle after draining the cooling system and removing the oil pan and the cylinder head.

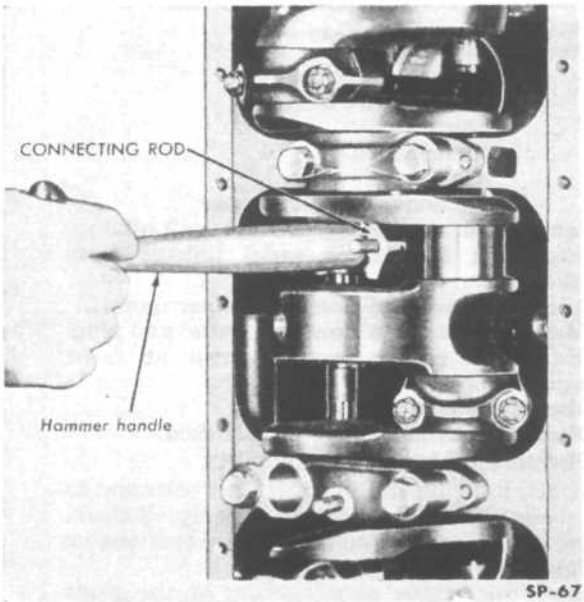


FIG. 21—REMOVING PISTON AND CONNECTING ROD ASSEMBLY

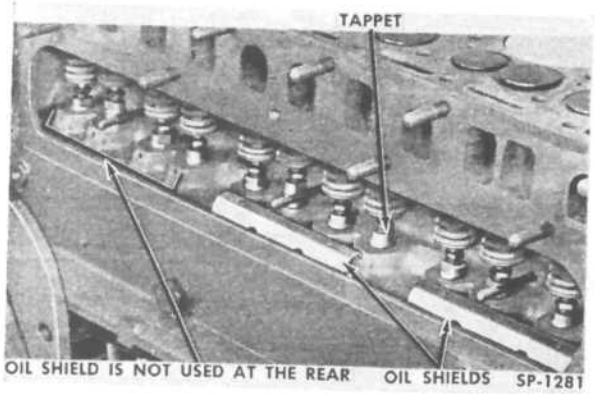


FIG. 22—VALVE TAPPET CHAMBER, TAPPETS AND OIL SHIELDS

D-16. Remove Valves and Springs

Remove the three bolts and gaskets that attach the valve tappet cover to the cylinder block and remove the cover and cover gasket. The two valve tappet chamber oil shields (Fig. 22) are held in position in the tappet chamber by means of spring clips on the underside of each shield. To remove the shields lift them out with the fingers or, if necessary, pry them out with a screwdriver.

With a valve spring lifter, compress the valve springs and remove the locks from the valve stems which are in the closed position (Fig. 23). Close the other valves by rotating the crankshaft and remove the locks from these valves in the same manner. Remove all valves and tag or place in a rack to indicate the location of each in the cylinder block.

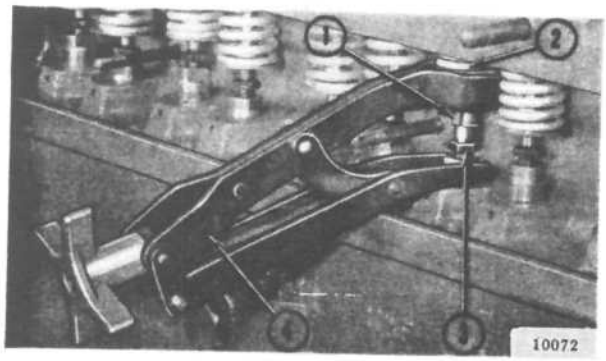


FIG. 23—REMOVING VALVE SPRING LOCKS

1—Valve Lock
2—Valve Spring
3—Tappet
4—Valve Spring Lifter

If a valve sticks in its guide and cannot be easily lifted out, pull the valve upward as far as possible and remove the spring. Lower the valve and remove any carbon deposits from the valve stem. This will permit removal of the valve. The valve springs can be pried out of the chamber with a screwdriver (Fig. 24).

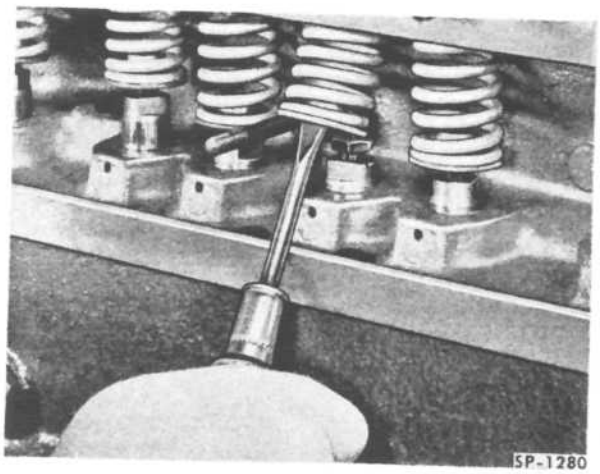


FIG. 24—REMOVING VALVE SPRINGS

D-17. Remove Vibration Damper and Hub Assembly

If the vibration damper assembly is to be removed with the engine installed in the vehicle, the cooling system must be drained and the radiator removed.

The vibration damper, pulley, and hub are removed from the crankshaft as a unit, using a special puller. Proceed as follows:

1. Remove the vibration damper bolt and lock washer from the end of the crankshaft.
2. Install a vibration damper puller (Fig. 25).
3. Turn the center screw of the puller against the end of the crankshaft until the vibration damper assembly is removed.

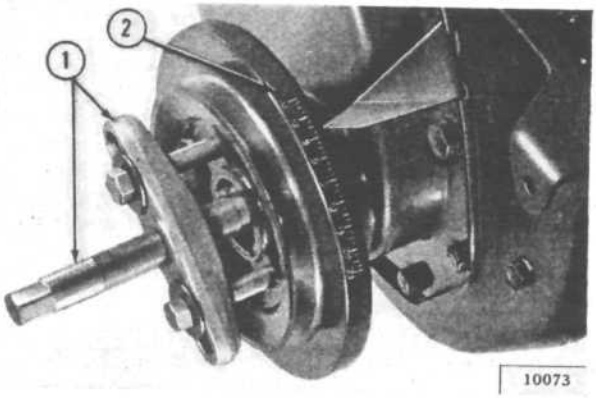


FIG. 25—REMOVING VIBRATION DAMPER

1—Puller
2—Vibration Damper

D-18. Remove Timing Chain Cover

Remove the two bolts and lock washers that attach the timing pointer to the timing chain cover and remove the pointer. Remove the remaining bolts, nuts, and lock washers, that attach the timing gear cover to the cylinder block. Remove the cover and gasket. Discard the gasket. Remove the crankshaft oil seal from the timing gear cover and discard the seal. Remove the hub key and the oil slinger from the crankshaft.

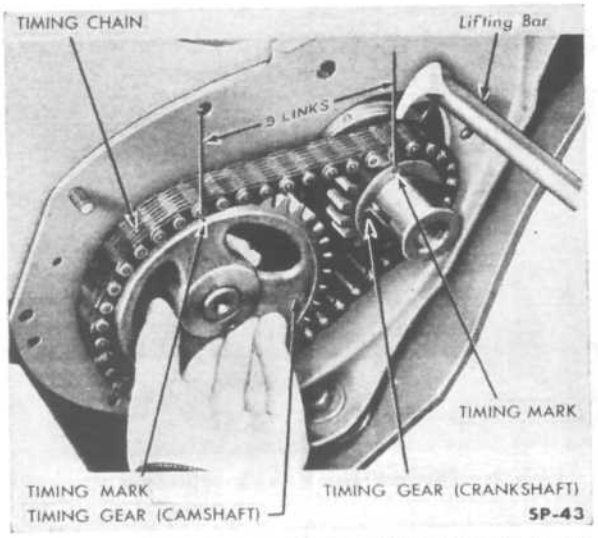


FIG. 26—REMOVING TIMING CHAIN AND GEARS

D-19. Remove Timing Gears and Chain

The timing chain and gears are removed from the engine as a unit. With a small chisel and hammer, straighten the lock plate at the camshaft gear retaining nut. Remove the nut and lock plate. With a hooked bar in position, pry alternately on the crankshaft gear and behind the spokes of the camshaft gear until both gears and timing chain are removed (Fig. 26). Remove the Woodruff keys.

D-20. Remove Front and Rear Filler Blocks

Remove the socket head screw and the slotted-head screws and lock washers that attach the front filler block to the engine front end plate. Remove the bolts that attach the filler block to the cylinder block. Remove the filler block. Remove the two slotted-head screws and lock washers that attach the rear filler block to the cylinder block. Remove the rear filler block. If the rear filler block is being removed for gasket replacement, with the engine in the vehicle, the filler block guard should also be removed as detailed in Par. D-22.

D-21. Remove Front End Plate

Remove the bolts and lock washers that attach the engine front end plate to the cylinder block. Remove the front plate and gasket. Discard the gasket.

D-22. Remove Rear Filler Block Guard

Install a remover as shown in Fig. 27. Rotate the crankshaft 180° and remove the guard.

D-23. Remove Crankshaft

Remove the lockwire, bolts, and flat washers that attach the main bearing caps to the cylinder block. Using a lifting bar beneath the recessed ends of one of the bearing caps, alternately pry up each end of the bearing cap, being careful not to exert enough pressure to damage the bearing cap or the dowels, until the cap is free from the dowels

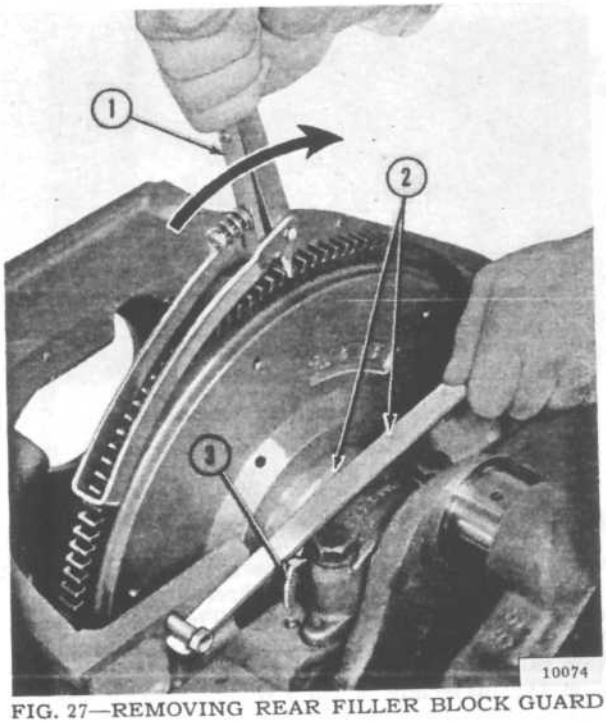


FIG. 27—REMOVING REAR FILLER BLOCK GUARD

1—Flywheel Turning Tool
2—Remover Tool
3—Filler Block Guard

(Fig. 28). Remove the bearing cap. Follow the same procedure to remove the remaining bearing caps. Lift the crankshaft from the cylinder block. Install the main bearing caps and bearings on the cylinder block in their original position. Removal of the crankshaft may be accomplished only with the engine out of the vehicle.

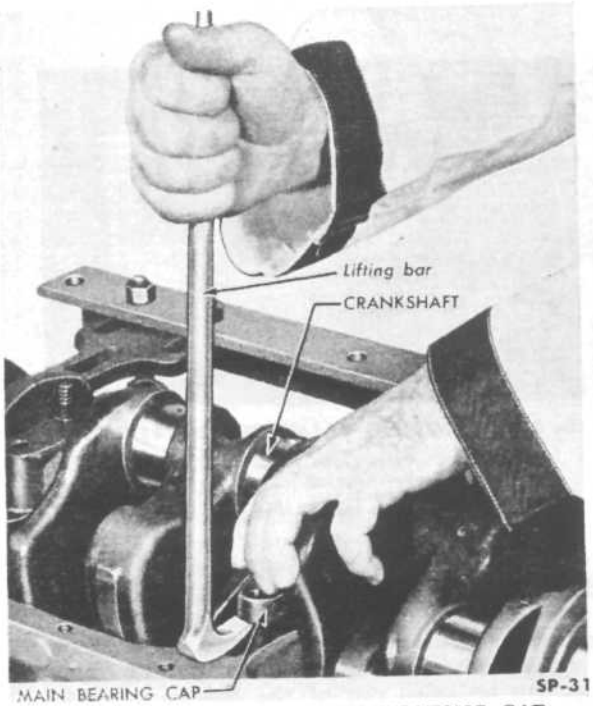


FIG. 28—REMOVING MAIN BEARING CAP

D-24. Remove Tappet Chamber Drain Tube

Remove the nut and lock washer that attach the tappet oil drain tube clip to the cylinder block. Remove the drain tube and clip.

D-25. Remove Camshaft

The removal procedures for the camshaft with the engine installed and with it removed differ considerably and are covered separately as follows:

D-26. Remove Camshaft (Engine out of Vehicle)

Proceed as follows:

a. Remove the nuts, bolts, washers and camshaft thrust plate from the front of the cylinder block.
b. Push the tappets away from the camshaft to provide sufficient clearance for removal of the camshaft.
c. Withdraw the camshaft from the front of the engine. Care must be exercised to prevent damage to the camshaft bearings (Fig. 29).

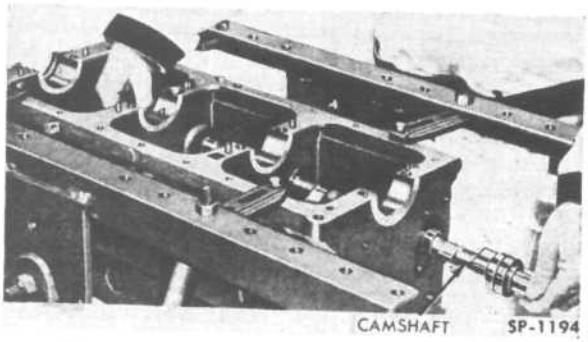


FIG. 29—REMOVING CAMSHAFT FROM CYLINDER BLOCK

D-27. Remove Camshaft (Engine in Vehicle)

Proceed as follows:

a. Drain the cooling system and remove the radiator. Remove the vibration damper, the timing chain cover and the timing gears and chain.
b. Disconnect the fuel lines and remove the fuel pump.
c. Remove the cylinder head, the oil pan and oil pump.
d. Remove the valve tappet chamber cover, the valves and springs. Refer to Par. D-16.
e. Hold the tappets in the fully up position with spring type clothes pins to prevent the tappets from interfering with the camshaft while removing it.
f. Remove the two bolts, washers and camshaft thrust plate from the front of the cylinder block.
g. Withdraw the camshaft from the front of the engine. Care must be exercised to prevent damage to the camshaft bearings.

D-28. Remove Tappets

Remove the tappets from the bottom or crankshaft side of the cylinder block after the camshaft has been removed. Tag each tappet or place them in a marked rack so they may be assembled in their original positions (Fig. 30).

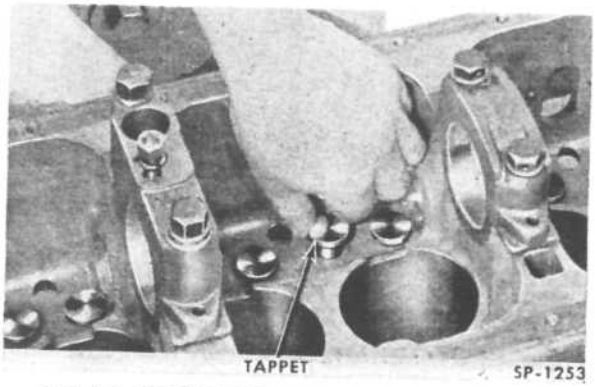


FIG. 30—REMOVING VALVE TAPPET FROM CYLINDER BLOCK

D-29. Remove Oil Gallery Plugs

Remove the plug at each end of the oil gallery in the cylinder block. This operation is only applicable with the engine out of the vehicle.

D-30. Remove Oil Pressure Relief Valve

The oil pressure relief valve is located in the right side of the cylinder block below the tappet chamber cover and consists of the parts shown in Fig. 31. Remove the relief valve parts as follows:

a. Remove the plug and gasket and pull out the valve spring and washer (if used).
b. Using suitable long-nose pliers, remove the valve.
c. If the valve sticks and cannot be removed with the pliers, a wooden wedge may be used. To make the wedge, cut a slit in the end of a piece of wooden dowel stock and insert a small wedge into the dowel just far enough to hold the wedge securely (Fig. 32).
d. Insert the tool in the hole in the block and into the valve. When tapped lightly with a hammer, this wedge will spread the dowel inside the valve. Remove the dowel and the valve which is wedged tightly on the end of the dowel: **CAUTION: Do not use a metal dowel as it may expand the valve, distorting it to the point of making removal difficult.**

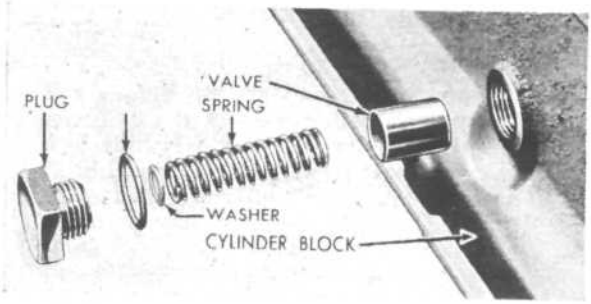


FIG. 31—OIL PRESSURE RELIEF VALVE

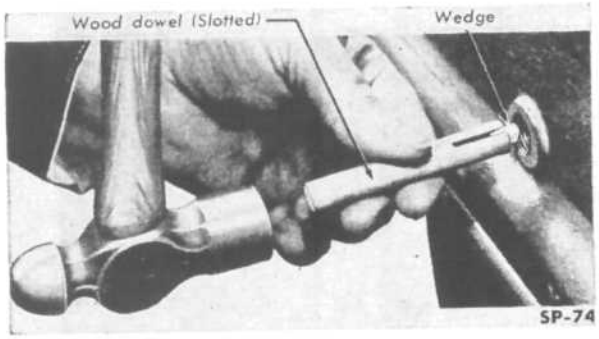


FIG. 32—REMOVING OIL PRESSURE RELIEF VALVE WITH WEDGE

D-31. ENGINE INSPECTION AND REPAIR

The inspection and repair procedures detailed herein are recommended to be followed when a complete engine overhaul is to be made with the engine out of the vehicle. These instructions can generally be applied separately with the engine in the vehicle. Wherever the procedure differs due to the engine being in the vehicle the necessary special instructions will also be provided.

Inspection and repair instructions are included to cover the cylinder block, crankshaft and bearings, connecting rods and bearings, oil pump, valves and tappets, pistons and rings, flywheel, timing gears, and the camshaft and bearings. In addition, fitting operations for these engine components are included.

Important: Before the inspection and repair procedures listed below are begun, the engine serial number must be checked for the presence of code letters denoting deviations from standard dimensions. Refer to Par. D-1.

D-32. Cylinder Block

The cylinder block must be thoroughly cleaned, inspected and repaired as detailed in the following paragraphs.

D-33. Cleaning

The cylinder block may be steam cleaned or cleaned with a suitable solvent. A scraper is recommended to remove hard deposits, except on highly finished surfaces. Special attention must be directed to the cleaning of the oil passages, tappet chamber, crankcase, and cylinder walls to remove all sludge, dirt and carbon deposits. After cleaning, use air pressure to dry the block thoroughly.

D-34. Inspection

Examine the cylinder block for minute cracks and fractures. Rusted valve springs or evidence of rust in the tappet chamber or the cylinder walls is a good indication of a possible crack in the block. Pressure testing the block will usually indicate the presence of a crack. A pressure test may be made by applying 30 to 60 pounds water and air pressure in the water jackets of the block. With the water jacket ports sealed off, a drop in pressure will indicate the presence of a crack.

NOTE: To make this test the cylinder head and water pump must be installed and the inlet and outlet must be sealed tight.

a. Examine all machined surfaces of the cylinder block for burrs and scores. Check cylinder block distortion by placing a straight edge along the length of the cylinder head surface of the block. With a feeler gauge check for clearance between the straight edge and the block, particularly between adjacent cylinders (Fig. 33).

b. Check the cylinder bores for out-of-round and taper to determine whether the bores require honing or reboring. For detail information refer to Par. D-35.

c. If main bearing caps are not removed carefully, raising both sides of each cap evenly until free of the dowels, the dowels may be bent. This is especially probable if a pry bar is used, first at one side of the cap and then the opposite, to raise the cap from the cylinder block. Bent main bearing cap dowels can cause misalignment of the bearing cap and resultant rapid bearing wear necessitating early bearing replacement.
Therefore, remove each main bearing cap carefully and if there is any reason to believe any of the dowels may have been bent during bearing cap removal, remove those dowels and install new ones as detailed below.

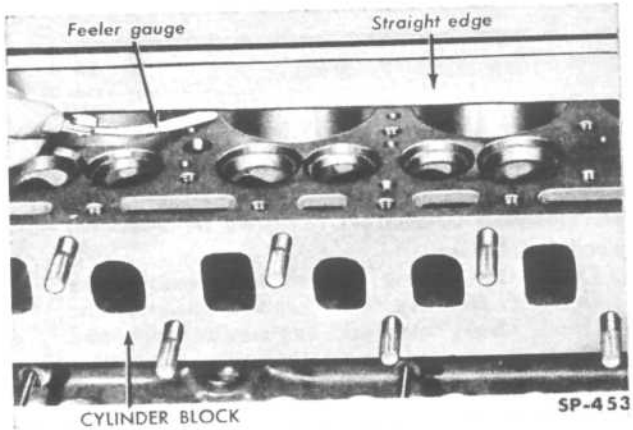


FIG. 33—CHECKING CYLINDER BLOCK FOR DISTORTION

d. Since the dowels must fit tight to assure cap alignment and are hardened which makes gripping them with a tool difficult, they are, in some cases, hard to remove. To simplify the operation, file a notch on each side of the dowel to accommodate a pair of diagonal cutters. Using a piece of bar stock under the diagonals for leverage, work the dowel out of the cylinder block.
Before installing a new dowel in the cylinder block make sure the dowel hole is clean. Start the dowel straight in the hole in the cylinder block, then tap the dowel lightly with a hammer until it bottoms in the hole.

When installing bearing caps, be sure to tighten the bolts in each cap evenly to pull the cap into place on the dowels without bending the dowels or distorting the bearing cap.

e. Other parts of the block which require inspection and possible repair, but which are directly related to other engine components (such as tappets, pistons, camshaft, valves, crankshaft and oil pump), are covered later in this Section under separate headings.

D-35. Cylinder Bores

The cylinder bores may be reconditioned by honing or reboring. A special tool is used to determine the out-of-round or taper condition of the cylinder and necessity for reconditioning.

Both honing and reboring of the cylinders must be closely coordinated with fitting the pistons to maintain specified tolerances.

Reboring the cylinders may be accomplished only when adequate facilities and trained or experienced mechanics are available. The engine must be removed from the vehicle and mounted in a suitable level holding fixture.

The amount of material to be removed is determined from the original diameter of the cylinder bores (3.3125-3.3145 inches) [84,137-84,188 mm. diameter] plus the amount of oversize in diameter of the oversize pistons to be fitted. Pistons are available in .010, .020, .025, .030, .040, .050 and .060 inch [,254, ,508, ,635, ,762, 1,016, 1,270, 1,524 mm.] oversizes. The largest cylinder bore will determine the oversize to which all cylinders must be rebored, since the size and weight of all pistons must be uniform to maintain proper engine balance.

Measure the cylinder diameters by making measurements both parallel to and at right angles to crankshaft over entire piston travel and at bottom of cylinder using Cylinder Bore Checking Gauge C-119 (Fig. 34). Proceed as follows:

a. If bores are scored; if out-of-round exceeds .005 of an inch [,127 mm.]; if diameters differ more than .005 of an inch [,127 mm.]; or if taper exceeds .005 of an inch [0,127 mm.] on diameter, it is generally recommended that cylinders be reconditioned by reboring and honing to the next oversize using new pistons of the proper size. NOTE: If reboring is performed, all cylinders must be rebored to the same oversize allowing .0015 of an inch [,0381 mm.] for final honing. All cylinder bore diameters must be within .002 of an inch [,0508 mm.] after reconditioning.

b. If bore measurements are within the above limits, but indicate hollows or waviness, cylinders should be honed with 250 grit stones (Fig. 35). Pump hone up and down in cylinder while it is rotating to produce a satin-finish, diamond cross-hatched pattern approximately 30° with horizontal. Hone only enough to correct waviness.

c. If cylinder bore correction is unnecessary, break the glaze on cylinder walls with a hone with 250 grit stones or with a suitable deglazing tool. Operate the hone or deglazer to obtain diamond cross-hatched pattern same as above.

d. During all operations, protect crankshaft journals and other engine parts from abrasive dust with oil soaked rags. Regardless of type of correction on cylinder walls, wash out bores thoroughly afterwards, using warm water and soap and apply a light coat of clean engine oil. If cylinders have been rebored or honed heavily, measure cylinder diameters again to assure proper selection of piston size.

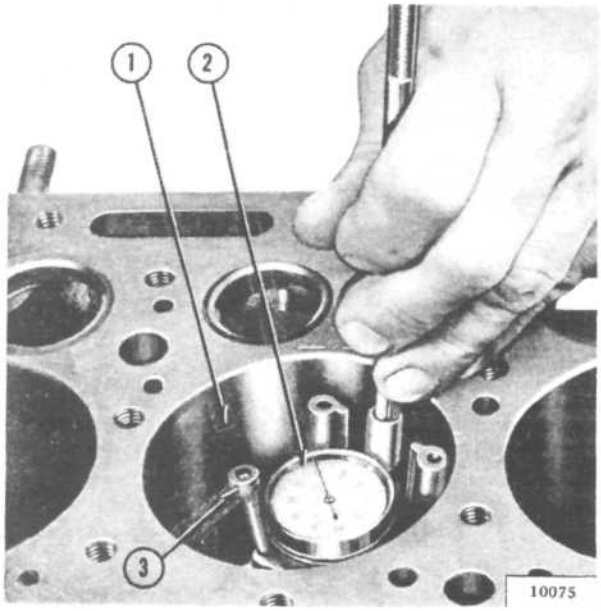


FIG. 34—CHECKING CYLINDER BORE

1—Cylinder Bore
2—Cylinder Bore Checking Gauge
3—Lock Screw

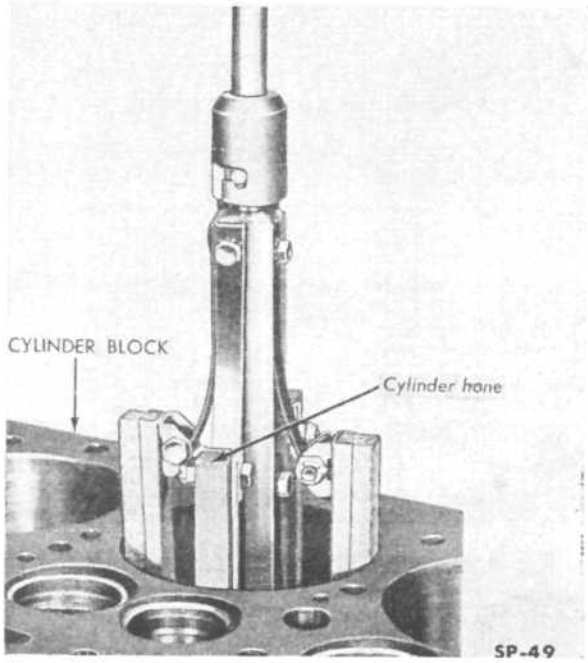


FIG. 35—HONING CYLINDER BORE

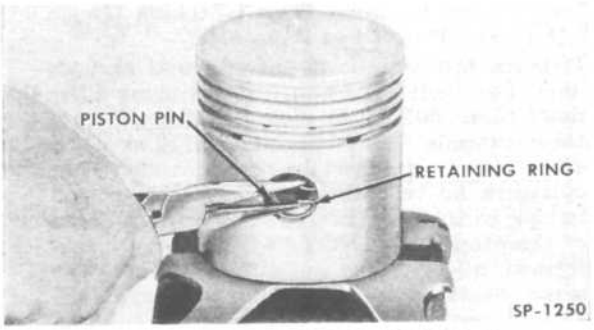


FIG. 36—REMOVING PISTON PIN RETAINING RINGS

D-36. Pistons, Rings and Connecting Rods

The pistons and connecting rods were removed from the engine as assemblies. If cylinders were rebored, new oversized pistons and rings will have to be installed as determined at the time cylinders were rebored.

Use standard size pistons in cylinder bores up to .009 inch [,229 mm.] oversize (measured at bottom of bore), .010″ [,254 mm.] oversize in bores .010-.019″ [,254-,483 mm.] oversize; .020″ [,508 mm.] in bores .020″-.024″ [,508-,610 mm.] oversize; .025″ [,635 mm.] in bores .025″-.029″ [,635-,737 mm.] oversize; .030″ [,762 mm.] in bores .030″-.039″ [,762-,991 mm.] oversize; .040″ [1,016 mm.] in bores .040″-.049″ [1,016-1,244 mm.] oversize; .050″ [1,270 mm.] in bores .050″-.059″ [1,270-1,499 mm.] oversize and .060″ [1,524 mm.] in bores .060″ [1,524 mm.] oversize and up.

If cylinders were not rebored, disassemble pistons and rods by removing piston pin retaining rings (Fig. 36) and pressing out pin. Keep the parts of each assembly separate so they may be installed in the same cylinder. Remove rings from piston. Clean carbon from piston head and clean ring grooves and drain holes. Use care not to scrape metal from side of grooves nor to make burrs on ring groove surfaces. Check pistons for broken lands, cracks, or worn grooves. Replace piston if necessary using same size as old piston. Proceed as follows:

a. Check fit of each piston to cylinder bore, when block and pistons are clean and dry and at approximately 70° F [21° C] by using Piston Fitting Gauge and Scale C-690 as shown in Fig. 37. Use a .004 inch [,1016 mm.] thickness gauge (½ inch wide) [12,7 mm.] if old pistons are to be used. When fitting new pistons, use .0015 inch [,0381 mm.] gauge. The piston is fitted upside down in the block to facilitate the operation, and the gauge must extend the full length of piston on the thrust side (side opposite slot in piston skirt). Scale should register 5-10 pounds [2,26-4,53 kg.] pull to remove thickness gauge from between cylinder wall and piston. Excessive pull indicates need for a slightly smaller piston or additional honing of cylinder. Insufficient pull indicates need for fitting a larger piston.

b. Check piston pin fit. The piston pin should be a palm push fit at room temperature. If the pin is loose, a new pin must be used. It may be necessary to use a .003 inch [,0762 mm.] or a .005 inch [,127 mm.] oversize pin and ream the piston with Piston Pin Reamer DD-82-2 (Fig. 38) to obtain a push fit.

c. After checking the piston pin fit in the piston, check its fit in the connecting rod bushing. The pin should just slip through the bushing under its own weight. If the pin is too tight, ream the inside diameter of the bushing with Piston Pin Reamer DD-82-2 (Fig. 39) to

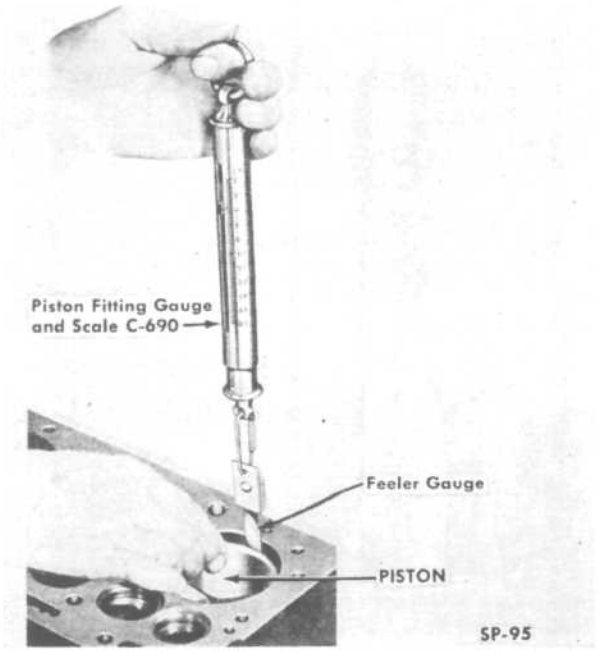


FIG. 37—FITTING PISTON IN CYLINDER BORE

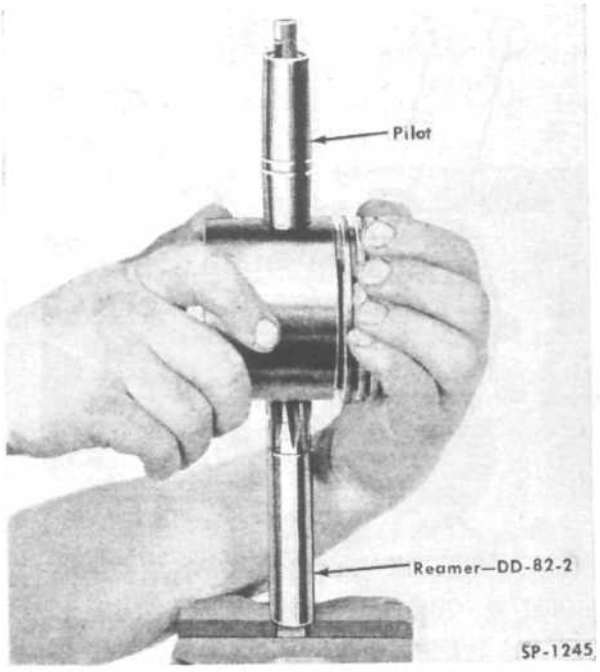


FIG. 38—REAMING PISTON PIN BORE

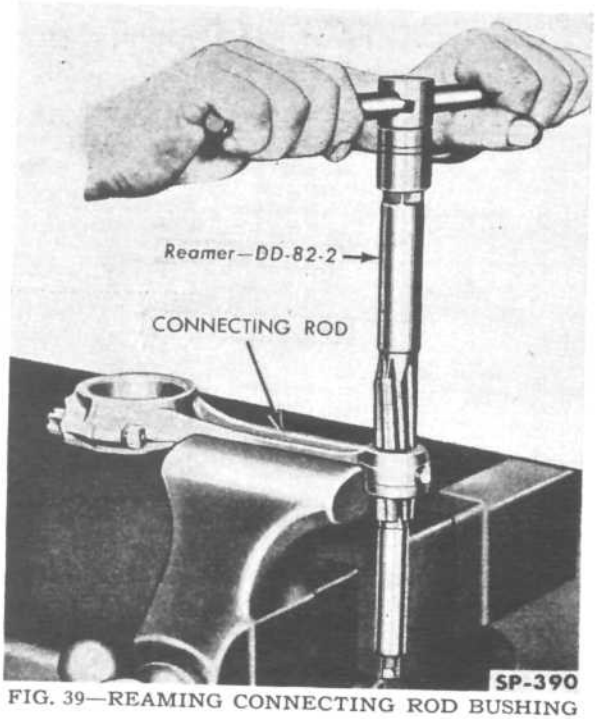


FIG. 39—REAMING CONNECTING ROD BUSHING

.8593″ to .8595″ [21,826 a 21,831 mm.] for a standard pin or, if an oversize pin is used, ream the bushing .003″ to .005″ [0,0762 a 0,127 mm.] oversize.

If the pin is too loose, install a new bushing and ream to proper size. The new bushing must be installed with the oil hole aligned to the oil hole in the connecting rod. The bushing must protrude 1/64 inch [,396 mm.] on each side of the connecting rod.

d. Check and correct connecting rod alignment with a connecting rod aligning fixture as shown in Fig. 40. Follow the instructions furnished with the fixture.

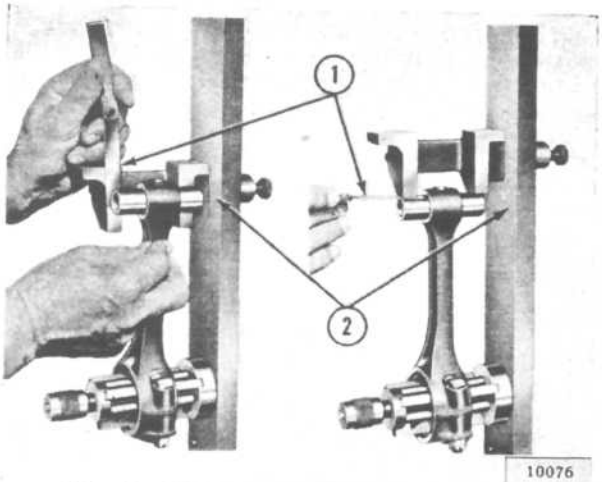


FIG. 40—CHECKING CONNECTING ROD ALIGNMENT

1—Feeler Gauge
2—Fixture

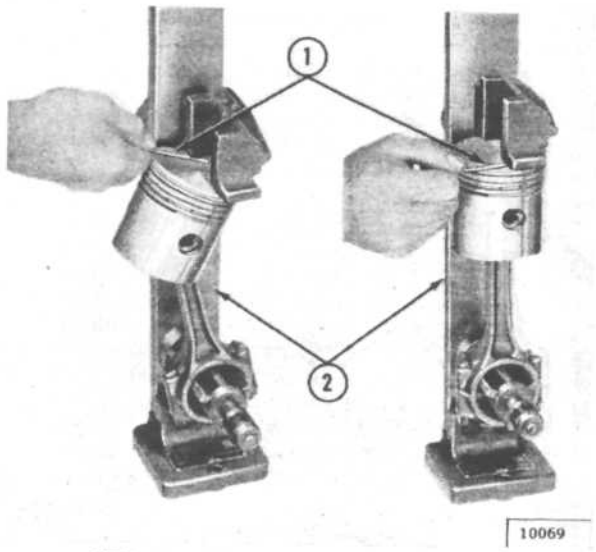


FIG. 41—CHECKING PISTON AND CONNECTING ROD ALIGNMENT

1—Feeler Gauge
2—Fixture

e. Assemble piston and rod by heating the piston to approximately 160° F [71° C]. Place the connecting rod in the piston, making sure the oil spurt hole in the rod is on the opposite side from the T slot in the piston. Install the piston pin, pushing it in by hand, and install the pin retaining rings.

f. Place piston and rod assembly in a fixture and check alignment of the assembly as shown in Fig. 41. Follow instructions furnished with the fixture.

g. Check width of piston ring grooves using a new piston ring and a feeler gauge as shown in Fig. 42.

RING TO GROOVE CLEARANCES

Upper Compression Ring	.002″-.004″ [,0508-,1016 mm.]
Lower Compression Ring	.003″-.007″ [,0762-,178 mm.]
Oil Control Rings	.006″-.010″ [.152-,254 mm.]

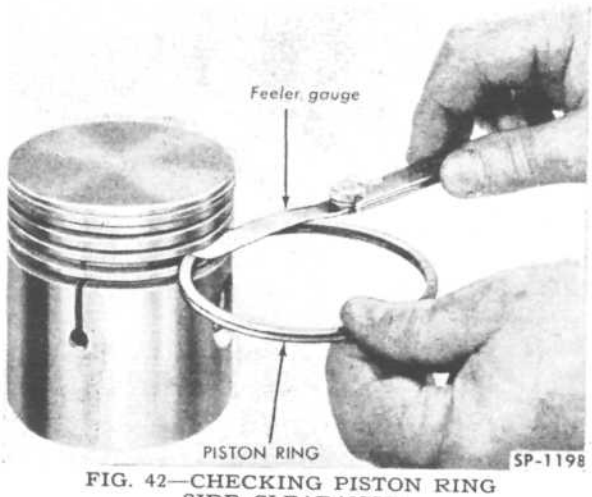


FIG. 42—CHECKING PISTON RING SIDE CLEARANCE

Insert feeler gauge between ring and piston to bottom of groove. Replace piston if ring grooves are not within allowable tolerances.

If a feeler gauge larger than .006 inch [,152 mm.] can be inserted 1/16 of an inch [1,588 mm.] between piston and upper compression ring, groove is worn excessively bell-mouthed and piston should be replaced.

h. Check piston ring end gap by placing compression ring in cylinder bore below ring travel using head of a piston to push ring in squarely. Minimum end gap must be .007 inch [,178 mm.] for all rings. If less, place ring in a jig and file ends to obtain minimum gap. Excessive filing or ring gap over .045 inch [1,143 mm.] indicates improper size rings were selected. Proper rings in cylinders rebored to usual oversizes should have a .007 to .020 inch [,178-,508 mm.] end gap without filing.

Select piston rings of proper size for installation in the oversize cylinder bores using the Piston Ring Application Chart in Par. D-37.

i. Install new ring set using either production replacement rings or oil control rings. Production replacement rings are the same as the original factory installed rings while oil control ring sets have different components, notably the oil ring expander. Follow instructions on ring envelopes for proper installation. Use a piston ring tool to install rings on pistons as shown in Fig. 43. Do not expand rings more than necessary to install, also be careful not to burr the piston with ends of rings. Make sure upper compression ring is installed in groove with correct side up. Position rings so gaps are staggered according to instructions on the envelope.

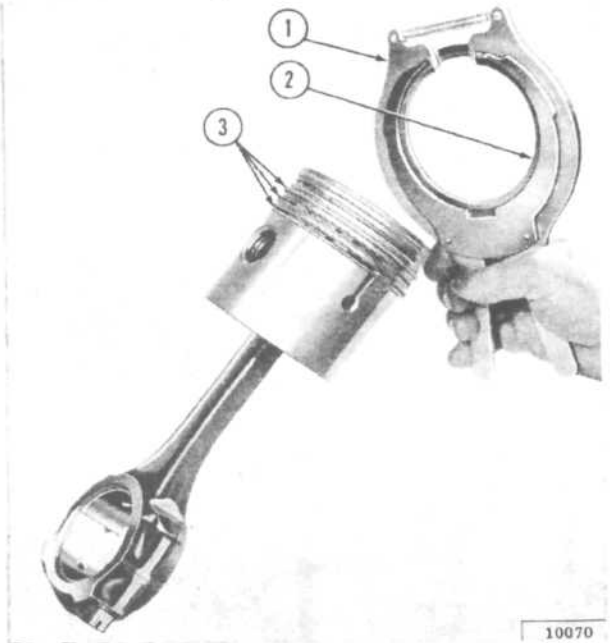


FIG. 43—INSTALLING RINGS ON PISTON

1—Piston Ring Installing Tool
2—Piston Ring
3—Piston Rings Installed

D-37. Piston Ring Application Chart

Actual Ring Size*	Ring Oversize Range*	For Best Fit Use in Cyl. Bore Oversize	Ring Gap Fitting
Std.	Std. to .009" (Std. to .229 mm.)	Std. to .009" (Std. to .229 mm.)	No fitting necessary
.020" (.508 mm.)	.010" to .029" (.254 to .737 mm.)	.010" to .019" (.254 to .483 mm.)	.007" Gap (.178 mm.)
		.020" to .024" (.508 to .610 mm.)	No fitting necessary
.030" (.762 mm.)	.030" to .039" (.762 to .991 mm.)	.025" to .029" (.635 to .737 mm.)	.007" Gap (.178 mm.)
		.030" to .034" (.762 to .863 mm.)	No fitting necessary
.040" (1.016 mm.)	.040" to .049" (1.016 to 1.244 mm.)	.035" to .039" (.889 to .991 mm.)	.007" Gap (.178 mm.)
		.040" to .049" (1.016 to 1.224 mm.)	No fitting necessary
.060" (1.524 mm.)	.050" to .069" (1.270 to 1.752 mm.)	.050" to .059" (1.270 to 1.499 mm.)	.007" Gap (.178 mm.)
		.060" to .069" (1.524 to 1.752 mm.)	No fitting necessary

D-38. Crankshaft

The crankshaft is machined from a heat treated carbon steel forging and is carefully balanced both dynamically and statically. The main bearing journals and crankpins are efficiently lubricated through the drilled oil gallery and passages in the cylinder block, through which oil is forced under pressure to the main bearings and through the cheeks of the crankshaft to the connecting rod bearings.

While the crankshaft is out of the engine be very careful when handling it to prevent damage to the connecting rod crankpins and the main bearing journals.

D-39. Crankshaft Cleaning

Clean out the drilled holes (oil passages) in the crankshaft journals with a small rifle brush or with a piece of wire. Blow out the passages with compressed air after cleaning. Clean the crankshaft thoroughly with a suitable cleaning solvent.

D-40. Crankshaft Inspection and Repair

Inspect the crankshaft for cracks, alignment, and condition of the crankpins and the main bearing journals. Cracks, misalignment, and scored or worn journals and crankpins necessitate crankshaft replacement. Also check the pilot bushing for wear or damage in the rear end of the crankshaft.

D-41. Checking Crankshaft Alignment

To check alignment, mount the crankshaft in the cylinder block with the front and rear bearings in place but the two intermediate bearings removed. With a dial indicator mounted on the crankcase and the indicator button resting on the intermediate bearing journals, one at a time, slowly rotate the crankshaft and note the reading on the indicator dial. Install the two intermediate bearings and remove the front and rear bearings. Then repeat the operation with the dial indicator, checking at the front and rear bearing journals. The maximum allowable run-out is .002" [0,0508 mm.].

D-42. Checking Main Bearing Journals

Main bearing journal diameters may be checked with the crankshaft assembled in the engine or out



FIG. 44—MEASURING CRANKSHAFT JOURNAL DIAMETER

of the engine. If the journal is to be checked with the crankshaft in the engine, then the bearing cap and upper and lower bearings must be removed from one journal at a time. A special journal micrometer as illustrated in Fig. 44 may be used. When the check is to be made with the crankshaft out of the engine, an ordinary 3″ micrometer may be used. The standard journal diameter is 2.3752″ to 2.3744″ [6,033 a 6,031 cm.] for all main bearings. Allowable taper or out-of-round of the journals is .001″ [0 0254 mm.].

D-43. Checking Connecting Rod Crankpins

Check the crankpin diameters with a micrometer to assure they are not out-of-round or tapered more than .001″ [0,0254 mm.]. The standard crankpin diameter is 2.0627″ to 2.0619″ [5,239 a 5,237 cm.].

D-44. Crankshaft Pilot Bushing

Inspect the crankshaft pilot bushing in the flywheel end of the crankshaft. The pilot bushing may be replaced with the engine in the vehicle or out of the vehicle. Remove the bushing with Clutch Shaft Pilot Bushing Remover KF-5 (Fig. 45).

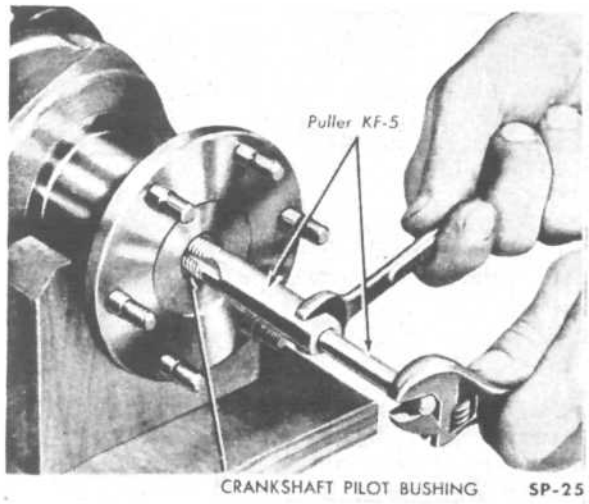


FIG. 45—REMOVING CRANKSHAFT PILOT BUSHING

The pilot bushing is installed and then burnished with Clutch Shaft Pilot Bushing Burnisher and Driver KF-6. The bushing is placed on the driving pilot end of the tool and driven into place in the crankshaft. The sleeve and nut are then installed on the driving pilot. Hold the driving pilot with a wrench and tighten the sleeve nut to remove the pilot which burnishes the bushing as it is withdrawn (Fig. 46).

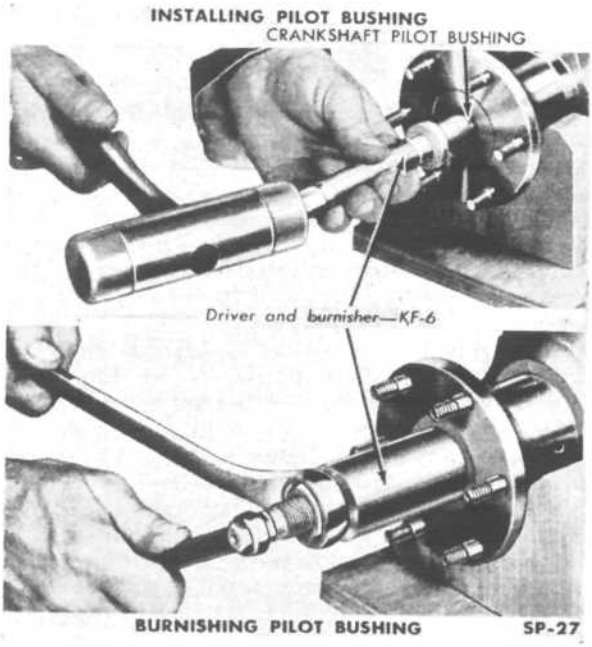


FIG. 46—INSTALLING AND BURNISHING CRANKSHAFT PILOT BUSHING

D-45. Crankshaft Main Bearings

The crankshaft main bearings are the replaceable type which, when correctly installed, provide proper clearance without filing, boring, scraping or shimming. Upper and lower bearing halves are retained in position with locks notched on the bearing to fit into corresponding notches in the cylinder block and bearing cap. All four main bearings have the same bore diameter but differ in width, only the two intermediate bearings being the same and interchangeable. Upper and lower halves of each bearing are the same. Crankshaft bearings should be replaced as a complete set of four bearings, each bearing consisting of two halves.

The following undersize crankshaft main bearings are available:

.001″ [0,025 mm.]	.012″ [0,304 mm.]
.002″ [0,050 mm.]	.020″ [0,508 mm.]
.010″ [0,254 mm.]	

The sizes .010″, .020″, and .030″ are intended for use with a crankshaft that has been turned to these sizes as standards. There are cases where the crankshaft does not need to be reworked and the slightly undersize bearings can be used.

Bearing sizes are rubber stamped on the back side of each bearing. The rear main bearing has an integral flange to serve as a crankshaft thrust washer.

The crankshaft main bearings may be replaced with the engine in the vehicle without removing the crankshaft.

NOTE: Effective with engine serial numbers SW-6-L-226-12252 and TW-6-L-226-47787, new improved crankshaft bearings entered production. The old and new bearings should not be intermixed. If only part of the crankshaft bearings are to be replaced on engines with serial numbers lower than the above listed numbers, the old style bearings should be installed. If all crankshaft bearings are to be replaced on any L6-226 engine, the new type bearings should be installed.

D-46. Crankshaft Main Bearing Replacement

When the bearings are to be replaced with the engine in the vehicle the oil pan, oil pump and front and rear filler blocks must be removed as detailed previously in this Section. Replace one bearing at a time. With the engine out of the vehicle, the crankshaft may be removed, permitting removal of all the bearing halves from the cylinder block and the bearing caps at the same time.

Remove bearing caps carefully by raising both sides of each cap evenly until free of the dowels so as not to bend the dowels. Do not use a pry bar.

To replace bearings with the engine in the vehicle, remove one bearing cap and lower half of the bearing. Remove the upper half of the bearing from between the crankshaft and the cylinder block (Fig. 47). Fit a removing tool into the oil hole in the crankshaft journal and rotate the crankshaft in the direction to raise the bearing lock out of the notch in the cylinder block, continuing the rotation until the bearing is removed.

D-47. Crankshaft Main Bearing Inspection

The crankshaft journals must be carefully inspected as detailed previously in Par. D-40. Worn journals will require undersize bearings. Scored, flaked or worn bearings must be replaced. Bearing wear can be checked by measuring the thickness which should be .09315-.09290 of an inch [2,366-2,359 cm.] for standard size bearings.

Measure the main bearing bores using a telescope gauge and micrometer (Fig. 48). Measure the bores at right angles to the split line and at 45 degrees to the split line. The standard bore diameter is 2.5622-2.5615 inches [6,508-6,506 cm.]. The bores should not be over .001 of an inch [,0254 mm.] out-of-round or .001 of an inch in taper from end to end. Also, the bores should not be more than .001 inch oversize, considering the average diameter of the bore.

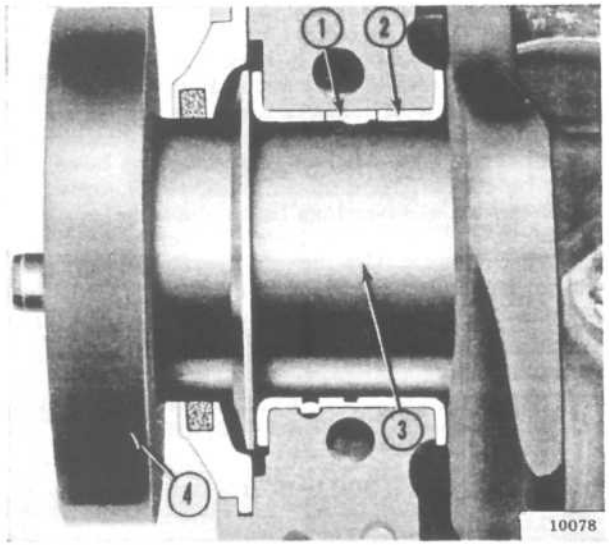


FIG. 47—REMOVING MAIN BEARING UPPER HALF WITH ENGINE INSTALLED

1—Removing and Installing Tool
2—Upper Bearing
3—Main Bearing Journal
4—Flywheel Mounting Flange

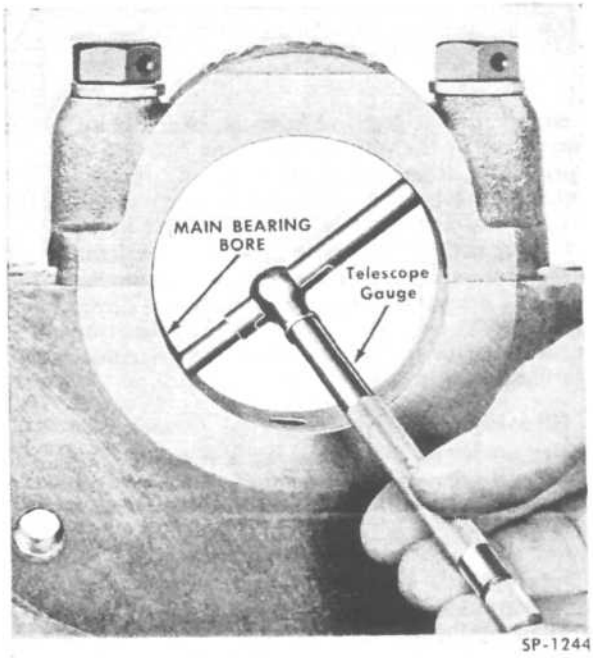


FIG. 48—MEASURING MAIN BEARING BORES

D-48. Fitting Crankshaft Main Bearings Using Plastigage

After wiping and carefully inspecting the bearing bore, install the proper bearing. See that the oil hole in the bearing upper half registers properly with the oil hole in the block, and that the bearing lock fits properly in the notch in the block. Install the crankshaft if replacing bearings with the engine out of the vehicle.

The desired running fit (difference between the diameter of the crankshaft journal and the inside diameter of the fitted bearing) for a main bearing is .001 of an inch [,0254 mm.] with limits of .0005-.0015 of an inch [,0127-,0381 mm.].

Install the bearing lower half and the bearing cap and draw the cap bolts down equally and only slightly tight. Rotate the crankshaft by hand to be sure it turns freely without drag. Pull the cap bolts tighter, first one then the other, a little at a time, intermittently rotating the crankshaft by hand until the recommended torque of 85-95 foot pounds [11,7-13,1 kg. m.] is reached. If the bearings are of

the correct size, and lubricated with light oil before installation, the crankshaft should turn freely in the bearings. If the crankshaft cannot be turned, a larger bearing is required. If there is no binding or tightness, it is still necessary to check clearance to guard against too loose a fit. Never file either the bearing cap or the bearing to compensate for too much clearance. Do not use shims under a bearing cap or behind a bearing shell. Do not run a new bearing half with a worn bearing half.

The use of "Plastigage" of the proper size to measure .001 of an inch [,0254 mm.] clearance is recommended for checking crankshaft main bearing clearance. This material is available in a package from Willys Parts Dept. under part number 204460. The method of checking clearance is as follows:

a. Remove the bearing cap and carefully wipe all oil from the bearing and the journal.

b. Lay a piece of "Plastigage" $\frac{1}{8}$ inch [3,17 mm.] shorter than the width of the bearing across the journal (lengthwise of the crankshaft).

c. Install the bearing and cap and tighten first one bolt, then the other, a little at a time to the specified torque. As the bearing tightens down around the journal, the "Plastigage" flattens to a width that indicates the bearing clearance.

d. Remove the cap and measure the width of the flattened "Plastigage," using the scale printed on the edge of the envelope (Fig. 49). The proper size "Plastigage" will accurately measure clearance down to .001 of an inch.

e. If the flattened "Plastigage" tapers toward the middle, or toward the end, or both ends, there is a difference in clearance, indicating a taper, a low spot, or other irregularity of the bearing or journal.

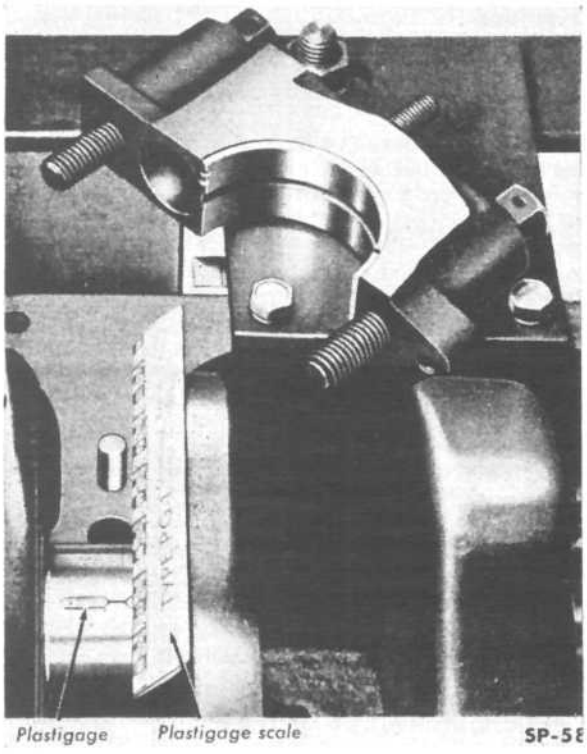


FIG. 49—CHECKING MAIN BEARING CLEARANCE WITH PLASTIGAGE

D-49. Fitting Crankshaft Main Bearings Using Shim Stock

Thin feeler or shim stock may be used instead of "Plastigage" to check bearing clearances. The method is simple, but care must be taken to protect the bearing metal surface from injury by too much pressure against the feeler stock.

a. Cut a piece of .001 of an inch [,0254 mm.] thick, by $\frac{1}{2}$ inch [12,7 mm.] wide, feeler stock $\frac{1}{8}$ inch [3,17 mm.] shorter than the width of the bearing. Coat this feeler stock with light engine oil and lay it on the bearing in the cap, as shown in Fig. 50. With the shim in this position, install the bearing and cap on the crankshaft.

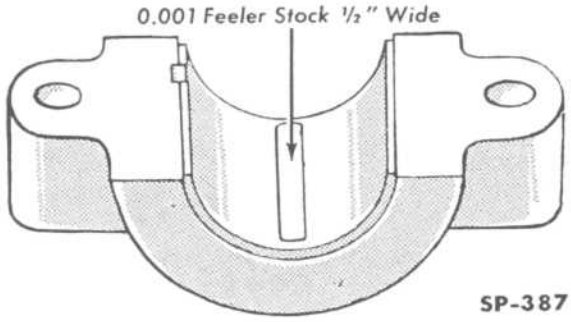


FIG. 50—SHIM STOCK IN POSITION ON MAIN BEARING

b. Tighten the bearing cap bolts, first one and then the other, a little at a time to 85-95 foot pounds torque [11,7-13,1 kg. m.].

c. Turn the crankshaft by hand not more than one inch in either direction. **CAUTION: Turning the crankshaft more may imbed the shim stock in the bearing, giving a false indication of fit and damaging the bearing.** If the bearing clearance is correct, the piece of .001 of an inch feeler stock should produce a light to heavy drag. If there is little or no drag the bearing fit is too loose—if the crankshaft will not turn there is not enough clearance. In either case another bearing must be selected to provide the proper fit.

d. After the bearing has been correctly fitted, remove the shim stock, wipe the bearing and journal carefully and apply clean engine oil to the surfaces. Replace the cap and tighten the bolts first one, then the other, a little at a time, to the prescribed torque. Replace the lock wires. The crankshaft should now turn freely without drag.

D-50. Connecting Rod Bearings

The connecting rod bearings, like the crankshaft main bearings, are the replaceable type. When correctly installed, the bearings provide proper clearance without filing, boring, scraping, or shimming. Upper and lower bearing halves are retained in position with locks notched in the bearing to fit

into corresponding notches in the cap and connecting rod. The position of the bearing lock and oil hole in the bearings for numbers 1, 3, and 5 connecting rods is the opposite of those for numbers 2, 4, and 6 and, therefore, they are not interchangeable. Connecting rod bearings should be replaced as a complete set of six bearings, each bearing consisting of two halves.

The following undersize connecting rod bearings are available:

.001″ [0,025 mm.]	.012″ [0,304 mm.]
.002″ [0,050 mm.]	.020″ [0,508 mm.]
.010″ [0,254 mm.]	

The bearings may be replaced with the engine in the vehicle when made accessible by removal of the oil pan. However, should it be necessary to replace the bearings due to wear, replacement of piston rings and piston pins is also recommended.

NOTE: Effective with engine serial numbers SW-6-L-226-12252 and TW-6-L-226-47787, new improved connecting rod bearings entered production. The old and new bearings should not be intermixed. If only part of the connecting rod bearings are to be replaced on engines with serial numbers lower than the above listed numbers, the old style bearings should be installed. If all connecting rod bearings are to be replaced on any L6-226 engine, the new type bearings should be installed.

D-51. Connecting Rod Bearing Replacement

The bearings are replaced by removing the bearing cap and the upper and lower bearing halves. The new bearings must be installed so that the oil holes align with those in the connecting rod and the locks must fit into the corresponding notches in the rod and cap and seat evenly. Each bearing cap must be installed on the connecting rod from which it was removed, and in the same position.

D-52. Connecting Rod Bearing Inspection

The crankpins must be carefully inspected as detailed previously in Par. D-40. Worn crankpins will require undersize bearings. Scored, flaked or worn bearings must be replaced.

D-53. Fitting Connecting Rod Bearings

The bearing fits may be roughly checked by shaking the connecting rod by hand, prior to removal of the bearing cap, to determine if it is loose on the crankshaft.

The bearing clearances may be measured with "Plastigage" or shim stock as follows:

After wiping and carefully inspecting the bearing bore, install the proper bearing. See that the oil hole in the bearing upper half registers properly with the oil hole in the connecting rod and that the lock fits properly in the notch in the rod. Never file either the bearing cap or the bearing to compensate for too much clearance. Do not use shims under a bearing cap or behind a bearing shell. Do not run a new bearing half with a worn half.

The desired running fit (difference between the diameter of the crankpin and the inside diameter of the fitted bearing) for a connecting rod bearing is .001 of an inch [,0254 mm.] with limits of .0005-.0015 of an inch [,0127-,0381 mm.].

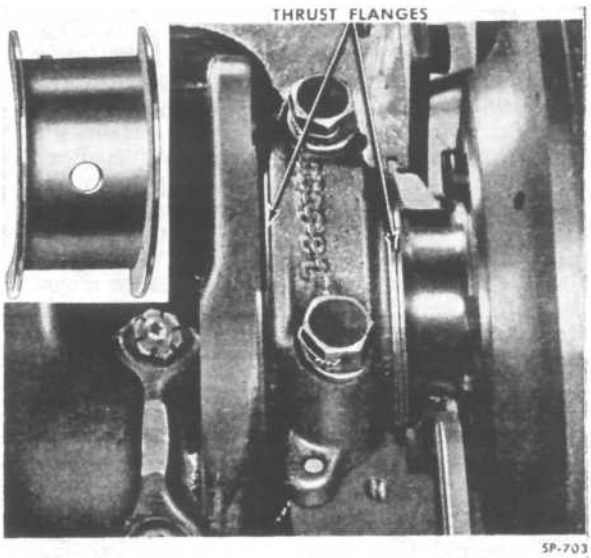


FIG. 51—REAR MAIN BEARING INSTALLATION

Install the bearing lower half and the connecting rod cap and draw the cap bolt nuts down equally and only slightly tight. Move the connecting rod endwise, one way or the other, on the crankshaft to be sure the bearing is not tight. Pull the nuts tighter, first one then the other, a little at a time, and keep trying the fit of the rod on the crankshaft by hand until recommended torque of 40-45 foot pounds [5,5-6,2 kg. m.] is reached. If the bearings are of the correct size, and lubricated with light engine oil before installation, the connecting rod should be easy to slide with the thumbs back and forth parallel to the crankpin. If the connecting rod is tight on the crankshaft, a larger bearing is required. If there is no binding or tightness, it is still necessary to check clearance to guard against too loose a fit.

The use of "Plastigage" or shim stock of the proper size to measure .001 of an inch [,0254 mm.] clearance is recommended for checking connecting rod bearing clearances. This is the same material recommended for checking crankshaft main bearings and the method of checking is similar. Refer to Par. D-48 and D-49. Connecting rod bearings are fitted to the same clearance as the main bearings but the torque specifications for connecting rod cap bolts is only 40-55 foot pounds [5,5-6,2 kg-m.].

D-54. Crankshaft End-Play

The end play of the crankshaft is controlled by flanges on the rear main bearing and the machined surface on the number 8 cheek and on the inner side of the oil seal flange of the crankshaft (Fig. 51). Allowable end play is .003 to .006 inch [,0762-,152 mm.]. If the crankshaft end play is greater than .006 inch the bearing flange is probably worn, which will necessitate bearing replacement.

D-55. Checking Crankshaft End-Play — Engine Out of Vehicle

Install the vibration damper bolt and washer. Mount a dial indicator on the front end of the

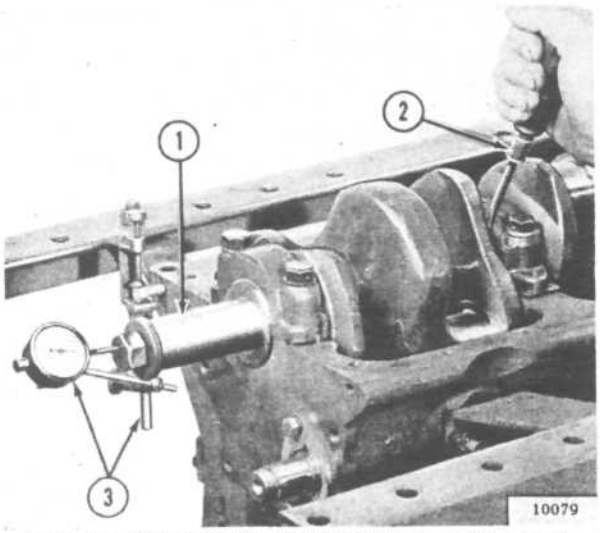


FIG. 52—CHECKING CRANKSHAFT END-PLAY

1—Crankshaft
2—Screwdriver
3—Dial Indicator

engine with the indicator button against the front end of the vibration damper bolt (Fig. 52). Move the crankshaft endwise to the rear as far as possible and set the indicator dial at zero. Then move the crankshaft forward, prying with a screwdriver as shown. The indicator reading is the total amount of end-play. Remove the dial indicator, cap screw and washer.

D-56. Checking Crankshaft End-Play — Engine in the Vehicle

When the engine is installed in the vehicle the end-play may be roughly checked by removing the clutch housing pan and moving the crankshaft backward and forward, while observing the amount of movement of the flywheel. Excessive end-play can only be caused by worn flanges on the rear main bearing.

D-57. Camshaft and Bearings

The camshaft is supported by four bearings (bushings) pressed into the cylinder block. The camshaft is chain driven from the timing gear at the front of the engine. A spiral gear, integral with the camshaft, drives the oil pump and distributor. The fuel pump is actuated by an arm which engages an eccentric on the camshaft. The camshaft bearings are pressure lubricated from the main oil gallery.

Because the plug at the rear of the cylinder block must be removed for accessibility, the camshaft bearings may only be replaced with the engine out of the vehicle.

D-58. Camshaft and Bearings Inspection

Clean the camshaft thoroughly in suitable cleaning solvent. Check the diameter of the camshaft journals with a micrometer. The specified journal diameters are as listed below:

CAMSHAFT JOURNAL DIAMETERS

Front	1.8725"-1.8735" (47.561-47.586 mm.)
Front Intermediate	1.8095"-1.8105" (45.961-45.986 mm.)
Rear Intermediate	1.7472"-1.7485" (44.378-44.411 mm.)
Rear	1.2475"-1.2485" (31.686-31.711 mm.)

If the camshaft journals are worn or out-of-round more than .001 of an inch [,0254 mm.] the cams are probably also worn and the camshaft should be replaced. The cam faces must not be scored or worn and must be perfectly smooth throughout their contact face. Run-out of the camshaft must not exceed .002 of an inch [,0508 mm.], measured with a dial indicator at the intermediate journals.

Inspect all four camshaft bearings to determine if they are loose in the cylinder block, scored, or if the oil holes are out of alignment. Using a telescope gauge and micrometer, check the inside diameter of each bearing (Fig. 53). The specified inside diameters are listed below:

CAMSHAFT BEARING BORES

Front	1.8745"-1.8755" (47.612-47.637 mm.)
Front Intermediate	1.8115"-1.8125" (46.012-46.037 mm.)
Rear Intermediate	1.7495"-1.7502" (44.437-44.452 mm.)
Rear	1.2495"-1.2505" (31.737-31.762 mm.)

Compare each journal diameter with the corresponding bearing diameter. If the bearings are defective or permit over .004 of an inch [,1016 mm.] running clearance, the bearings and/or the camshaft must be replaced.

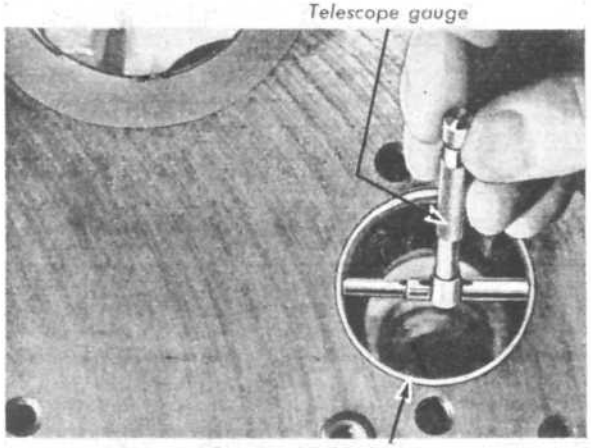


FIG. 53—CHECKING CAMSHAFT BEARING INSIDE DIAMETER

D-59. Camshaft Bearing Replacement

Replacement camshaft bearings are line bored in sets at the factory, and do not require additional machining. If it is found necessary to replace one bearing, all bearings must be replaced.

D-60. Camshaft Bearing Removal

To remove the camshaft bearings, remove the expansion plug from the rear camshaft bearing bore. Place all of the puller bushings into the bearings. Screw the two pieces of the puller bar together and slide the bar through the puller bushings in the bearings. Remove the bearings, one at a time, placing the slotted washer in the slot in the bar at the back of the bearing to be removed. Strike the nut end of the bar with the sliding weight to remove the bearing (Fig. 54).

D-61. Camshaft Bearing Installation

Install new camshaft bearings, one at a time, using the puller bushing that fits the bearing being installed. Install the pilots in the bores in the cylinder block and slide the replacer bar through the pilots and the puller bushing (with the bearing on it).

Fit the slotted washer into the slot in the bar at the back of the bearing to be installed. Align the

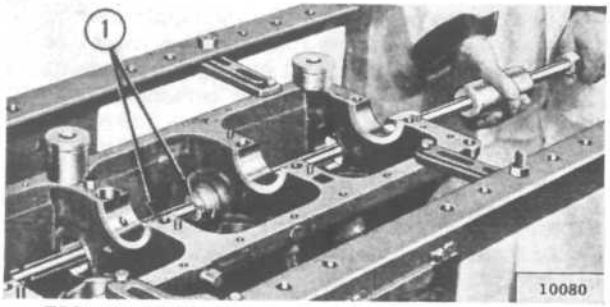


FIG. 54—REMOVING CAMSHAFT BEARINGS
1—Camshaft Bearing Remover and Replacer

bearing with the bore, making sure the oil hole in the bearing is in position to align with the oil hole in the bore. When installing the front bearing, the small groove leading from the oil hole must be toward the front of the cylinder block.

Strike the nut end of the replacer bar with the sliding weight to drive the bearing into place, centering it in the bore. Fig. 55. Clean out the expansion plug seat of the rear bearing bore. Apply Willys Perfect Seal Gasket Paste and install a new expansion plug.

D-62. Timing Gears, Chain and Cover

The timing gears are mounted at the front of the engine, a wide short chain providing the drive. The gears are keyed to their respective shafts. Lubrication is provided by a continuous stream of oil from the engine pressure system. The timing gears and chain are enclosed by the sealed timing chain cover.

Two types of timing chains and gears are in use (Fig. 56). The timing gears, chain and cover are accessible for inspection or replacement with the engine installed in the vehicle after removing the radiator, vibration damper and timing chain cover. Usually when one of the timing gears or the chain needs to be replaced, all of the parts should be replaced. When both of the gears and the chain are being replaced with new parts, "Morse Chain" and "Link Belt" makes of parts can be used interchangeably.

Engine S/N TW-6L-226-90919 and up
Engine S/N SW-6L-226-14188 and up

A new timing chain and gear set was installed in production with the starting engine serial numbers listed. A set consists of crankshaft gear, camshaft gear, and chain, and these components cannot be interchanged with the earlier parts. As a complete set, however, they can be installed on earlier engines.

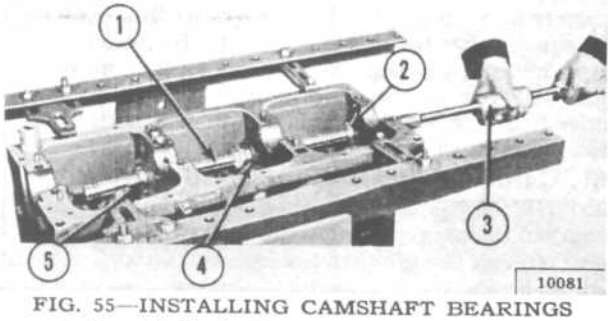


FIG. 55—INSTALLING CAMSHAFT BEARINGS
1—Camshaft Bearing Replacer
2—Pilot
3—Slide Hammer
4—Camshaft Bearing
5—Pilot

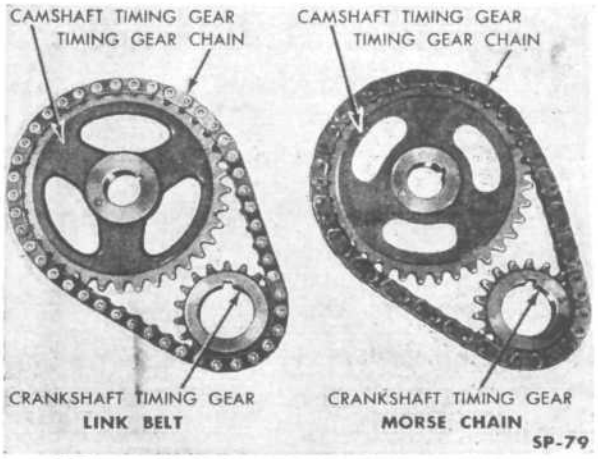


FIG. 56—TWO TYPES OF TIMING CHAINS AND GEARS

D-63. Inspection and Repair

Check the general condition of both gears and chain and inspect for evidence of excessive wear. Replace excessively worn or damaged gears or chain.

Check the chain for excessive wear or stretch. Press on one side of the chain midway between the crankshaft and camshaft gears. If deflection of the chain is more than ½" [1,8 cm.], the chain has been stretched or excessively worn and must be replaced.

Inspect the cover and replace if bent or damaged. It is recommended that the crankshaft oil seal in the cover be replaced while the cover is removed, to assure a good seal around the crankshaft.

D-64. Timing Chain Cover Oil Seal

Drive out the old seal and replace with a new seal, using an oil seal driver (Fig. 57). When installing the new seal, be sure that the cover is braced

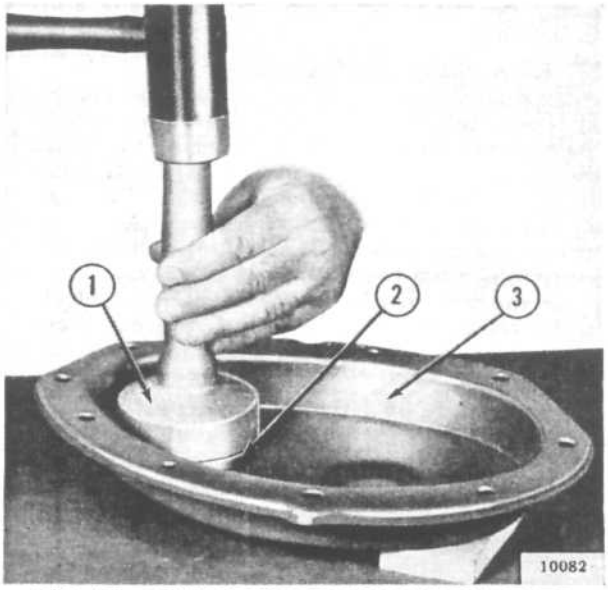


FIG. 57—INSTALLING TIMING CHAIN COVER OIL SEAL
1—Driver
2—Timing Chain Cover
3—Oil Seal

so that the oil seal opening flange is firmly flush on a flat surface. This will prevent cocking the new seal. Apply a thin coating of sealing compound around the outer edge of the seal and place the seal in the opening so that the seal lip faces toward the rear. Apply a non-acid lubricant thoroughly to the seal after installation.

D-65. Vibration Damper

The vibration damper is mounted on the front end of the crankshaft. The damper is designed to reduce the amplitude of torsional vibration set up in the engine. A distorted, broken or otherwise damaged vibration damper must be replaced.

D-66. Valves, Springs and Guides

The valves, springs and guides are installed in the cylinder block. The valve seats on the top of the cylinder block with the stem extending down through the guide and into the tappet chamber. The valve spring is assembled and locked on the lower end of the valve stem. The retaining lock is the split type, which fits in a recess on the valve stem and into the taper in the valve spring retainer. The valves, springs, and guides may be repaired or replaced with the engine in the vehicle when made accessible by removal of the tappet chamber cover and cylinder head.

D-67. Valves, Springs and Guides Inspection

Visually inspect all valves for excessive burning, warpage, or cracks and discard if such conditions exist. Measure the valve stem diameter with a micrometer. The intake valve stem diameter is .3414-.3406 of an inch [8,671-8,651 mm.]. The exhaust valve stem diameter is .3382-.3390 of an inch [8,590-8,610 mm.]. The specified valve stem to guide clearance is .0008-.0026 of an inch [,0203-,0660 mm.] for the intake valves and .0032-.0050 of an inch [.0812-,127 mm.] for the exhaust valves. Replace valves having worn stems. Thoroughly clean valves of all traces of carbon and then polish the valve stems with steel wool or crocus cloth.

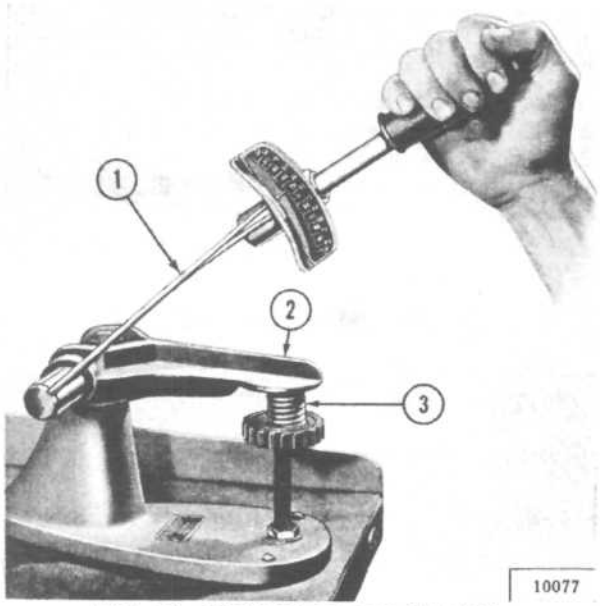


FIG. 58—TESTING VALVE SPRING

1—Torque Wrench 2—Spring Testing Fixture
3—Valve Spring

Valve springs must be thoroughly cleaned and then tested for tension, using a testing fixture and a suitable torque indicating wrench (Fig. 58). The spring tension, when the spring is compressed to $1^{21}/_{32}$ inches [42,06 mm.] in length, is 45 pounds [20,4 kg.], plus or minus $2^{1}/_{2}$ pounds [1,1 kg.]. Replace springs that are not within specifications.

Check valve guides in the cylinder block with "go" and "no go" gauge, if available, or a proper sized valve guide pilot. The inside diameter is .3432-.3422 of an inch [8,71-8,69 mm.] for both intake and exhaust valves. Any valve guide which is broken or has worn on the inside to cause excessive valve stem to guide clearance must be replaced. The guide must be a press fit in the cylinder block.

Check the alignment of the spring seat in the cylinder block with the valve guide bore. If evidence of valve stem scuffing or wear is present this condition can be corrected by increasing the valve spring seat bore diameter thus allowing the spring to center concentrically around the valve stem.

D-68. Refacing Valves

Refacing the valves may be accomplished with a valve refacer (Fig. 59). The manufacturer's instructions should be followed when using the refacing equipment.

Reface the intake valves to an angle of 30 degrees and the exhaust valves to an angle of 45 degrees. Take off only the minimum of metal required to clean up the valve faces. If the outer edge of the valve becomes too thin or sharp due to excessive grinding, the valve must be replaced. The valves must be lapped into the valve seats, using a suitable lapping compound, after the valve seats are refaced as described in Par. D-70.

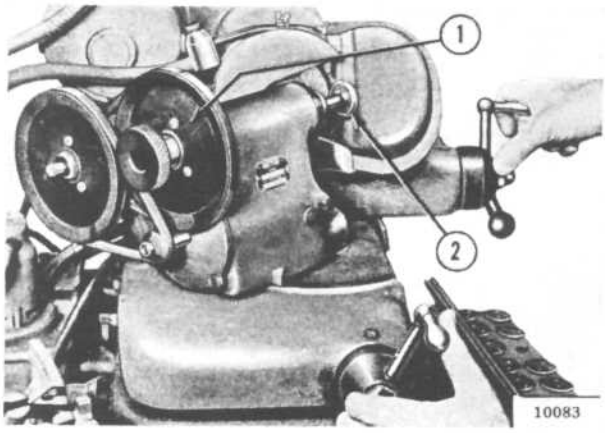


FIG. 59—REFACING VALVES

1—Valve Refacer
2—Valve

D-69. Exhaust Valve Seat Insert Replacement

Hardened valve seat inserts for exhaust valves were installed in production beginning with engine serial number SW-6-L-266-13815 and TW-6-L-226-81088. They will only occasionally require replacement.

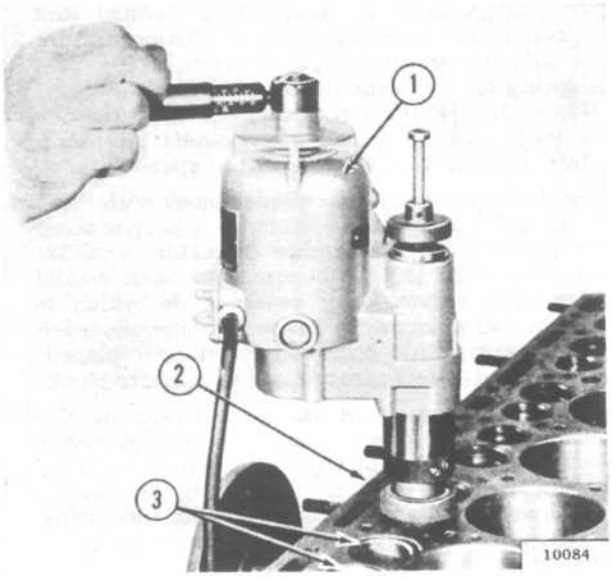


FIG. 60—REFACING VALVE SEATS

1—Valve Seat Refacer
2—Cylinder Block
3—Valve Seats

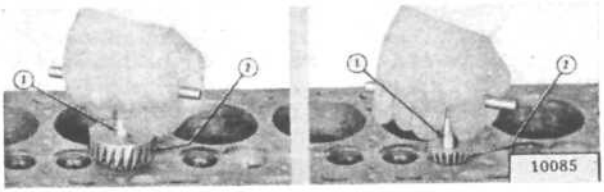
To avoid damaging the block, remove an insert with a tool designed for this purpose. When installing a new insert, make certain the counterbore is clean and smooth. Use an installer tool that will keep the insert in true alignment with the bore. Cool the insert and the installing tool with dry ice for 30 minutes. Immediately after removing a seat insert from the dry ice, position it over the counterbore. Make certain the valve seat is facing out. Drive the insert with the tool until it bottoms in the counterbore. After installation, check the valve seat for concentricity with the valve guide. Grind the valve seat using the procedure given in Par. D-70.

D-70. Valve Seat Inspection and Refacing

Inspect the valve seats for cracks, burns, pitting, ridges, or improper angle and reface. During any general engine overhaul it is advisable to reface the valve seats regardless of their condition. If valve guides are to be replaced, this must be done before refacing the valve seats.

Refacing the valve seats may be accomplished with a valve seat grinder in accordance with the manufacturer's instructions (Fig. 60).

The valve seat width after refacing should measure $\frac{5}{64}$ to $\frac{3}{32}$ of an inch [1,98-2,38 mm.] for intake valves and $\frac{3}{32}$ to $\frac{7}{64}$ of an inch [2,38-2,78 mm.] for exhaust valves. The width may be checked by placing a scale across the face of the seat (Fig. 150). If the width of the seat is greater than specified it should be narrowed by removing stock from the top of the seat with a valve seat relief counterbore and if necessary from the lower edge of the seat with a 70° valve seat cutter (Fig. 61 and 62).



NARROWING WIDTH OF VALVE SEAT

FIG. 62:
1—Pilot
2—Relief Counterbore

FIG. 63:
1—Pilot
2—Narrowing Cutter

The proper method of valve seat refacing when using a valve seat relief counterboring set and a 70° valve seat narrowing cutter is outlined below. Seat width should always be narrower than the valve face as illustrated by A in Fig. 64. Wide valve seats tend to collect carbon while narrow valve seats prevent the valve head from rapidly dissipating heat to the block.

Valve ports in L6-226 engines are not machined perpendicular to the centerline of the crankshaft, therefore the valve head sets at an angle in relation to the top surface of the block when properly assembled in its guide (see B in Fig. 64).

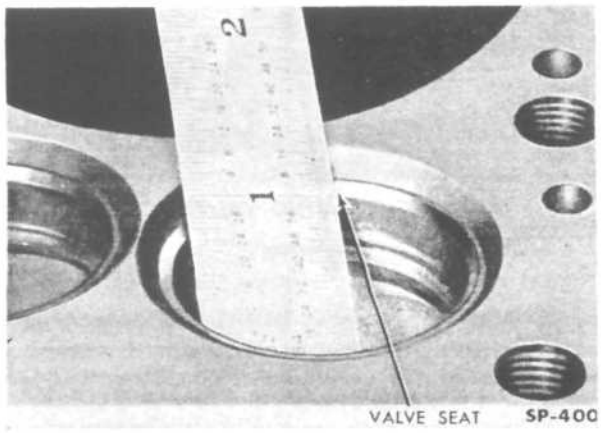


FIG. 61—CHECKING VALVE SEAT WIDTH

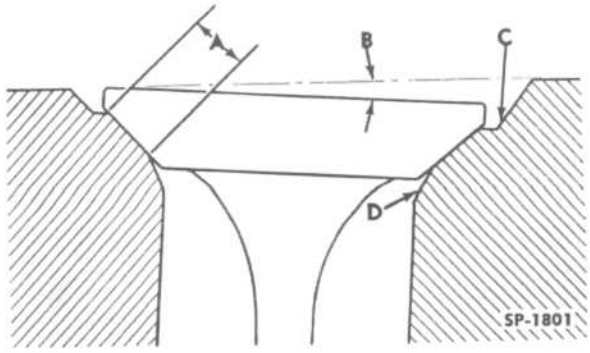


FIG. 64—PROPERLY REFACED VALVE SEAT

When a valve seat has been refaced several times or where it must be cut deeply for adequate reconditioning, the seat may become too wide for efficient operation and/or a high shoulder may be left in the block. In such cases, the counterbore in the surface of the block must be recut. Also, narrow the valve seat (shown at C in Fig. 64). This operation is performed only **after** the valve seats have been refaced and then only when necessary.

If the counterbore in the block is satisfactory and the valve is setting high on the valve seat, a 70° valve seat narrowing cutter may be used with a pilot to increase the inside diameter of the valve port thereby reducing the seat width from the lower inside edge of the seat as shown by D in Fig. 64. In some cases, it is necessary to obtain proper concentricity of the diameter at the lower inside edge of the seat, or to clean up any roughness in the valve port that is evident just below the valve seat.

CAUTION: When using valve seat cutting tools, care must be taken to remove only the minimum amount of metal necessary to satisfactorily accomplish that phase of the operation being performed. Excessive removal of material may damage the block beyond repair by factory approved methods, or nullify the reconditioning work that had been accomplished on the valve seat up to that point.

A simple check can be made to prove the fit of the valve in the valve seat by spreading a thin film of prussian blue on the valve face and then inserting the valve into the valve seat (Fig. 65). With hand pressure, rotate the valve a quarter of a turn and then remove the valve and observe the transfer of prussian blue to the valve seat. An uneven transfer of prussian blue will indicate an inaccurate valve and valve seat refacing operation.

D-71. Valve Guide Replacement

Damaged, loose, or worn valve guides must be replaced. The guides may easily be removed with Valve Guide Remover and Replacer KF-27 (Fig. 66). If a valve guide is loose in the cylinder block, the valve guide bore should be reamed and an oversize guide should be installed.

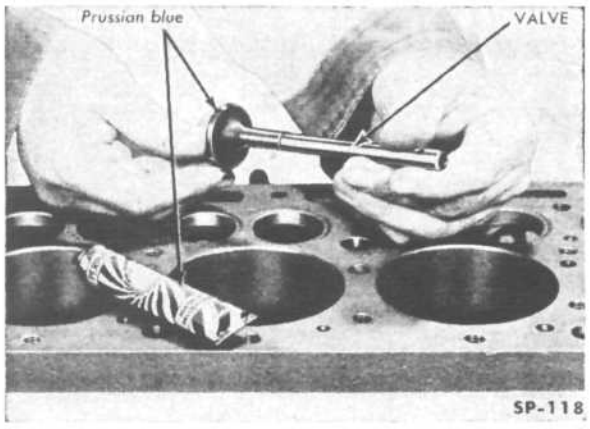


FIG. 65—CHECKING FIT OF VALVE IN VALVE SEAT

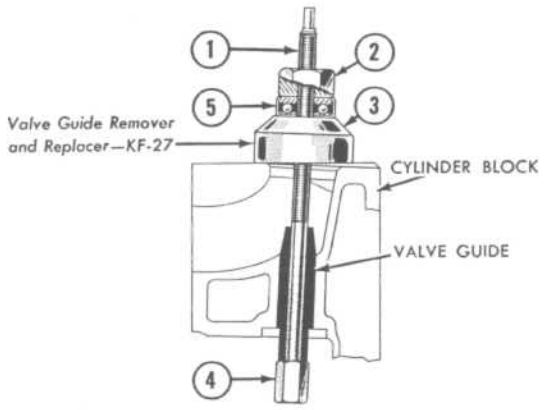


FIG. 66—REMOVING VALVE GUIDE FROM CYLINDER BLOCK

Assemble the tool as shown in Fig. 66, using the angular spacer (3), with the thickest part of the spacer toward the manifold side of the cylinder block, and the small nut (4) at the end of the shaft inside the valve chamber. Be sure to place the thrust bearing with the rotating face toward the nut on the outside end of the tool. Hold the shaft (1) to prevent rotation and tighten the nut (2) until the valve guide is pulled free.

Check the valve guide bore in the block as well as the outside diameter of the new valve guide for size, to obtain .0005-.003 of an inch [,0127-,0762 mm.] press fit. Valve guides are available in .0005 and .0055 of an inch [,0127-,139 mm.] oversizes, marked "A" and "L" respectively for identification.

To replace a valve guide, place the guide (tapered end toward the top of the block) in the proper position in the bore. Assemble Valve Guide Remover and Replacer KF-27 as shown in Fig. 67, using the collar (8) with the proper end set into the valve port bore as required, and the recessed nut (6) at

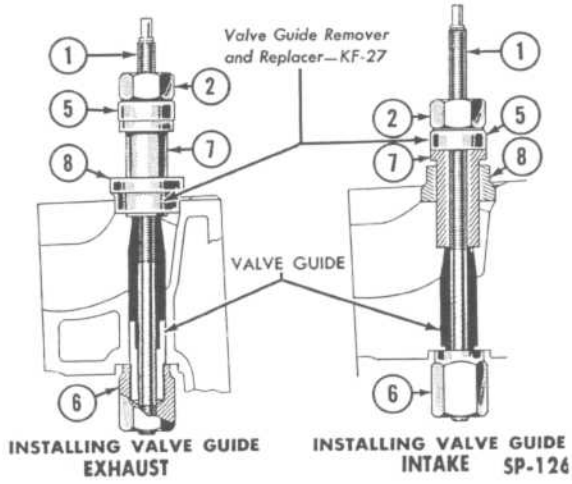


FIG. 67—INSTALLING VALVE GUIDE IN CYLINDER BLOCK

the end of the shaft inside of the valve chamber and the sleeve (7) at the top of the shaft. Hold the shaft (1) to prevent rotation and tighten the nut (2) until the valve guide top end is 1 7/32 inches [30,95 mm.] below the top face of the cylinder block.

Use Valve Guide Reamer C-249 to ream the valve guides to .3432-.3422 inch [8,71-8,69 mm.] diameter (Fig. 68).

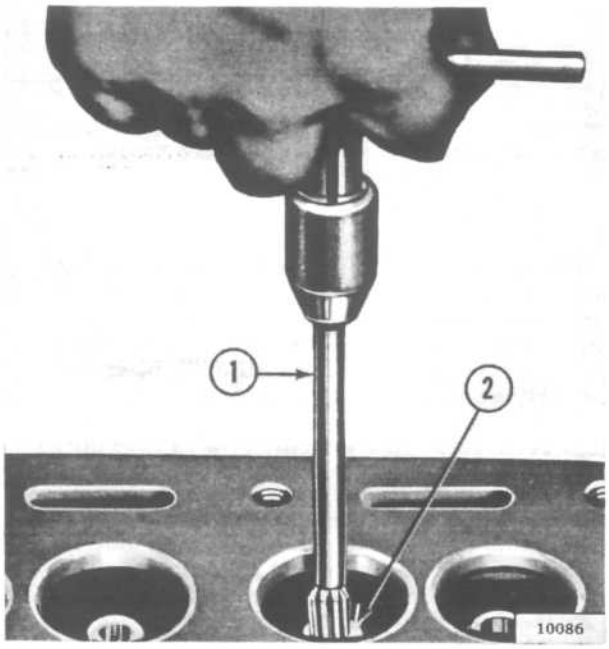


FIG. 68—REAMING VALVE GUIDE

1—Reamer
2—Valve Guide

D-72. Tappets and Cover

The tappets, like the camshaft, are made of steel.

A mushroom type, two piece self-locking tappet is used in Model L6-226 engine. The tappets, operating directly on the lobes of the camshaft, are housed in bores of the cylinder block tappet chamber. The tappets are adjustable to maintain the specified clearance between the tappet and valve stem. Tappets are available in standard size and .001, .002 and .005 inch [,0254, ,0508, ,127 mm.] oversizes. Oversize tappets are identified by a letter on each tappet as follows: .001 oversize is identified by the letter "B", .002 is "D" and .005 is "K".

The tappet chamber cover includes an integral ventilator tube to provide crankcase ventilation. The cover is mounted on the cylinder block to cover the tappet chamber and prevent the loss of oil.

Inspect each tappet carefully. Worn, scored or damaged tappets must be replaced. Standard tappet diameter is .6855-.6860 of an inch [17,41-17,42 mm.]. Tappets are a selective fit in the tappet bores. Proper tappet fit may be determined by rotating the tappet in the bore; if properly fitted, a slight drag should be evident. If the tappet is loose, selectively fit another standard or an oversize tappet, or ream the bores to accommodate the next oversize tappet (Fig. 69).

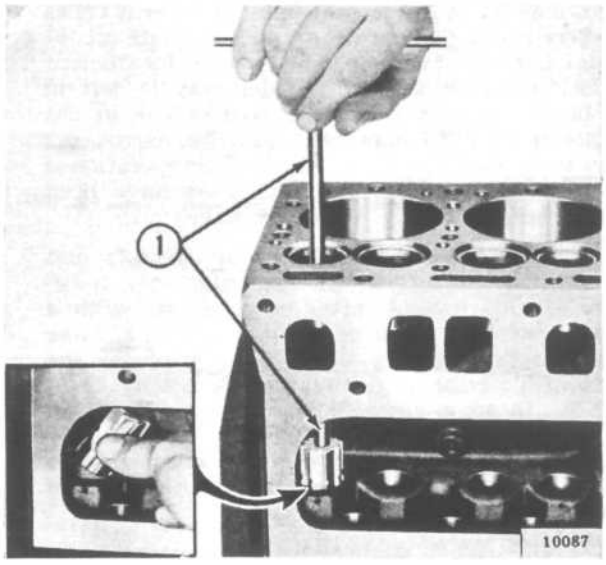


FIG. 69—REAMING TAPPET BORES

1—Reamer

D-73. Crankshaft Rear Oil Seal

The rear end of the crankshaft is sealed against oil leaks by the gaskets (or seals) of the rear filler block and filler block guard. The filler block guard is mounted in a recessed groove of the cylinder block and is held in position by the filler block, with the gasket (or seal) fitting snugly against the crankshaft.

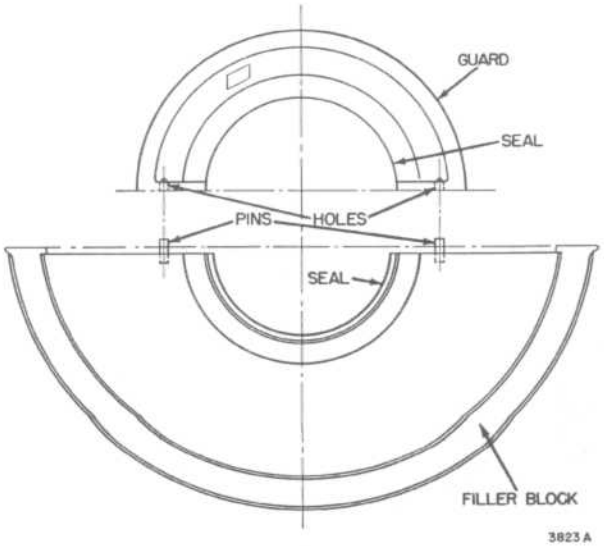


FIG. 70—CRANKSHAFT REAR FILLER BLOCK DOWEL PINS

A new rear bearing oil seal assembly designed to reduce the possibility of leakage at the rear oil seal entered production with engine serial numbers SW-6-L-226-13542 and TW-6-L-226-74176. The improved rear bearing filler block is provided with dowel pins, as shown in Fig. 70. The guard assembly has holes to mate with the pins on the filler block.

NOTE: With this assembly, the oil pan side gaskets must have a hole in the proper location for the pins. See Par. D-109.

Whenever a filler block and guard are removed that do not have the dowel pins, they should be replaced with this new assembly. For converting to the doweled block and guard, a special Rear Oil Seal Service Kit with all the necessary parts is available.

The filler block is bolted to the cylinder block with the gasket (or seal) fitting snugly against the crankshaft (Fig. 71).

The filler block and guard are removable for gasket replacement with the engine installed in the vehicle when made accessible by removing the oil pan.

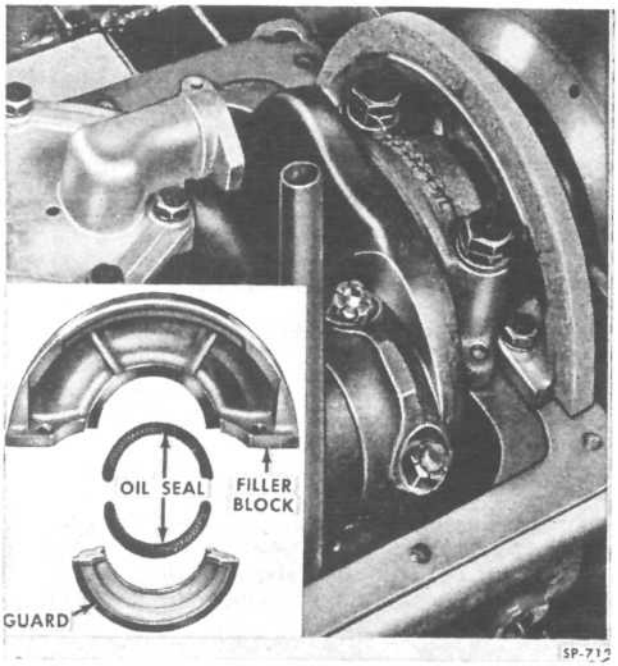


FIG. 71—CRANKSHAFT REAR OIL SEAL AND FILLER BLOCK

D-74. Crankshaft Rear Filler Block Guard

Clean the crankshaft rear filler block guard thoroughly. Remove and discard the gasket (or seal) and clean the groove in the guard. A graphite impregnated oil seal should be used when replacement of the gasket is necessary.

To install the oil seal, slightly flatten the seal and insert it in the groove, seating it firmly by rolling with a mandrel. Roll from the ends toward the center of the seal. The ends of the seal should extend slightly beyond the flat surface of the guard. In order that this seal may be effective against oil leakage, it must be centered with respect to the crankshaft and exert uniform pressure all the way around the crankshaft. No shellac or sealing compound is needed between the oil seal and the groove in the guard.

D-75. Crankshaft Rear Filler Block

Clean the rear filler block thoroughly. Remove the cork gasket (or seal) material and carefully clean the grooves. Lightly coat the contact surfaces of the oil pan end gasket with Willys Perfect Seal Gasket Paste and place the gasket in the groove in the filler block.

To install the oil seal, insert it in the groove and seat it firmly by rolling with a mandrel. Roll from the ends toward the center of the seal. The ends of the seal should extend slightly beyond the flat surface of the filler block (Fig. 72).

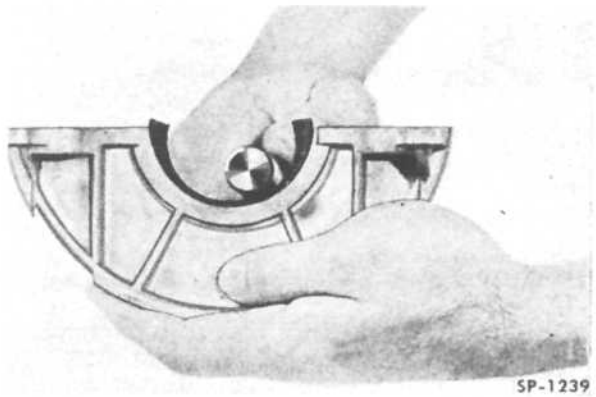


FIG. 72—INSTALLING OIL SEAL IN CRANKSHAFT REAR FILLER BLOCK

D-76. Crankshaft Front Filler Block

The front filler block is mounted to the cylinder block and front end plate. A gasket cemented in the groove of the filler block provides the front seal for the oil pan.

The filler block gasket may be replaced with the engine installed in the vehicle, after it has been made accessible by removal of the oil pan.

D-77. Oil Pump

The engine is pressure lubricated by means of a submerged, gear-type, oil pump (Fig. 73) located in the oil pan. The pump, gear driven by the camshaft, draws oil through a floating oil screen and forces it under pressure to the main oil gallery, and thence to all main, connecting rod and camshaft bearings, as well as to the tappets, timing chain and gears. The cylinder walls and pistons are supplied with oil from spurt holes in the lower ends of the connecting rods. The pressure at which the oil relief valve opens with standard setting is approximately 35 lbs. [2,46 kg-cm^2]. Safe minimum pressure is 6 lbs. [0,421 kg-cm^2] at idle and 20 lbs. [1,406 kg-cm^2] at 2000 rpm. (35 mph. [56 k.]).

The oil pump may be removed for repairs or replacement with the engine installed in the vehicle after it is made accessible by removal of the oil pan.

D-78. Oil Pump Disassembly

Before disassembling the oil pump clean it thoroughly in a suitable cleaning solvent.

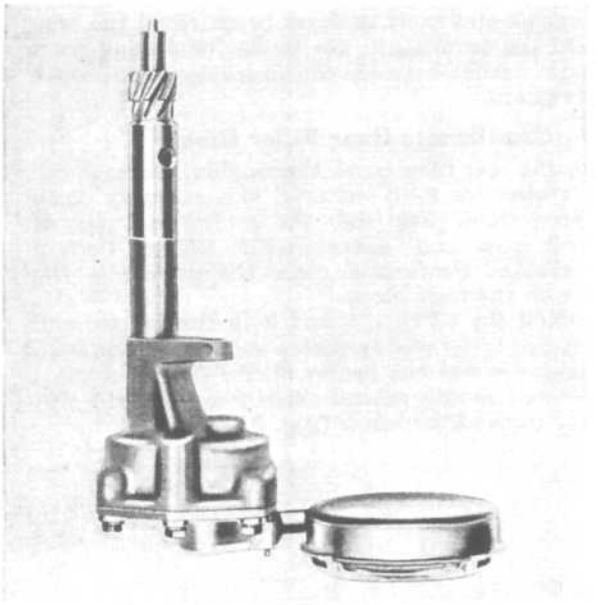


FIG. 73—OIL PUMP AND SCREEN

a. Remove the cotter pin attaching the float to the pump. Remove the float from the pump.
b. Remove the pump cover and gasket. Discard the gasket.
c. Drive out the pin that secures the camshaft drive gear to the oil pump drive shaft.
d. Using a suitable drift, drive out the drive shaft (Fig. 74).
e. Remove the idler gear from the pump body.

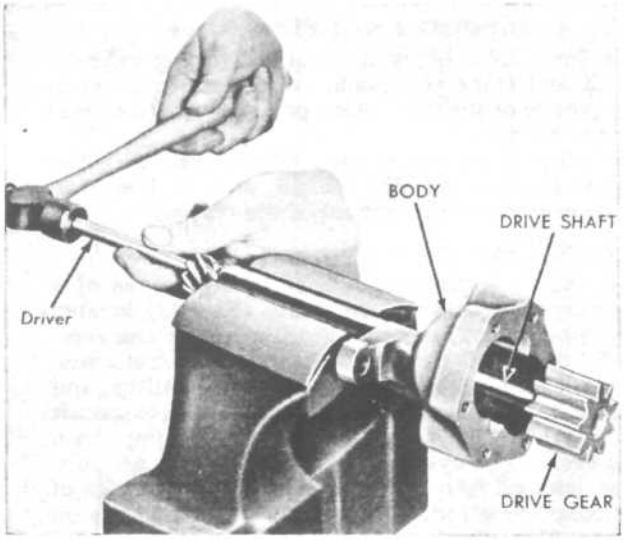


FIG. 74—REMOVING OIL PUMP DRIVE SHAFT AND GEAR

f. Remove the idle gear shaft (if necessary).
g. Remove the drive gear from the drive shaft. The gear is pressed on and keyed to the shaft.

D-79. Inspection and Repair

Replace the oil pump body if it is cracked or damaged. If the oil pump body bushing is worn to permit a clearance of over .005 of an inch [,127 mm.] measured between the gear teeth and the pump body (Fig. 75), the bushing must be replaced and line reamed to .500-.501 of an inch [12,70-12,72 mm.] diameter.

If the drive shaft is worn it must be replaced. Specified drive shaft diameter is .4990-.4985 of an inch [12,67-12,66 mm.]. If the cover plate is worn from contact with the gears or if it is cracked, it must be replaced. Using the edge of a steel scale

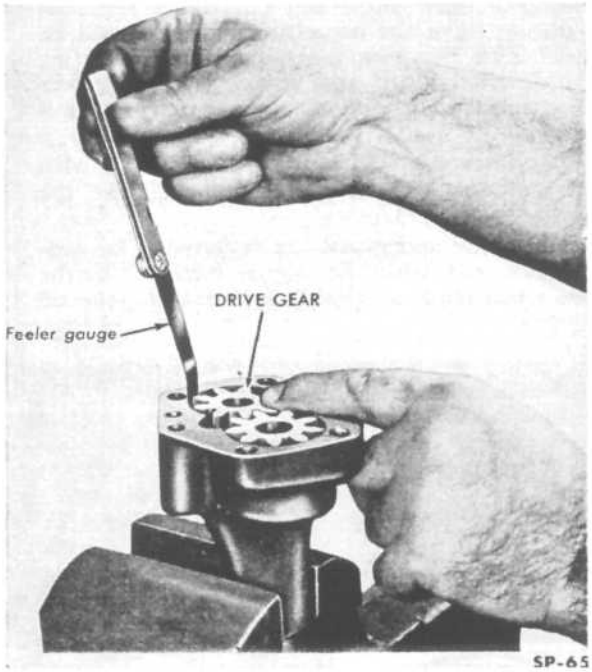


FIG. 75—CHECKING GEAR TOOTH TO BODY CLEARANCE

placed across the bottom face of the pump gears check the clearance between the scale and the face of the pump body with a feeler gauge (Fig. 76). This clearance must be .001-.004 of an inch [,0254-,1016 mm.].

If the teeth of the gears show excessive wear, the gears should be replaced. However, if inspection of various parts indicates extensive wear it is recommended that the oil pump assembly be replaced.

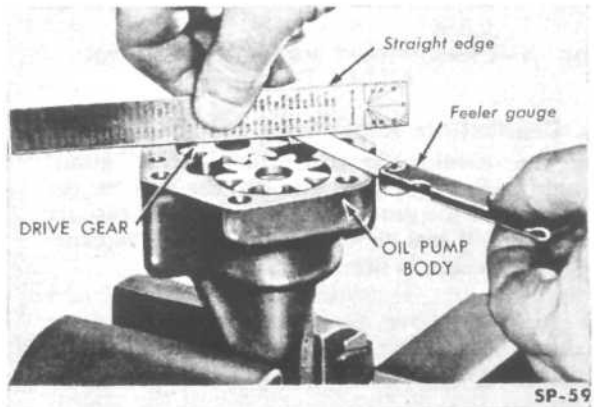


FIG. 76—CHECKING GEAR TO COVER CLEARANCE

The float assembly should be thoroughly cleaned and blown out with compressed air. Replace the float if it or the screen is damaged.

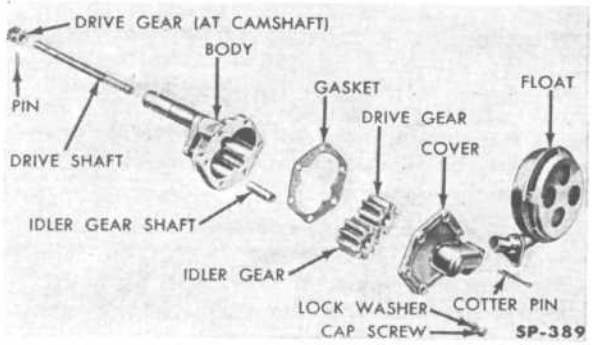


FIG. 77—OIL PUMP

D-80. Oil Pump Assembly

(Fig. 77). After inspection and repair of the oil pump components assemble the pump as follows:

a. Press the gear on the drive shaft with the hole in the gear and in the shaft aligned. Install a new pin and peen the ends of the pin, making sure they are flush with the outside diameter of the gear. If a new shaft is to be installed it is furnished with a new camshaft gear already assembled.
b. Install the drive shaft and gear assembly in the oil pump body.
c. Press the drive gear on the lower end of the drive shaft, using a new key. As indicated in Fig. 78 the gear should be pressed onto the shaft until there is .002-.004 of an inch [,0508-

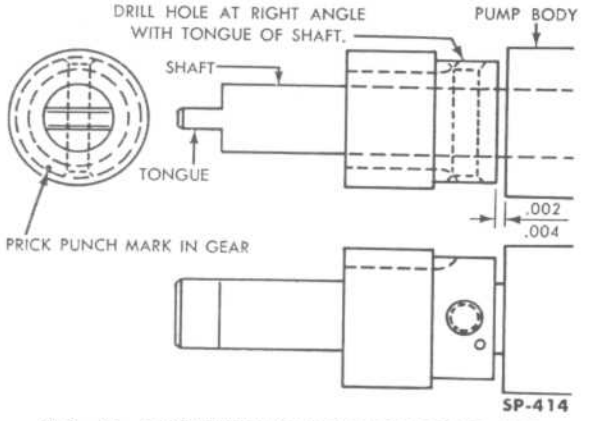


FIG. 78—LOCATING CAMSHAFT GEAR ON OIL PUMP SHAFT

,1016 mm.] clearance measured between the end of the camshaft gear and the pump body.
d. Press the idler gear shaft into the oil pump body and install the idler gear on the shaft.
e. Install a new gasket and the pump cover. **NOTE:** Effective with engine serial numbers SW-6-L-226-13509 and TW-6-L-226-74081, a production change was made to include a tab lock washer under each of the six oil pump cover screws. The installation of these tab lock washers will eliminate the possibility of the cover coming loose. Install the tab lock washers on all pump cover screws without them.
Torque the oil pump cover screws 7 to 10 lb-ft. [1,0 a 1,4 kg-m.].
f. Install the oil pump float on the cover and secure it with a cotter pin.
g. Rotate the drive shaft. The shaft and gears must rotate freely.

D-81. Oil Pump Bushing (In Cylinder Block)

Replace the oil pump bushing if it is worn or loose in the cylinder block bore. A loose bushing may slip out of place and restrict the oil gallery.

The bushing may be driven out with a suitable drift inserted in the distributor drive shaft bore from the top of the cylinder block. Install the bushing from the bottom of the cylinder block, using a suitable driver. The bushing must be flush with the bottom of the cylinder block and must not restrict the oil gallery.

D-82. Oil Pan

Examine the oil pan carefully for evidence of corrosion, dents, or other damage. Replace with a new pan if necessary. Special attention must be given to the bolting flange to assure proper alignment and a tight seal at the cylinder block. Whenever the oil pan is removed, replace all gaskets regardless of condition.

D-83. Flywheel

The flywheel is mounted to the rear flange of the crankshaft. The crankshaft, flywheel, and clutch assembly are statically and dynamically balanced separately and as a unit; therefore, the components should be assembled in their original relative positions to maintain this balance, if possible.

D-84. Flywheel Inspection

Inspection should be done only when assembling the flywheel to the crankshaft when assembling the engine. Clean the flywheel thoroughly with a suitable cleaning solvent and wipe dry. Inspect the clutch face of the flywheel for burned condition, rivet grooves or scuffed condition.

Check the flywheel for run-out, warping, and wear. Mount the flywheel on the crankshaft, with the crankshaft in the cylinder block. Mount a dial indicator with the contact button of the indicator resting against the clutch face of the flywheel (Fig. 79). Set the indicator at zero and rotate the flywheel. Maximum allowable run-out is .005" [0,127 mm.].

Relocate the dial indicator and check the run-out on the surface where the clutch pressure plate cover bolts to the flywheel. Maximum allowable run-out is .005 of an inch [,127 mm.]. Excessive run-out at the bolt circle or the clutch face will seriously affect clutch action; therefore, it is recommended that the flywheel be replaced if the run-out exceeds the specified limits.

Inspect for worn, broken or chipped ring gear teeth and replace the ring gear if necessary. Stripped threads in the tapped holes for pressure plate cover will require replacement of the flywheel.

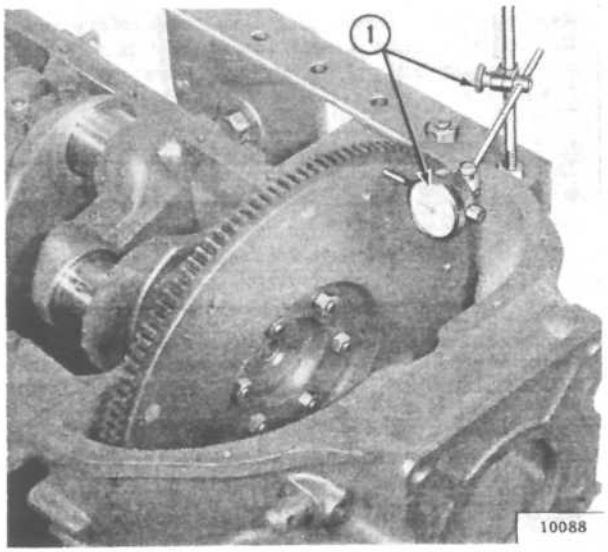


FIG. 79—CHECKING FLYWHEEL RUN-OUT

1—Dial Indicator

D-85. Ring Gear Replacement

To remove the ring gear from the flywheel, drill a 3/8 inch [9,52 mm.] hole through the ring gear and cut through any remaining metal with a cold chisel. Remove the ring gear from the flywheel. Thoroughly clean the ring gear surface of the flywheel. Heat the new ring gear evenly to 650°-700°F. [343°-371° C.], and place it on the cold flywheel, making certain that the chamfer on the teeth is opposite the clutch side of the flywheel. Be sure that the ring gear is firmly seated on the flywheel. Allow the ring gear to cool slowly to shrink it onto the flywheel.

D-86. Clutch Housing

The clutch housing, which encloses the flywheel and clutch, is bolted to the cylinder block. A removable pan, bolted to the bottom of the housing, provides access to the clutch and flywheel. The rear of the housing provides the front support for the transmission.

Examine the housing for cracks and distortion of the machined surfaces. The front face must seat evenly against the cylinder block or engine rear end plate without evidence of warpage. The rear face must be parallel to the front face. Improper alignment will seriously affect the alignment of the power train. In addition the hole in the rear of the housing, which serves as a pilot for the transmission, must be concentric with the crankshaft.

With the clutch housing installed, the run-out of the pilot hole and the rear face of the housing can be checked with a dial indicator. Install a clutch plate aligning arbor on the crankshaft pilot bushing, expanding it so that it is tight and will not wobble. Then attach the dial indicator to the arbor with the indicator button resting against the rear face of the clutch housing.

Rotate the flywheel, noting the run-out on the indicator. Maximum allowable run-out is .005 of an inch [,127 mm.]. Relocate the dial indicator so that the indicator button will indicate the run-out of the pilot hole in the clutch housing. Rotate the flywheel and note the run-out which should not exceed .006 of an inch [,152 mm.].

If desired, a suitable fixture can be made to attach to the flywheel with one of the flywheel bolts, provided the clutch is not installed on the flywheel, so that the dial indicator can be mounted on it to check the clutch housing run-out. **NOTE: Clutch housing run-out should be checked after the clutch housing is installed when assembling the engine.**

D-87. Core Hole Expansion Plugs

Any evidence of coolant leakage around the core hole plugs will require plug replacement. There are five plugs in the left side of the cylinder block and one at the rear (Fig. 80).

The plugs can be replaced with the engine installed in the vehicle.

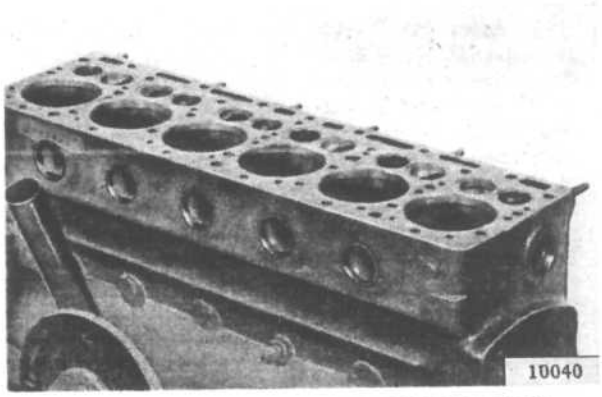


FIG. 80—CORE HOLE EXPANSION PLUGS

The expansion plugs may be removed by drilling a 1/2 inch [12,7 mm.] hole through the expansion plug, drilling as close as possible to the flange of the plug. Cut through the flange with a hacksaw blade being careful not to cut into the cylinder block. Drive a small drift between the flange and block where the cut was made. Pry the plug out of the block.

Before attempting to install the new plug, clean the hole in the block thoroughly. Apply a thin coat of Willys Perfect Seal Gasket Paste on the plug. Install the plug.

D-88. Cylinder Head

Replace the cylinder head if cracked, or warped 1/32 inch [,793 mm.] or more over the full length of the head. If any tapped hole for spark plugs or water temperature gauge has damaged threads which cannot be cleaned up with the proper tap, or if the threads are stripped, replace the cylinder head. Be sure that all water passages are open and that all carbon is removed.

D-89. ENGINE ASSEMBLY

The engine assembly procedure in the following paragraphs is given in the sequence to be followed when the engine is being completely overhauled.

Individual inspection, repair, and fitting operations previously detailed are to be performed when necessary throughout the assembly procedure.

The assembly procedure does not cover accessories. If a new cylinder block fitted with pistons is used many of the operations will be unnecessary. Most of the operations as given are also applicable with the engine installed in the vehicle.

D-90. Install Oil Gallery Plug

Dip plug threads in suitable sealing compound and install the plugs in the front and rear ends of the oil gallery.

D-91. Install Tappets

The tappets and camshaft can be installed while the engine is in the car if the radiator, timing gear cover, oil pan, cylinder head and camshaft have been removed as detailed in Par. D-25. Insert the tappets in the proper locations after the adjustment screw has been turned down to leave about ¼ inch [6,35 mm.] of adjustment remaining. Be sure that all tappets fit snugly in their respective bores. Refer to Par. D-72 for the fitting procedure.

D-92. Install Camshaft and Thrust Plate

Lubricate all camshaft bearings and cam surfaces generously with clean light engine oil. Install the camshaft, locating it properly in the bearings. Install the camshaft thrust plate with two bolts and lockwashers. Tighten the bolts to 12-15 foot pounds torque [1,6-2,0 kg-m.].

D-93. Install Oil Drain Tube

Install the oil drain tube with the clip, lockwasher, and nut previously removed. Be sure that the tube is installed in the drain hole, the top end flush with the bottom of the valve chamber.

D-94. Install Crankshaft Rear Filler Block Guard

Apply Willys Perfect Seal Gasket Paste to the outer edge and shoulder of the rear filler block guard. Install the guard in the cylinder block. Make certain that the seal is concentric with and accurately fits the crankshaft to eliminate any oil leak at this point. Refer to Par. D-73 for the fitting procedure.

D-95. Install Crankshaft and Bearings

If any of the bearing cap dowels have been bent during bearing cap removal, remove those dowels and install new ones. Be sure the dowel hole is clean before installing a new dowel. Check that the new dowel is started straight and bottoms in the hole.

Fit the four upper main bearings into their respective locations in the cylinder block. Fit the four lower main bearings into their respective bearing caps.

Lubricate all bearing surfaces generously with clean light engine oil. Place the crankshaft in position in the cylinder block and install the main bearing caps. Tighten the bolts to 85-95 foot pounds [11,7-13,1 kg-m.] torque, rotating the crankshaft after the installation of each bearing cap is completed (Fig. 81). Install lock wire in the bearing cap bolts of the front, front intermediate and rear bearings. The rear intermediate bearing cap bolts must not be wired until after the oil pump is installed. Refer to Par. D-45 for information on fitting main bearings.

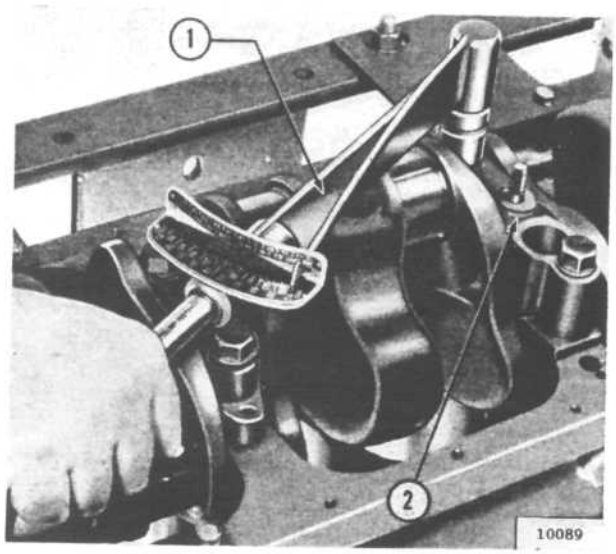


FIG. 81—TIGHTENING MAIN BEARING CAP BOLTS

1—Torque Wrench
2—Main Bearing Cap

D-96. Install Front End Plate

Apply a thin coat of Willys Perfect Seal Gasket Paste to both sides of the front end plate gasket and assemble the gasket to the front end plate. Install the front end plate on the cylinder block. Tighten the 5/16 inch [7,9 mm.] diameter bolts to 12-15 foot pounds torque [1,6-2,0 kg-m.] and the 7/16 inch [11,1 mm.] diameter bolts to 40-50 foot pounds torque [5,5-6,9 kg-m.].

D-97. Install Oil Pressure Relief Valve

Be certain that the recess in the cylinder block is clean and that all pressure relief valve parts are clean, then install the valve, spring, washer (if used), plug gasket, and the plug. Tighten the plug securely. Refer to Fig. 31.

D-98. Install Flywheel Housing

Be certain that the mating surfaces of the clutch housing and cylinder block are clean and smooth. Place the clutch housing in position and attach to the cylinder block, installing the long bolts with the lockwasher and nuts on the flywheel housing side. Install the two lockwashers and bolts in the two top center holes. Install the remaining lockwashers and bolts. Tighten all bolts securely. Check the clutch housing alignment as described in Par. D-86.

D-99. Install Flywheel

Be sure that the crankshaft flange to flywheel mating surfaces are clean to permit proper flywheel alignment. Place the flywheel on the mounting bolts on the crankshaft (Fig. 82). The bolts are so spaced that the flywheel will fit in only one position. Assemble the lockwashers and nuts to attach the flywheel, tightening the nuts alternately

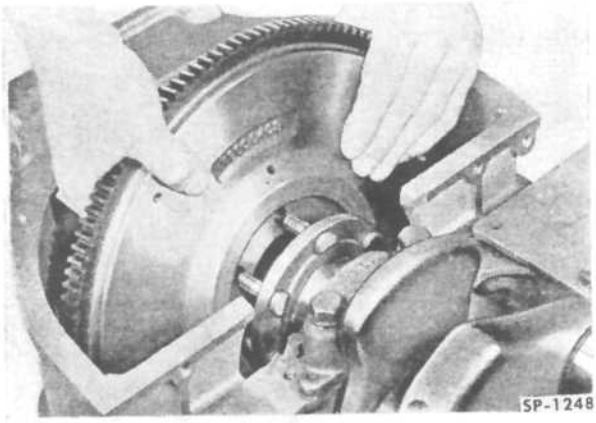


FIG. 82—INSTALLING FLYWHEEL ON CRANKSHAFT

and evenly until each nut is tightened to 35–40 foot pounds torque [4,8-5,5 kg-m.]. Refer to Par. D-83 for checking flywheel alignment.

D-100. Install Clutch

To install the clutch assembly with the engine out of the vehicle, use Clutch Plate Aligning Arbor C-360. Placing the clutch disc in position against the flywheel, insert the Arbor into the crankshaft pilot bushing and against the clutch disc expanding the arbor in the bushing to hold it in place (Fig. 83). Hold the clutch pressure plate assembly in position against the clutch disc and install the six attaching bolts and washers tightening the bolts alternately and evenly. Remove the arbor.

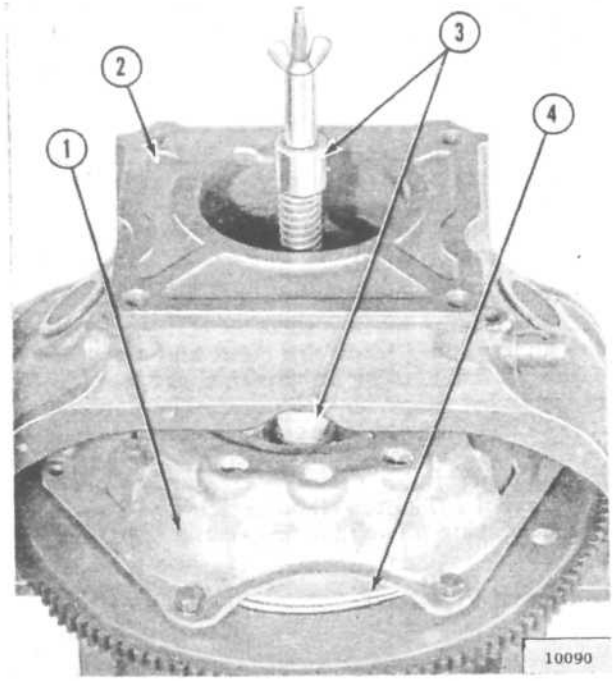


FIG. 83—INSTALLING CLUTCH ON FLYWHEEL

1—Pressure Plate Assembly
2—Clutch Housing
3—Clutch Arbor
4—Clutch Disc

D-101. Install Valves and Springs

Install valve springs and retainers by slipping the top end of the spring onto the bottom end of the valve guide and with a large screwdriver pry the spring and washer over the tappet adjusting screw. Make certain that the two close wound coils of each spring are at the top.

Insert all intake and exhaust valves in their proper locations. Using a valve spring lifter (refer to Fig. 23), compress the springs, while holding the valves down, so that the valve stem extends through the valve spring retainer far enough to permit installation of the valve spring locks. Heavy lubricating oil or grease placed on the inside surface of the valve locks will help to hold the locks on the valve stem until the valve spring lifter can be removed. After the valves are installed check the spring height of each spring with the valves in the closed position. If the spring extends down beyond the mean of the gauge, install a service shim on top of the spring.

Adjust the valve tappets to the proper specified clearance. Refer to Par. D-117 for specifications and adjustment procedure.

D-102. Install Timing Gears and Chain

Set the timing gears into the timing chain so that the timing marks on the two gears are exactly nine links or ten pins apart. Refer to Fig. 26. Place the small gear of the assembly on the crankshaft and the large gear on the camshaft after the Woodruff keys are placed in their respective keyways (Fig. 84).

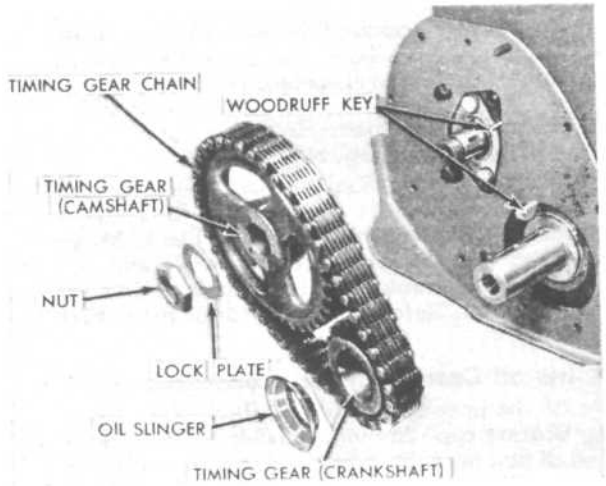


FIG. 84—TIMING GEARS AND CHAIN

The gears should slip onto the shafts (after the shafts are rotated to properly align the keyways) with finger pressure. If the camshaft gear must be tapped onto the shaft make certain that the camshaft bearing journals are not contacting the side of numbers 1, 5, or 9 tappets (Fig. 85).

This interference may exist if the camshaft has moved to the rear from its normal position during the installation of the camshaft timing gear. The camshaft must be held forward while the timing

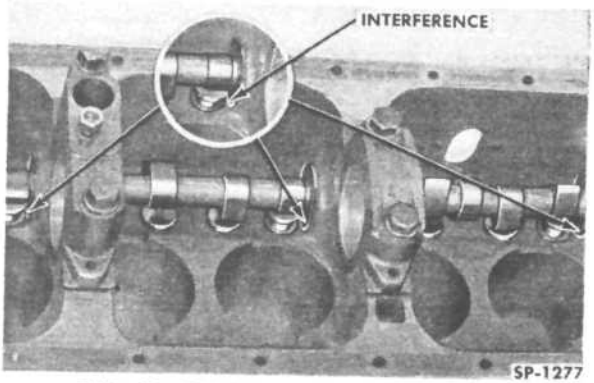


FIG. 85—CAMSHAFT JOURNAL AND TAPPET INTERFERENCE

gears are tapped on, to prevent damaging the tappets.

When the timing gears are fully seated, place the lock plate on the end of the camshaft, with the tab in the hole in the camshaft timing gear. Install the timing gear retaining nut and tighten to 35–40 foot pounds torque [4,8–5,5 kg-m.]. Bend up a section of the lock plate against the hex flat of the timing gear nut. Install the crankshaft oil slinger on the crankshaft, against the timing gear.

D-103. Install Timing Chain Cover

Apply a thin coat of Willys Perfect Seal Gasket Paste to both sides of the timing chain cover gasket. Position the gasket on the timing chain cover. Place Timing Cover Oil Seal Installing Sleeve KF-28 on the front end of the crankshaft and carefully locate the timing chain cover on the front of the cylinder block, using the sleeve as a guide and to prevent damaging the seal. Attach the cover with the bolts, lockwashers and nuts and tighten to 12–15 foot pounds torque [1,6–2,0 kg-m.]. Two of the cover bolts also mount the timing pointer bracket as shown in Fig. 86. Remove the Sleeve KF-28.

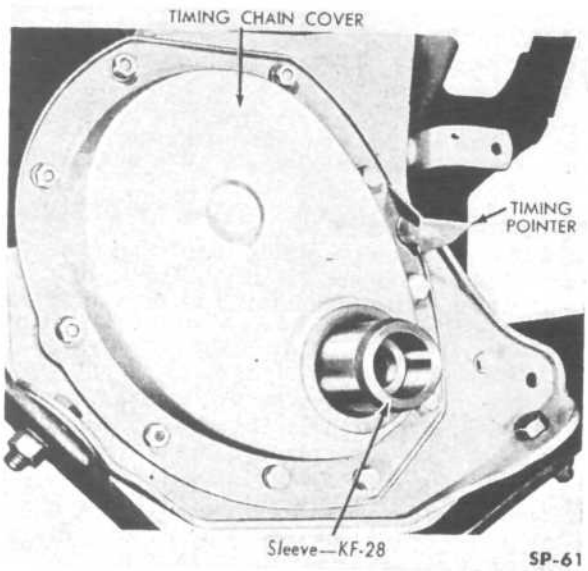


FIG. 86—INSTALLING TIMING CHAIN COVER AND POINTER

D-104. Install Pistons and Connecting Rods

Before installing each piston and connecting rod assembly in the cylinder block, generously lubricate the entire assembly with clean heavy engine oil. Install each piston and connecting rod assembly in the cylinder to which it was previously fitted. When installing each assembly, rotate the crankshaft so that the crankpin is in the down position. Stagger the ring gaps so that no two gaps are aligned vertically and are not located over the T-slot in the piston skirt. Insert the connecting rod in the cylinder, with the oil spurt hole toward the camshaft side of the cylinder block. Fit a piston ring compressor tightly around the piston. Then, using a hammer handle, gently tap the piston into the cylinder (Fig. 87).

Lubricate the connecting rod bearing surfaces generously with clean light engine oil and install the bearing cap (Fig. 90). Use new self locking nuts and tighten to 40-45 foot pounds torque [5,5-6,2 kg-m.].

Refer to Par. D-35 and D-36 for detailed information on fitting pistons and rings in the cylinder bores.

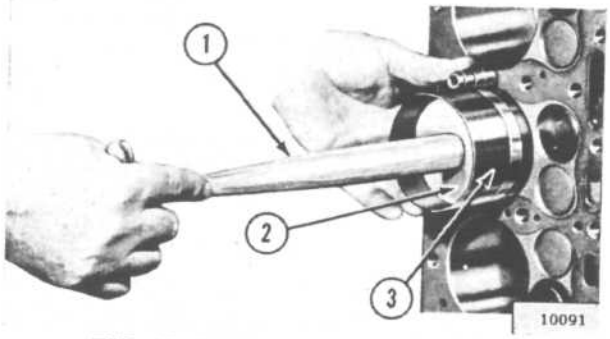


FIG. 87—INSTALLING PISTON AND CONNECTING ROD ASSEMBLY

1—Hammer Handle
2—Piston
3—Piston Ring Compressor

D-105. Install Oil Pump

The oil pump must be installed so that it is properly timed with the camshaft since the distributor is driven by the oil pump shaft. To accomplish this, rotate the crankshaft to move the piston in the number 1 cylinder to the top of its stroke. Insert the distributor main drive shaft in position, from the top of the cylinder block. Rotate the oil pump drive shaft so that when the oil pump is installed the oil pump drive shaft tongue engages the slot in the lower end of the distributor main drive shaft. The slot in the top of the distributor main drive shaft must be approximately parallel to the side of the cylinder block (Fig. 91). Install the lockwasher and nut, tightening the nut to secure the oil pump to the main bearing cap. Install lock wire in the rear intermediate main bearing bolts and oil pump attaching bolt to complete the installation. Now lift out the distributor main drive shaft to permit cylinder head installation.

D-106. Install Vibration Damper

To install the vibration damper and hub assembly, insert the cork keyway plug in the front part of the keyway in the hub. Place the key in the crankshaft

keyway. Lubricate the polished surface of the damper hub; then, slide the vibration damper assembly onto the crankshaft and install the lock washer and bolt to retain the assembly. Tighten the attaching bolt to 100–130 foot pounds torque [13,8–17,9 kg-m.].

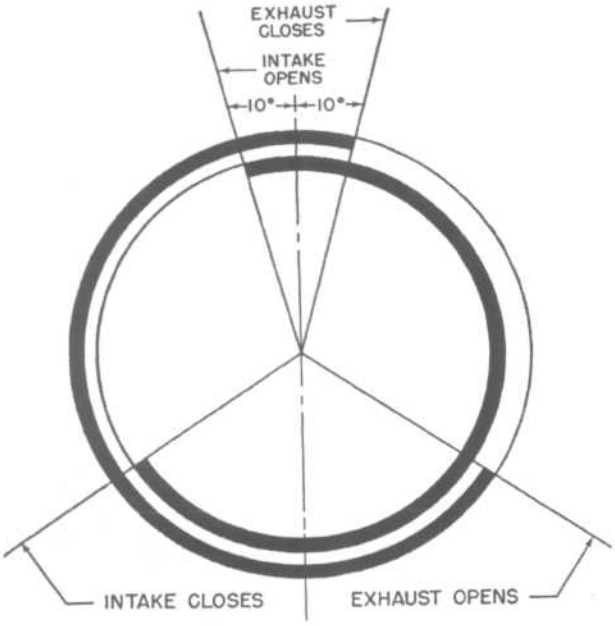


FIG. 88—VALVE TIMING—EARLY L6-226 ENGINES

D-107. Valve Timing

A high-torque camshaft was installed in production effective with engine serial numbers SW-6-L-13138 and TW-6-L-66747. The following procedure for timing valves applies to both early (Fig. 88) and late (Fig. 89) production engines.

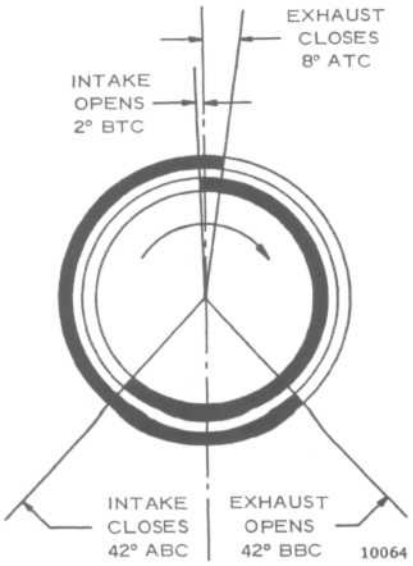


FIG. 89—VALVE TIMING—LATE L6-226 ENGINES

a. Check the timing marks on the vibration damper indicated by the timing pointer for top dead center piston position in No. 1 cylinder.

b. Adjust No. 1 cylinder exhaust valve tappet to a cold clearance of .020″ [0,508 mm.] (.0175″ [0,444 mm.] for late engines) with No. 6 cylinder exhaust valve (No. 12 valve) wide open. Adjust No. 1 cylinder intake valve (No. 2 valve) tappet to a cold clearance of .018″ [0,457 mm.] (.0175″ [0,444 mm.] for late engines) with No. 6 cylinder intake valve (No. 11 valve) wide open.

c. With spark plugs removed, turn the engine slowly clockwise to the point of zero clearance for No. 1 cylinder intake valve tappet and check the timing indicator. It should show 10° (late engines 2°) plus or minus 2° before top center, for the opening of this valve. Turn the engine still further clockwise to establish the closing point for No. 1 cylinder exhaust valve. This should be 10° (late engines 8°) plus or minus 2° after top center.

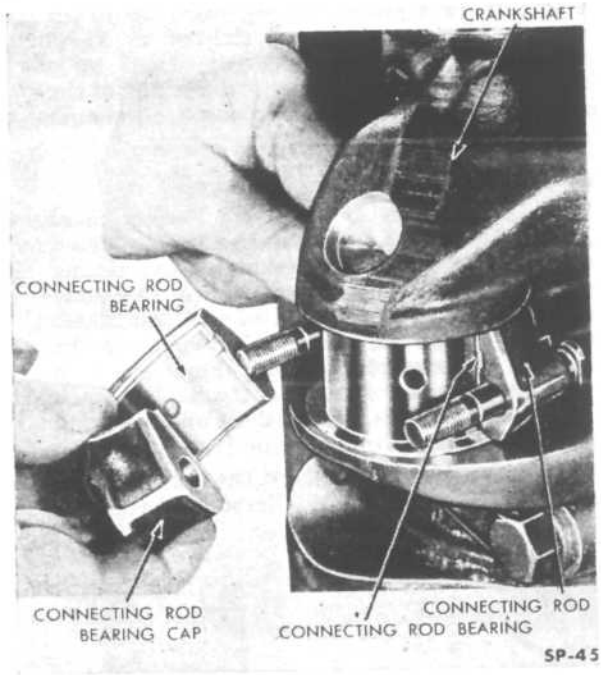


FIG. 90—INSTALLING CONNECTING ROD BEARING CAP

D-108. Remount Engine

Remount the engine on the stand, supporting it at the rear end plate or flywheel housing. Remove the brackets attaching the engine stand to the flange of the cylinder block.

D-109. Install Oil Pan

Apply a thin coat of Willys Perfect Seal Gasket Paste over the engine surface of the oil pan gaskets. Place the oil pan gaskets in position on the cylinder block.

Install the front filler block, using a new cork gasket coated with Willys Perfect Seal Gasket Paste. Since the filler block fits in place against the oil pan gaskets, the gaskets must be on the cylinder block before installing the filler block.

Install the rear filler block, using a new cork gasket coated with Willys Perfect Seal Gasket Paste. The rear filler block also fits against the oil pan gaskets, hence the gaskets must be on the cylinder block before installing the rear filler block.

NOTE: Where an engine has a filler block with dowel pins (see paragraph headed CRANKSHAFT REAR OIL SEAL) the oil pan side gaskets must have matching holes shown as A in Fig. 91. It is possible to have new oil pan side gaskets without these holes. When required, locate and make the holes in the gaskets using the dimensions given in Fig. 91.

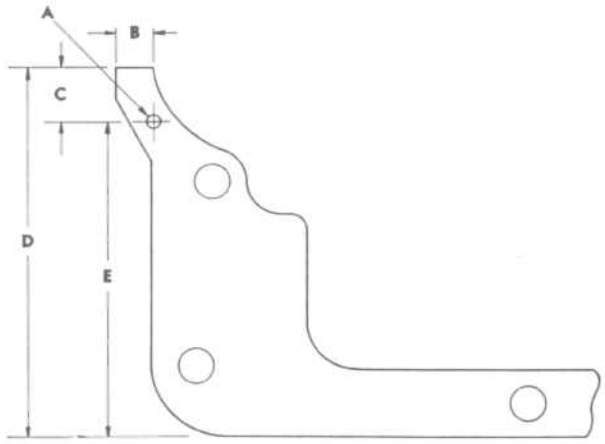


FIG. 91—OIL PAN GASKET HOLE LOCATION

A— .125" [0,318 cm.] Dia.
B— .373" [0,947 cm.]
C— .613" [1,557 cm.]
D—3.938" [10,003 cm.]
E—3.325" [8,446 cm.]

To complete the installation of the front filler block, install the lower three cap screws through the timing chain cover, threading them into the front filler block to hold it against the engine front end plate.

Apply a liberal coating of nondrying Permatex or equal to front and rear filler block seal grooves in the oil pan. Set the oil pan in position on the cylinder block and install the oil pan bolts and lockwashers, tightening them to 12 to 15 lb-ft. torque [1,6 a 2,0 kg-m.]. Wipe off the excess Permatex. Install the oil pan drain plug and gasket and tighten the plug securely.

D-110. Install Valve Tappet Cover

Apply a thin coat of Willys Perfect Seal Gasket Paste over both sides of the valve tappet cover gasket, and position the gasket on the cover. Then assemble the cover to the cylinder block and attach with the three gaskets and nuts. Tighten the nuts to 7–10 foot pounds torque [,96–1,3 kg-m.].

NOTE: Before installing the cover, be sure that the two tappet chamber oil shields at the front of the engine are properly installed so that the spring clips hold them in place.

D-111. Install Cylinder Head

Make certain that the entire top of the cylinder block assembly, the lower surface of the cylinder head, and the cylinder head gasket are clean. Blow all dirt or carbon out of the blind tapped bolt holes in the cylinder block before cylinder head and gasket are installed. Check the cylinder head for distortion. If it is distorted more than $\frac{1}{32}$ inch (.793 mm.) over its full length, replace the head. Install as follows:

a. Cut the hexagonal heads from two cylinder head bolts (Part No. 733955) and file a screw driver slot in the cut end.

b. Install the two modified bolts as guide pins in the cylinder block holes numbered 24 and 26 in Fig. 92.

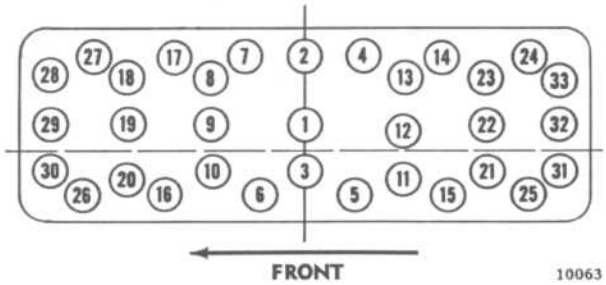


FIG. 92—CYLINDER HEAD BOLT TIGHTENING SEQUENCE

c. Place the head gasket over the guide pins and on the cylinder block, then place the cylinder head over the guide pins.

d. Coat the threads of the cylinder head bolts with Willys Perfect Seal Gasket Paste.

e. Install the cylinder head bolts and tighten them down snugly in the sequence indicated in Fig. 92. Remove the two guide pins installed in Step b. Complete tightening of the head bolts by using a torque wrench to tighten the bolts in the proper sequence to the specified torque of 35–45 foot pounds [4,8–5,5 kg-m.].

f. Start the engine and let it warm up to normal operating temperature, then tighten the head bolts to 35–45 foot pounds torque [4,8–5,5 kg-m.] in the proper sequence.

g. Check all head bolts and the head gasket for leaks.

h. It is advisable to check the tightness of the head bolts again after 500 to 600 miles [800–960 km.] of normal operation.

D-112. Install Distributor Main Drive Shaft

Insert the distributor main drive shaft in the opening in the cylinder head. The slot in the head of the shaft must be approximately parallel to the sides of the cylinder block with the offset (narrow) side toward the valve side of the cylinder block (refer to Fig. 93). When properly positioned the shaft will protrude approximately $\frac{1}{8}$ of an inch [3,17 mm.] above the top of the cylinder head.

D-113. Install Manifolds

Assemble the intake and exhaust manifolds before installing them on the cylinder block. Make certain that no foreign objects are inside the manifolds, and that all passages are clear. Place the manifold gasket in position on the side of the cylinder block. Then, carefully slide the manifolds onto the studs



FIG. 93—CORRECT POSITION OF DISTRIBUTOR MAIN DRIVE SHAFT

and against the cylinder block, being careful not to damage the gasket. Hold the manifolds in that position while a retainer and nut are assembled on one of the top studs to support the manifolds. Install retainers and nuts on all manifold studs except the top end and lower center studs, on which a plain washer and nut are used. Tighten all nuts to 30–35 foot pounds torque [4,1–4,8 kg-m.] starting from the center of the manifold and working out toward the ends.

D-114. Install Water Pump

Make certain that the mating surfaces of the water pump and the cylinder block are clean and smooth. Apply a coat of Willys Perfect Seal Gasket Paste to both sides of the water pump gasket. Position the gasket against the cylinder block. Slide the water pump onto the studs and against the gasket and cylinder block. Install the attaching bolts, stud nuts and lock washers. Tighten the bolts and nuts alternately and evenly to 15 to 20 lb-ft. torque [2,1 a 2,8 kg-m.].

D-115. VALVE ADJUSTMENT

D-116. General Information

Proper adjustment of the intake and exhaust valve tappets is important to prevent burning of valves and poor engine performance. This adjustment consists of obtaining a specified clearance between the tappet adjusting screw and the end of the valve stem. The relative positions of these parts are shown in Fig. 94.

The tappets should be adjusted to the proper clearance with the engine cold (at room temperature) and without starting the engine. Each valve tappet can be properly adjusted only when the tappet is on the heel or "low" portion of the cam.

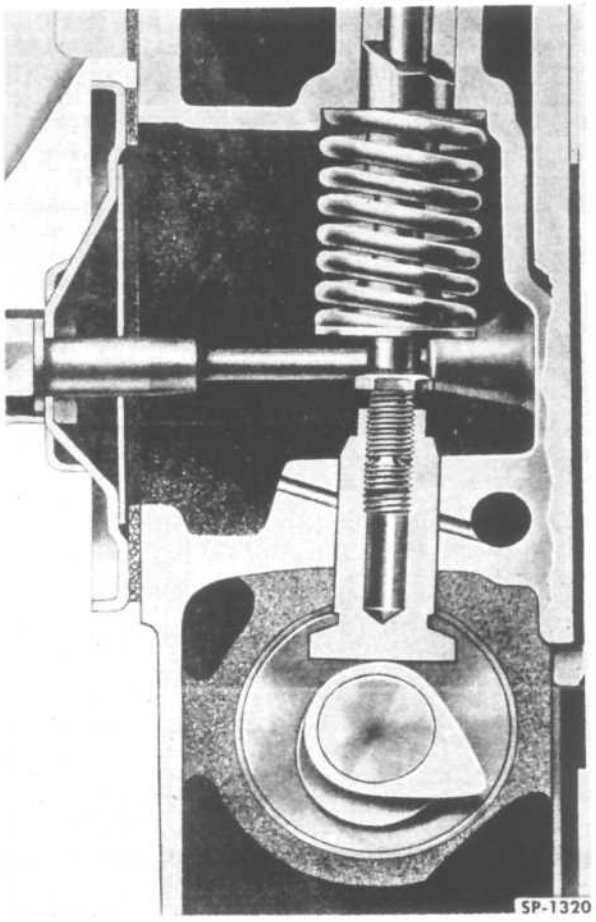


FIG. 94—CAMSHAFT, TAPPET AND VALVE

D-117. Valve Adjustment Procedure

The tappets are adjusted by turning the tappet adjusting screw to obtain the proper clearance. Special wrenches should be used to facilitate adjustment. The proper clearance is .014 of an inch [,355 mm.] for both the intake and the exhaust valves. Adjustment of tappets is as follows:

Crank the engine over to close the valve and check the clearance with a feeler gauge (Fig. 95). To adjust the clearance hold the tappet from turning with a tappet wrench and turn the tappet adjusting

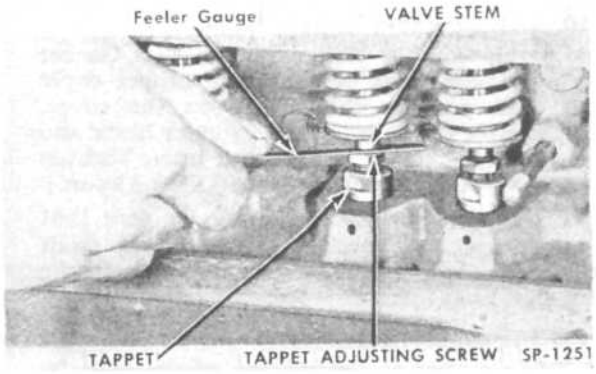


FIG. 95—CHECKING VALVE CLEARANCE

screw using a second tappet wrench to obtain the proper clearance (Fig. 96). Remove the wrenches and recheck the clearance. Readjust if necessary. Check and adjust each of the tappets to the proper clearance in the following sequence. Tappets are counted consecutively starting from the front of the engine.

D-118. Tappet Adjustment Sequence

With Valves	No. 1 and 3 fully raised	—	Adjust Tappets	No. 10 and 12
With Valves	No. 8 and 9 fully raised	—	Adjust Tappets	No. 4 and 5
With Valves	No. 2 and 6 fully raised	—	Adjust Tappets	No. 7 and 11
With Valves	No. 10 and 12 fully raised	—	Adjust Tappets	No. 1 and 3
With Valves	No. 4 and 5 fully raised	—	Adjust Tappets	No. 8 and 9
With Valves	No. 7 and 11 fully raised	—	Adjust Tappets	No. 2 and 6

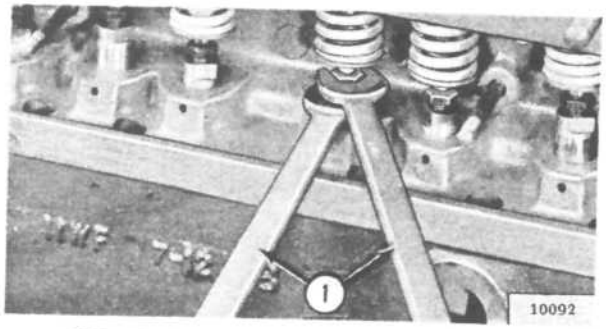


FIG. 96—VALVE TAPPET ADJUSTMENT

1—Tappet Wrenches

D-119. OILING SYSTEM

The engine pressure lubrication system is designed to provide adequate lubrication to all working parts of the engine (Fig. 97).

The engine is pressure lubricated by a gear type oil pump driven from the engine camshaft. The pump is provided with a floating, screened, intake that prevents the recirculation of any sediment that might accumulate in the oil pan.

By means of this pump the engine oil is forced through the drilled passages in the crankshaft, to efficiently lubricate the main and connecting rod bearings. Oil is also force fed to the camshaft bearings, timing gear chain and timing gears and valve tappets. The pressure under which oil is forced through the system is controlled by an oil pressure relief valve, located in the engine cylinder block. The relief valve is designed to open when excess pressure develops in the system, relieving the pressure and returning the excess oil to the oil pan.

The cylinder walls and piston pins are supplied with oil from spurt holes in the connecting rods. At the same time, a portion of the engine oil is continually by-passed through the oil filter which effectively removes foreign matter which may be suspended in the oil. The oil pressure gauge in the instrument panel and the oil level gauge or dip stick in the side of the engine provide a means for checking the oil pressure and oil level.

The engine crankcase is ventilated by circulating air through it to remove fuel and water vapor which would otherwise condense and contaminate the engine oil. Air is drawn into the crankcase through the breather cap on the oil filler tube. After circulating inside the crankcase, the air is drawn out through a tube on the valve tappet chamber cover. The end of the tube extends down into the air stream resulting from the forward motion of the car producing suction at the tube outlet.

D-120. Oil Filter

Model L6-226 engine is equipped with the replaceable element type oil filter. This oil filter must be serviced periodically as outlined in the Lubrication Section. To replace the filter element remove the cover, lift out the old element and install a new one. The filter assembly may be replaced by detaching the oil lines at the case and removing the clamp bolts and washer.

D-121. Oil Pressure Relief Valve

(Refer to Fig. 31). The oil pressure relief valve is located in the right side of the cylinder block below the valve chamber and toward the rear of the engine. The relief valve consists of a valve, spring, washer (if used), gasket and plug which can be removed as described in Par. D-30.

Inspect the valve and the bore in the cylinder block and remove all dirt or foreign matter, cleaning thoroughly. If the valve is scored replace it. If the valve bore is scored smooth it with crocus cloth. If the valve spring is collapsed or weak, replace the spring or install service washers between the spring and the plug as required to increase the spring tension and the oil pressure.

D-122. Checking Oil Pressure

When the engine is operating at normal temperature, the oil pressure gauge in the instrument panel should indicate oil pressure of 35–40 pounds per square inch [2,4–2,8 kg./sq. cm.] above 30 mph. [48 kph.]. In cold weather, the pressure will be higher until the engine warms up to normal operating temperature. If the oil pressure gauge indicates very low pressure, or none at all, stop the engine at once and check the engine oil level as shown on the oil level gauge or dip stick. Next check the oil pressure gauge to be sure it is functioning properly. Test procedures are given in "Electrical" section. When sure the gauge is indicating correctly check the following:

a. Check the oil pressure relief valve. If the oil pressure is low the valve may be stuck open or the spring may be weak. If the oil pressure is high the valve may be stuck closed.

b. Check for oil leaks if the oil pressure is low.

c. Check the oil pump intake screen after removing the oil pan, if the oil pressure is low. The screen may be plugged with sludge, restricting the oil pump intake.

d. Remove the oil pump and disassemble it to check for worn gears, sheared pins, etc., if the oil pressure is low.

e. Check for worn main and connecting rod bearings, if the oil pressure is low.

SERVICE DIAGNOSIS

Poor Fuel Economy

Ignition Timing Slow or Spark Advance Stuck
Carburetor Float High
Accelerator Pump Not Properly Adjusted
High Fuel Pump Pressure
Fuel Leakage
Leaky Fuel Pump Diaphragm
Loose Engine Mounting Causing High Fuel Level in Carburetor
Low Compression
Valves Sticking
Spark Plugs Bad
Spark Plug Cables Bad
Weak Coil or Condenser
Improper Valve Tappet Clearance
Carburetor Air Cleaner Dirty
High Oil Level in Air Cleaner
Dragging Brakes
Front Wheels Out of Alignment
Tires Improperly Inflated
Inaccurate Odometer
Faulty Fuel Tank Cap
Clogged Muffler or Bent Exhaust Pipe

Lack of Power

Low Compression
Ignition System (Timing Late)
Improper Functioning Carburetor or Fuel Pump
Fuel Lines Clogged
Air Cleaner Restricted
Engine Temperature High
Improper Tappet Clearance
Sticking Valves
Valve Timing Late
Leaky Gaskets
Muffler Clogged
Bent Exhaust Pipe

Low Compression

Leaky Valves
Poor Piston Ring Seal
Sticking Valves
Valve Spring Weak or Broken
Cylinder Scored or Worn
Tappet Clearance Incorrect
Piston Clearance too Large
Leaky Cylinder Head Gasket

Burned Valves and Seats

Sticking Valves or too Loose in Guides
Improper Timing
Excessive Carbon Around Valve Head and Seat
Overheating
Valve Spring Weak or Broken
Valve Tappet Sticking
Valve Tappet Clearance Incorrect
Clogged Exhaust System

Valves Sticking

Warped Valve
Improper Tappet Clearance
Carbonized or Scored Valve Stems

Valves Sticking — Continued

Insufficient Clearance Valve Stem to Guide
Weak or Broken Valve Spring
Valve Spring Cocked
Contaminated Oil

Overheating

Inoperative Cooling System
Thermostat Inoperative
Improper Ignition Timing
Improper Valve Timing
Excessive Carbon Accumulation
Fan Belt too Loose
Clogged Muffler or Bent Exhaust Pipe
Oil System Failure
Scored or Leaky Piston Rings

Popping-Spitting-Detonation

Improper Ignition
Improper Carburetion
Excessive Carbon Deposit in Combustion Chambers
Poor Valve Seating
Sticking Valves
Broken Valve Spring
Tappets Adjusted too Close
Spark Plug Electrodes Burned
Water or Dirt in Fuel
Clogged Lines
Improper Valve Timing

Excessive Oil Consumption

Piston Rings Stuck in Grooves, Worn or Broken
Piston Rings Improperly Fitted or Weak
Piston Ring Oil Return Holes Clogged
Excessive Clearance, Main and Connecting Rod Bearings
Oil Leaks at Gaskets or Oil Seals
Excessive Clearance, Valve Stem to Valve Guide (Intake)
Cylinder Bores Scored, Out-of-Round or Tapered
Too Much Clearance, Piston to Cylinder Bore
Misaligned Connecting Rods
High Road Speeds or Temperature
Crankcase Ventilator Not Operating

Bearing Failure

Crankshaft Bearing Journal Out-of-Round
Crankshaft Bearing Journal Rough
Lack of Oil
Oil Leakage
Dirty Oil
Low Oil Pressure or Oil Pump Failure
Drilled Passages in Crankcase or Crankshaft Clogged
Oil Screen Dirty
Connecting Rod Bent

L6-226 ENGINE SPECIFICATIONS

		Metric
Engine:		
Type	L-head	.....
Number of Cylinders	6	6
Bore	3 5/16"	84,13 mm.
Stroke	4 3/8"	111,12 mm.
Piston Displacement	226.2 cu. in.	3707 cm^3
Compression Ratio:		
Standard	6.86 to 1	6,86 a 1
Optional	7.3 to 1	7,3 a 1
Horsepower — Max. Brake	105 @ 3600 rpm.	105 a 3600 rpm.
Compression	155 @ 185 rpm.	10,9 kg-cm^2 a 185 rpm.
Horsepower (SAE)	26.33	26,33
Maximum Torque	190 lb-ft. @ 1400 rpm.	26,27 kg-m. a 1400 rpm.
Firing Order	1-5-3-6-2-4	1-5-3-6-2-4
Crankshaft:		
Counterweights	5 Integral	.....
Bearing Journals:		
Front	2.374" to 2.375" x 1.062"	6,030 a 6,032 x 2,697 cm.
2	2.374" to 2.375" x 1.250"	6,030 a 6,032 x 3,175 cm.
3	2.374" to 2.375" x 1.250"	6,030 a 6,032 x 3,175 cm.
Rear	2.374" to 2.375" x 1.321"	6,030 a 6,032 x 3,355 cm.
Thrust	Rear	.....
End Play	.002" to .006"	0,051 a 0,152 mm.
Bearing Clearance	.0008" to .0028"	0,0203 a 0,0711 mm.
Type	Steel Backed Matrex	.....
Connecting Rod:		
Center to Center Length	7.00"	17,78 cm.
Upper End	Floating	Floating
Lower Bearing Type	Steel Backed Matrex	.....
Lower Bearing Effective Length	1.063"	27,00 mm.
Clearance on Crankshaft	.0007" to .0025"	0,0177 a 0,0634 mm.
End Play	.006" - .011"	0,152 a 0,279 mm.
Installation	From Above	.....
Piston and Rings:		
Piston Material	Aluminum Alloy	.....
Features	Cam Ground, T-Slot, Tin Plated	.....
Length	3 17/32"	8,96 cm.
Clearance:		
Top Land	.020" to .030"	0,508 a 0,762 mm.
Skirt	.0007" to .0017"	0,0177 a 0,0431 mm.
Number of Rings	4	4
Compression Rings	Two .0930" to .0935"	(2) 2,36 a 2,37 mm.
Oil Ring	Two .1545" to .1550"	(2) 3,92 a 3,93 mm.
Ring Gap	.008" to .016"	0,203 a 0,406 mm.
Piston Pin:		
Length	2.779"	70,58 mm.
Diameter	.8592"	21,82 mm.
Type	Floating	.....
Clearance in Piston	.0002" (Selective Fit)	0,005 mm.
Camshaft:		
Number of Bearings	4	4
Bearing Journal Diameter:		
Front	1.8730"	47,57 mm.
Front Intermediate	1.8100"	45,97 mm.
Rear Intermediate	1.7478"	44,39 mm.
Rear	1.2480"	31,69 mm.
Thrust Taken	Front	.....
End Play Control	Thrust Plate	.....

L6-226 ENGINE SPECIFICATIONS (Continued)

		Metric
Intake Valve:		
Tappet Clearance — Cold	.014"	0,355 mm.
Seat Angle	30°	30°
Diameter of Head	1.520"	38,61 mm.
Over all Length	5 5/16"	13,17 cm.
Stem Diameter	.3402" to .3410"	8,641 a 8,661 mm.
Stem to Guide Clearance	.001" to .003"	0,025 a 0,076 mm.
Intake Opens	2° BTC	2° BTC
Intake Closes	42° BTC	42° BTC
Lift	.284"	7,21 mm.
Exhaust Valve:		
Tappet Clearance — Cold	.014"	0,355 mm.
Seat Angle	45°	45°
Diameter of Head	1.328"	33,73 mm.
Over all Length	5 13/64"	13,22 cm.
Stem Diameter	.3382" to .3390"	8,590 a 8,610 mm.
Stem to Guide Clearance	.0032" to .0050"	0,0812 a 0,1270 mm.
Exhaust Opens	42° BBC	42° BBC
Exhaust Closes	8° ATC	8° ATC
Lift	.284"	7,213 mm.
Intake Valve Spring:		
Free Length	1 31/32"	50,01 mm.
Valve Closed	51 lbs. @ 1 43/64"	3,58 kg-cm² - 42,46 mm.
Valve Open	107 lbs. @ 1 5/16"	7,29 kg-cm² - 33,32 mm.
Exhaust Valve Spring:		
Free Length	1 31/32"	50,01 mm.
Valve Closed	51 lbs. @ 1 43/64"	3,58 kg-cm² - 42,46 mm.
Valve Open	107 lbs. @ 1 5/16"	7,29 kg-cm² - 33,32 mm.
Camshaft Drive:		
Type	Chain	.....
Material:		
Crankshaft Sprocket	Steel	.....
Camshaft Sprocket	Cast Iron	.....
Chain:		
Number of Links	46	46
Width	1.000"	25,4 mm.
Pitch	.500"	12,7 mm.
Fan Belt:		
Angle of V	36°	36°
Outside Length	41"	104 cm.
Width	.438"	12,70 mm.
Oil Pump:		
Type	Gear	.....
Drive	From Camshaft	.....
Minimum Safe Oil Pressure	6 lbs. @ Idle	0,42 kg-cm² - Idle
	20 lbs. @ 2000 rpm. (35 mph.)	1,4 kg-cm² - 2000 rpm. [56 kph.]
Normal Oil Pressure	35 lbs. @ 1700 rpm.	2,46 kg-cm² - 1700 rpm.
Relief Valve Opens	35 - 40 lbs.	2,46 a 2,81 kg-cm²

F4-134 ENGINE

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Camshaft and Valve Tappets	E-7	Oil Pressure Indicator	E-24
Camshaft Drive	E-10	Oil Pump	E-20
Connecting Rods	E-14	Pistons	E-15
Crankshaft	E-12	Piston Pins	E-17
Crankshaft Rear Bearing Seal	E-13	Piston Rings	E-16
Cylinder Bores	E-19	Piston and Rod Assembly	E-18
Engine Mounting	E-26	Tappet Clearance	E-5
Engine Removal	E-27	Valve Grinding	E-2
Floating Oil Intake	E-21	Valve Guides	E-4
Flywheel	E-22	Valve Installation	E-6
Oil Filler Tube	E-25	Valve Seat Inserts	E-3
Oil Pressure Gauge	E-23	Valve Timing	E-11

E-1. GENERAL

This engine is of the F-head type which is a combination valve in head and valve in block construction. The large intake valves mounted in the head allows rapid, unobstructed flow of fuel to the combustion chambers through short, water jacketed intake passages. They are operated by push rods through rocker arms in the conventional manner. The exhaust valves are mounted in the block with increased water jacketing to provide better control of heat. They are operated by conventional valve tappets.

In common with all manufacturers, some engines are built with oversize cylinder bores or undersize crankshaft journals. These engines are considered standard as parts of the correct sizes are supplied. Before ordering parts or doing any work with the pistons or bearings of a particular engine, it is important to check the engine serial number to determine if oversize or undersize parts are required. Definite information is given by a letter stamped after the serial number. The letters used and their meaning is given below.

A — .010″ [0,254 mm.] undersize main and connecting rod bearings.

B — .010″ [0,254 mm.] oversize pistons.

AB — Combination of A and B.

At the end of this section, you will find listed the complete specifications covering the engine. When adjustments are necessary, refer to these specifications so that factory clearances are maintained.

E-2. Grinding Valves

Should tests show that lack of power and poor fuel economy is caused by low compression due to improper seating of the valves, the maximum engine performance can usually be restored by reseating and grinding the valves. Care should be used when valves are ground to maintain factory limits and clearances as only by maintaining these can one expect to get good engine performance.

When it is necessary to grind the valves it will be best to follow the procedure outlined in the following paragraphs.

a. Drain the cooling system by opening the drain cock at the right lower corner of the radiator.

b. Remove the rocker arm cover.

c. Disconnect the carburetor controls and tubes and remove the carburetor.

d. Disconnect the vacuum booster tube at the head.

e. Remove the rocker arm oil supply line from head.

f. Remove the oil fill tube supporting bracket from the head.

g. Disconnect wire from heat indicator sender.

h. Disconnect the spark plug wires from the plugs and remove the plugs.

i. Remove the upper radiator hose.

j. Remove the water pump by-pass tube from front end of cylinder head (early models).

k. Remove the cylinder head attaching nuts including the one located inside the manifold and accessible through the carburetor opening.

l. Lift the head until the rocker arms will slide to one side. Lift out the push rods.

m. Lift the head from the block.

n. Remove the valve cover plate from the side of the block directly back of the exhaust manifold. Use cloth to block off the three holes in the exhaust valve chamber floor to prevent the valve retaining keys from falling into the crankcase should they be accidentally dropped.

o. This engine is equipped with free-type valves with a ball bearing built as part of the spring retainer. With a valve spring compressor inserted between the valve tappet and spring retainer, raise the springs on the valves which are in a closed position and remove the valve locks. Turn the crankshaft until those valves which are open are closed and remove the remaining locks.

p. Remove the exhaust valves. Examine the stems of valves which employ the ball bearing rotator. Wear marks around the circumference of the stem

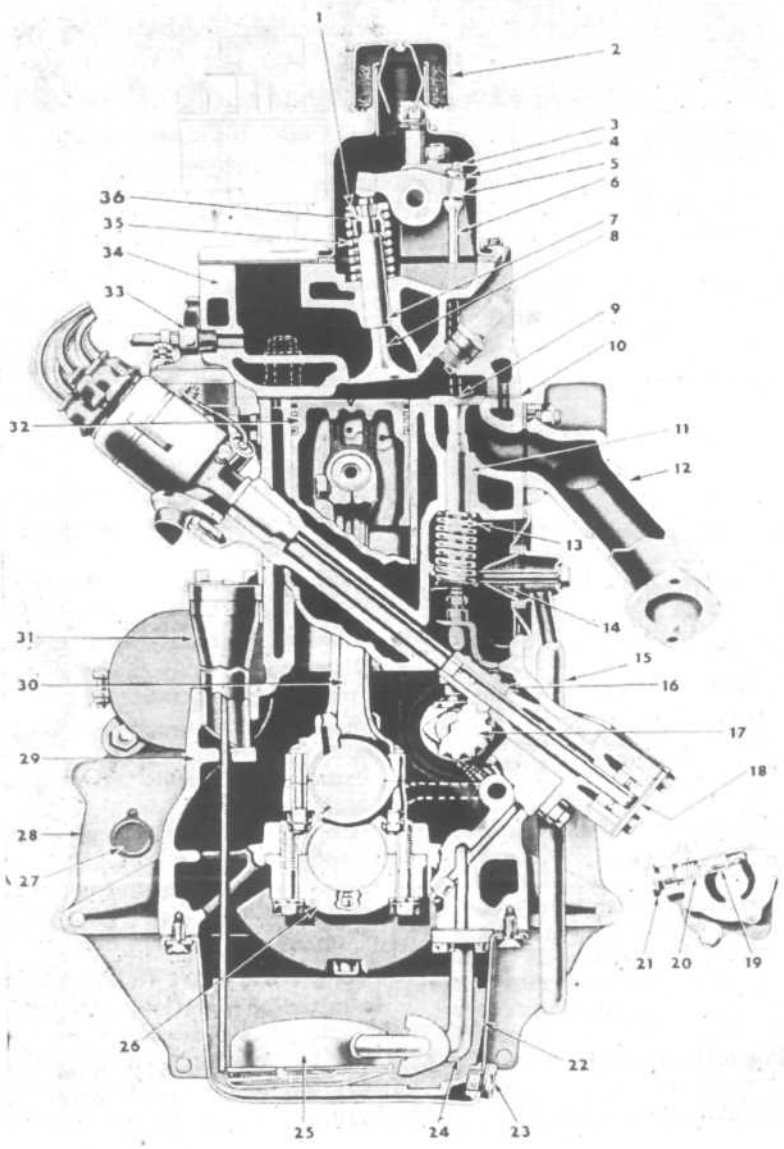


FIG. 97—FOUR-CYLINDER F-HEAD ENGINE — END VIEW

1—Inlet Valve Spring Retainer
2—Ventilator
3—Adjusting Screw
4—Adjusting Screw Lock Nut
5—Rocker Arm
6—Push Rod
7—Inlet Valve Guide
8—Inlet Valve
9—Exhaust Valve
10—Cylinder Head Gasket
11—Exhaust Valve Guide
12—Exhaust Manifold
13—Exhaust Valve Spring
14—Crankcase Ventilator Baffle
15—Crankcase Ventilator Tube
16—Oil Pump Gear
17—Camshaft Gear
18—Oil Pump Cover
19—Oil Relief Valve Plunger
20—Oil Relief Valve Spring
21—Oil Relief Valve Spring Retainer
22—Oil Pan
23—Oil Drain Plug
24—Oil Float Support
25—Oil Float Assembly
26—Crankshaft Bearing Cap
27—Timing Mark Cover
28—Engine Support Plate
29—Crankcase
30—Connecting Rod
31—Oil Filler Tube
32—Piston
33—Vacuum Tube
34—Cylinder Head
35—Intake Valve Spring
36—Oil Seal

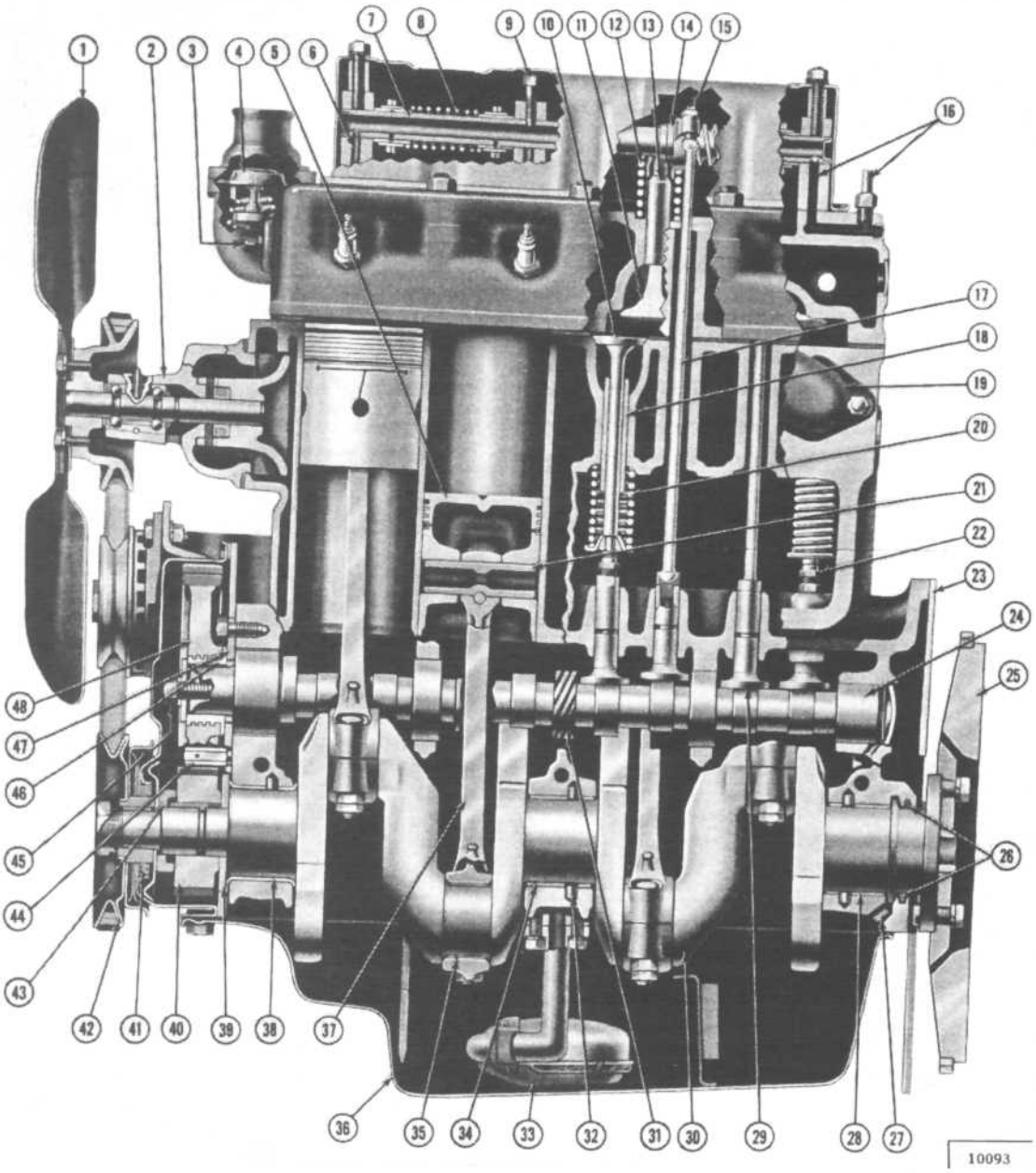


FIG. 98—FOUR-CYLINDER F-HEAD ENGINE—SIDE VIEW

1—Fan Assembly
2—Water Pump Assembly
3—Plug
4—Thermostat
5—Piston
6—Oil Return Tube
7—Rocker Arm Shaft
8—Rocker Arm Shaft Spring
9—Ventilator
10—Rocker Arm Shaft Lock Screw
11—Exhaust Valve
12—Inlet Valve
13—Inlet Valve Spring
14—Inlet Valve Guide
15—Rocker Arm
16—Adjusting Screw
17—Oil Inlet Tube
18—Push Rod
19—Exhaust Valve Guide
20—Exhaust Manifold
21—Exhaust Valve Spring
22—Piston Pin
23—Valve Tappet Adjusting Screw
24—Engine Rear Support Plate
25—Camshaft
26—Flywheel
27—Rear Bearing Oil Seal
28—Oil Return Channel
29—Rear Main Bearing Shell
30—Tappet
31—Crankshaft
32—Oil Pump Drive Gear
33—Main Bearing Dowel
34—Oil Float Assembly
35—Center Main Bearing Shell
36—Connecting Rod Bearing
37—Oil Pan
38—Connecting Rod
39—Front Main Bearing Shell
40—Front Engine Plate
41—Crankshaft Gear
42—Crankshaft Front End Seal
43—Seal Baffle
44—Fan and Generator Pulley
45—Crankshaft Gear Spacer
46—Timing Gear Oil Jet
47—Camshaft Gear Screw
48—Camshaft Thrust Plate Spacer
49—Camshaft Thrust Plate
50—Camshaft Gear

indicate that the valve is rotating satisfactorily. Vertical heavy pressure areas indicate that the valve is not rotating and the rotor bearing built in the lower spring retainer should be examined and replaced if faulty.

q. With a valve spring compressor, remove the intake valves and springs from the head. Identify them for return to the same cylinder from which they were removed.

r. Wash the springs thoroughly in solvent. Examine them for damage or corrosion from acid etching. Measure the over all free length and check the pressure of each spring on a spring testing fixture as shown in Fig. 99. The specifications which must be maintained to assure satisfactory operation are given below.

Exhaust Valve Springs	
Free length	2 1/2" [63,50 mm.]
With valve closed (compressed to 2 7/64") [53,5781 mm.]	53 lbs. [24,040 kilo.]
With valve open (compressed to 1 3/4") [44,45 mm.]	120 lbs. [54,430 kilo.]
Intake Valve Springs	
Free length	1 31/32" [50,0062 mm.]
With valve closed (compressed to 1 21/32") [42,0687 mm.]	73 lbs. [33,112 kilo.]
With valve open (compressed to 1 3/8") [34,925 mm.]	160 lbs. [72,574 kilo.]

When using the type of spring checking fixture shown in Fig. 99, it is necessary to convert the torque wrench reading which is in pounds-feet to the static pound pressure of the specifications above. This is accomplished by multiplying the torque wrench reading by two. For example, should the torque wrench reading be 50 lb-ft. the static pressure of the spring will be 50 x 2 or 100 lbs.

Clean the carbon from the cylinder head, top of pistons, valve seats and cylinder block.

Clean the valve guides with a wire guide brush; clean the valves on a wire wheel brush, making sure that all carbon is removed from the top and bottom of the heads, as well as the gum which might have accumulated on the stems.

Reface both exhaust and intake valves and the valve seats at an angle of 45°.

Note: Each exhaust valve is seated against a seat machined in the block on earlier engines and against an exhaust valve seat insert shrunk into the cylinder block on later engines. Instructions regarding valve seats apply equally to both types of valve seats.

Check each valve seat after grinding with a dial indicator as shown in Fig. 100. The valve seat



FIG. 99—SPRING TESTING

should not be out-of-round more then .002" [0,0508 mm.]. After reseating, lap the valve to the valve seat with fine valve grinding compound.

Check the clearance between the valve stems and valve guides carefully. Standard intake valve clearance is .0007" to .0022" [,01778 mm. to ,05588 mm.] and the exhaust valve clearance is .0025" to .0045" [,0635 mm. to ,1143 mm.].

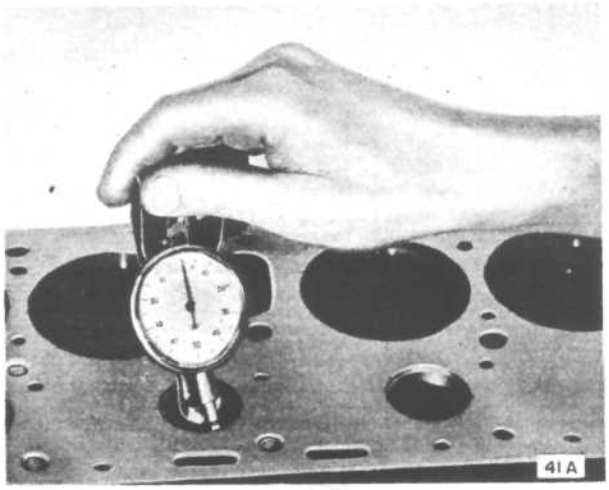


FIG. 100—GAUGING VALVE SEATS

Excessive clearance between the valve stems and guides will cause improper seating and burned valves. When there is too much clearance between the intake valve stem and guide there is a tendency to draw oil vapor through the guide on the suction stroke causing excessive oil consumption, fouled spark plugs and poor low speed performance.

To check the clearance of the valve stem to the valve guide, take a new valve and place in each valve guide and feel the clearance by moving the valve stem back and forth. If this check shows excessive clearance it will be necessary to replace the valve guide, if not, the valve stem is worn.

E-3. Exhaust Valve Seat Insert Replacement

Hardened valve seat inserts for exhaust valves were installed in production beginning with engine serial number IT-73584. They will only occasionally require replacement. To avoid damaging the block, remove an insert with a tool designed for this purpose. When installing a new insert, make certain the counterbore is clean and smooth. Use an installer tool that will keep the insert in true alignment with the bore. Cool the insert and the installing tool with dry ice for 30 minutes. Immediately after removing a seat insert from the dry ice, position it over the counterbore. Make certain the valve seat is facing out. Drive the insert with the tool until it bottoms in the counterbore. After installation, check the valve seat for concentricity with the valve guide. Grind the valve seat at an angle of 45° and check after grinding with a dial indicator as shown in Fig. 100.

E-4. Removing and Replacing Valve Guide

Should it be necessary to replace the guides use a valve guide driver tool, Fig. 101, both to remove the old guides and install the new. A suitable puller for the exhaust valve guides can be made from a piece of 2″ [50,8 mm.] pipe, 6″ [152,4 mm.] long and a ⅜″ [9,525 mm.] bolt 10″ [254 mm.] to 12″ [304,8 mm.] long with a threaded end, a small hexagon nut which will pass through the hole in the cylinder block and a 2″ [50,8 mm.] washer with a ⅜″ [9,525 mm.] hole in it. When using this tool, the old exhaust valve guides are driven through the block into the valve compartment.

When replacing the exhaust guides, maximum engine performance can only be secured when the top of exhaust guide is positioned one inch [25,4 mm.] below the top face of the cylinder block as shown in Fig. 102. The standard driver is equipped with an adapter ring which correctly positions the guide. The lower end of the intake guide is positioned flush with the cylinder head casting as shown in Fig. 102.

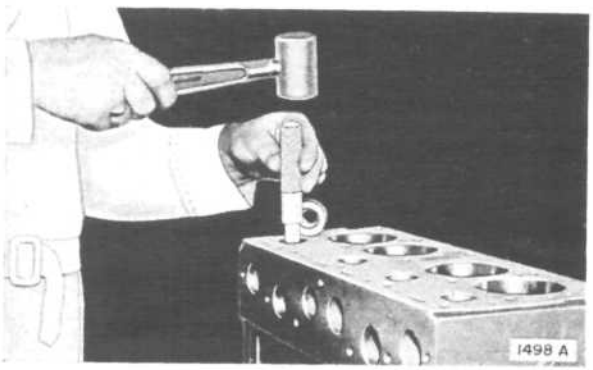


FIG. 101—VALVE GUIDE DRIVER

Should the standard driver be unavailable, a substitute may be made from a piece of ½″ [12,7 mm.] round steel 6″ [152,4 mm.] long. Turn down one end to ⅜″ [9,525 mm.] in diameter for a distance of 2″ [50,8 mm.] to form a pilot and shoulder.

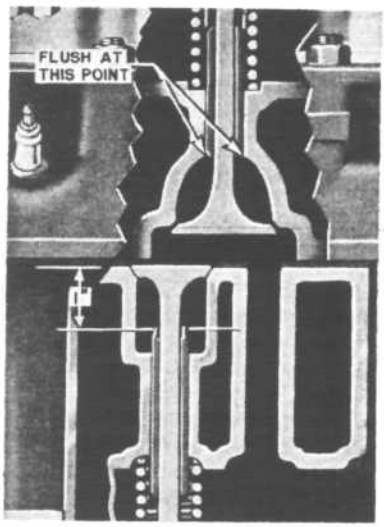


FIG. 102—VALVE GUIDE POSITIONS

Should this type driver be used, it will be necessary to measure to correctly locate the exhaust valve guides.

E-5. Valve Tappet Clearance

See Fig. 103.

Check the clearance of the valve tappets in the cylinder block which should be .0005″-.002″ [,0127-,0508 mm.]. Check by moving each tappet back and forth in the block. Should the clearance seem excessive, it might be necessary to replace one or more which are supplied .004″ [,1016 mm.] oversize. This operation is covered in Par. E-7.

E-6. Valve Installation

Assemble the exhaust valve springs and retainers with the closed coils of the springs placed up to seat in the block. See Fig. 103. Install the valves in the same positions from which they were removed. If of the "free" type having caps mounted over the lower ends, be sure that the rotor caps and spring retainer locks are thoroughly clean and reinstalled on the same valves from which they were originally removed with the worn side of both locks contacting the cap.

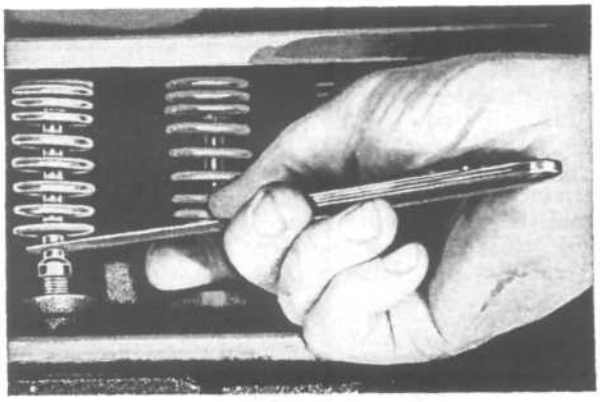


FIG. 103—VALVE TAPPETS AND SPRINGS

The rotor parts when new are made to be interchangeable. When correctly fitted there is from .000″ to .004″ [,000 to ,1016 mm.] clearance between the bottom of the valve and the cap when the upper edge of the cap contacts the spring retainer locks. Clearance is sufficient to allow the cap to raise the locks as the valve is opened. Spring pressure is relieved allowing the valve to rotate a fraction of a revolution during each lift cycle. There is some wear of rotor parts. However, this wear is compensating so that clearances change little. For this reason, it is essential that both locks and cap be reinstalled on the valve from which they were removed with the worn face of both locks contacting the upper edge of the cap. Should the contact face of the locks be badly worn, install a new cap and new locks. In the absence of new locks, turn the old ones over to provide a new wearing surface.

After the valves are installed, turn the engine until each valve is successively wide open. Try each valve for free operation by turning it. If they turn with slight effort, there is sufficient clearance for free operation. Maximum up and down clearance in the cap may be measured by mounting a dial indicating gauge on the valve head and measuring the vertical movement of the valve without compressing the spring. Should there be insufficient clearance to provide free operation, grind a slight amount from the lower end of the valve stem. Should there be too much clearance, lap a small amount from the upper edge of the cap using fine emery cloth placed on a smooth surface.

When installation of the exhaust valves is completed, remove the cloth blocks from the valve compartment floor openings.

Install the intake valves and springs in the cylinder head placing the ends of the springs having closed coils down against the cylinder head.

IMPORTANT: Be sure to install a new rubber oil seal ring on each intake valve stem before installing the retainer locks. With the retainer and spring compressed, position a seal ring on the valve stem just above the lock recess, install the locks and release the spring.

Clean the top of the block and pistons of all foreign matter and install the gasket without using sealer or other compound. Clean the cylinder head and install it on the cylinder block placing a piece of clean wood about 1″ [25,40 mm.] thick between the block and head. Install the intake valve push rods shoving the rocker arms to one side to make the installation. Remove the piece of wood and lower the head until the rocker arm ball ends enter the push rod sockets and then allow the head to seat on the block. Install the cylinder head nuts with the ignition wire clips over the end studs. Tighten the nuts with a torque wrench in the sequence shown in Fig. 104 to 60–70 lb-ft. [8,3–9,6 kg-m.] for both stud nuts and screws. Do not overlook installing the cap screw in the intake manifold directly under the carburetor opening.

Clean and adjust the spark plugs, setting the electrode gaps at .030″ [,762 mm.]. Install the plugs to prevent any foreign matter entering the combustion chambers during the remaining operations.

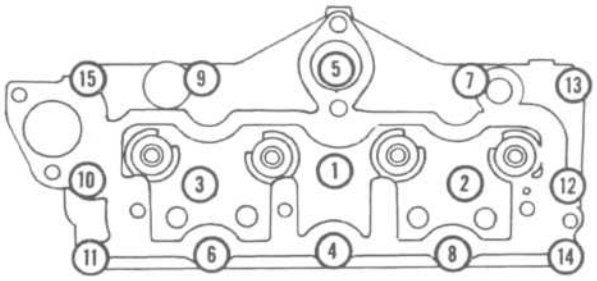
Reinstall the water pump by-pass tube and the upper radiator hose. Reinstall the heater tube if so equipped and install the heat indicator wire.

Reconnect the rocker arm oil line and the vacuum booster tube. Reinstall the oil filler tube brace bracket screw.

Recondition the carburetor as outlined in the "Fuel" section. Install the carburetor using a new gasket and connect the throttle and choke controls and the fuel line.

Before starting the engine, which will result in heating the exhaust manifold, adjust the exhaust valve tappets to .016″ [0,406 mm.].

Note: With "free" valves (having caps over the lower ends) clearance may be reduced to .012″ [0,304 mm.] to eliminate objectionable noise.



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FIG. 104 —CYLINDER HEAD BOLT TIGHTENING SEQUENCE

Set the intake valve rocker arm adjustments sufficiently close to the standard .018″ [,4572 mm.] adjustment to allow the engine to run without any of the valves holding open.

Start the engine and allow it to run until operating temperature is reached, after which check the cylinder head nuts with a torque wrench to be sure that they are tightened to specifications. With the engine operating at idle speed make final adjustment of the rocker arms to .018″ [,4572 mm.] and recheck the exhaust valve adjustments. Install the rocker arm cover using a new gasket. Cement a new gasket on the valve cover plate. Install the

cover and ventilator tube using a new gasket back of the tube and new copper ring gaskets under the attaching screw heads.

Recondition the distributor and set the ignition timing according to instructions under "Distributor" in the "Electrical" section.

Reconnect the air cleaner tube and road test the vehicle.

E-7. Camshaft and Valve Tappets

The camshaft rotates on four bearings. The front bearing is a replaceable steel-shell bushing with babbitt facing while the other three bearings are precision machined in the cylinder block and have no bushings. The camshaft is driven by helical-cut timing gears, a steel gear on the crankshaft and a pressed fiber gear on the camshaft.

The camshaft bearings are lubricated under oil pressure through drilled passages in the crankcase. End thrust of the shaft is carried by a thrust plate bolted to the crankcase. The front bearing is pressed into place and staked to prevent rotation and endwise movement in the crankcase.

The timing gears are lubricated through a jet threaded into the crankcase which sprays oil from the front main bearing on the tooth contact point of the gears.

The valve tappets are lubricated through oil troughs cast in the crankcase. The troughs are filled by oil spray from the connecting rod ends and passages are drilled through the tappet guides to carry the oil to the tappets. A groove cut around the center of the tappet shank carries the oil up and down in the guide.

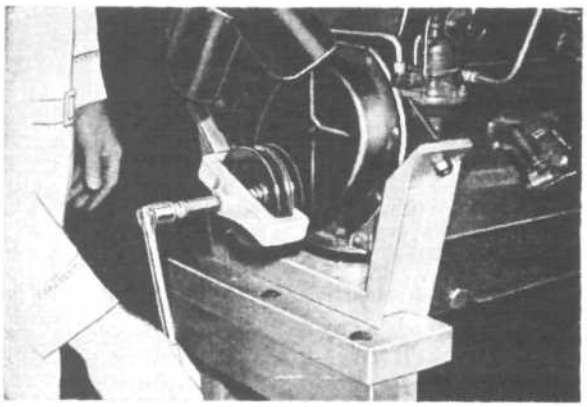


FIG. 105—CRANKSHAFT PULLEY PULLER

E-8. Removal of Camshaft or Valve Tappet

Drain the radiator and cylinder block, remove the radiator and grille, cylinder head, valves and valve springs. Follow instructions given in Par. E-2.

Remove the fuel pump and oil pump assemblies.

Remove the oil pan, crankshaft pulley with Puller Tool No. W-175, Fig. 105, fan belt and fan assembly.

Remove the front engine cover and the camshaft gear and thrust plate. The camshaft and crankshaft gears may be readily removed by using the recommended puller, Tool No. W-172, shown in Fig. 106.

Tie the valve tappets up at their highest point of travel with small "C" clamps or spring clip type clothespins. Remove the shaft.

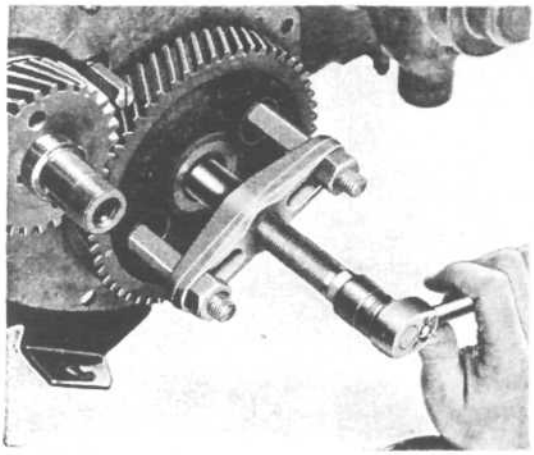


FIG. 106—TIMING GEAR PULLER

Before removing the tappets, carefully check their clearance in the guides to replace those which have excessive clearance. Oversize available is .004" [,1016 mm.] which should be fitted with .0005" to .002" [,0127 to ,0508 mm.] clearance. Remove the tappets and inspect the faces where they contact the cams. Replace any that are scored, rough or cracked.

Carefully inspect the shaft for scores and roughness of cam and bearing surfaces. The camshaft and bearings wear little as the shaft turns at half crankshaft speed so replacement of the shaft or bearing is seldom necessary. To facilitate a check of bearing clearances, however, the standard running tolerances are given at the end of this section.

E-9. Replacing Camshaft or Valve Tappets

Install the valve tappets and clip them in position. Install the camshaft and the camshaft thrust plate and spacer. Install the valves.

Install the camshaft gear, setting the valve timing as outlined in Par. E-11.

Clean the old gasket from the timing gear cover and cement a new one in position. Examine the oil seal to determine if it is serviceable and replace it if in doubt. Install the cover.

The balance of the assembly is the reverse of disassembly.

E-10. Camshaft Drive

Camshaft drive is through helical cut timing gears, a steel gear being used on the crankshaft and a pressed fiber gear on the camshaft. Lubrication is positive through a jet, Fig. 98, No. 46, threaded into the crankcase directly above the gear contact and through a drilled passage to the front main bearing.

Should it be necessary to replace the timing gears, attention must be given to the end float of both the camshaft and crankshaft and to the running clearance of the gears. It is also advisable to check both the jet and oil passage to be sure that they are clear.

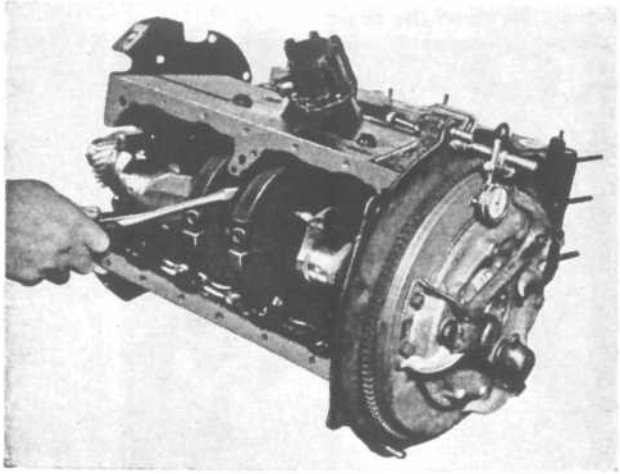


FIG. 107—GAUGING CRANKSHAFT END PLAY

End float of the crankshaft is set by the running clearance between the crankshaft thrust washer and the front face of the front main bearing. The standard end play is .004″ to .006″ [,1016 to ,1524 mm.] which is controlled by a shim placed between the thrust washer and the shoulder on the crankshaft. Check the end float with a dial indicator gauge as shown in Fig. 107. If clearance is incorrect, adjustment is made by adding or removing shims. Should the thrust washer be removed, be sure that it is reinstalled with the beveled inner edge toward the crankcase.

End float of the camshaft is determined by the running clearance between the face of the camshaft gear and the thrust plate, Fig. 98, No. 49, mounted on the crankcase. The standard clearance is .004″ to .007″ [,1016 to ,1778 mm.] which is determined by the thickness of the thrust plate spacer and which may best be measured without disassembly by a dial indicator gauge. As a general rule this clearance will change little through wear or even when a new gear is installed. Should a check show too little end float, place a shim of suitable thickness between the gear hub and the spacer. Too much end float may be corrected by dressing off the spacer a suitable amount.

To predetermine the correct end float, if the gear, spacer and thrust plate have been removed, measure the thickness of both the thrust plate and spacer with a micrometer. The thickness of the spacer must be approximately .006″ [,1524 mm.] greater than that of the thrust plate. When this is true and the parts are assembled and drawn tightly together by the gear retaining screw, the end float will be within standard limits. When the spacer is installed, be sure that the inner beveled edge is placed toward the crankcase.

Standard running tolerance between the gears is .000″ to .002″ [,000 to ,0508 mm.] which should be checked with a dial indicator.

When the gears have been removed, it is necessary, when reinstalling them, to retime the valves.

E-11. Valve Timing

To set the valve timing, install the gears with the crankshaft and camshaft so positioned that the timing gear marks are in alignment as shown in Fig. 108. For timing the ignition, see the "Electrical" Section.

To check the valve timing, carefully set the inlet valve rocker arm adjustment for No. 1 cylinder to .026″ [,6604 mm.]. Rotate the crankshaft clockwise until the piston in No. 1 cylinder is ready for the intake stroke. To determine this, remove the spark plug from No. 1 cylinder and test the compression with a finger over the spark plug opening. The intake valve opens at 9° before top center. Note the distance between the "TC" and "5°" marks on the timing gear cover and estimate the 9° before top center position.

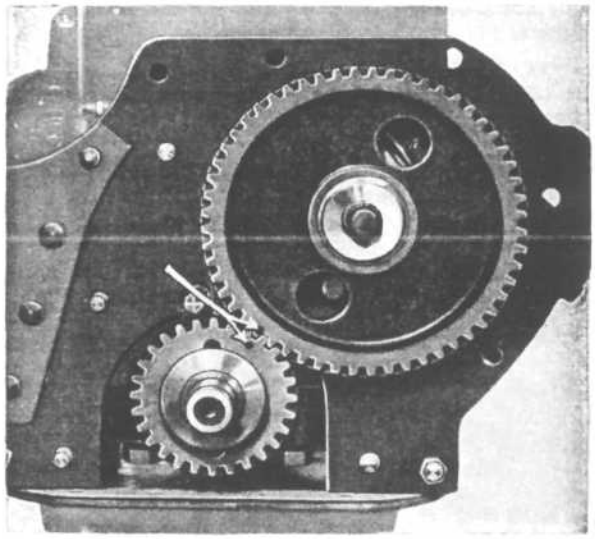


FIG. 108—TIMING GEARS

With the crankshaft in this position, timing is correct if the rocker arm is just tight against the valve stem. Do not overlook resetting the rocker arm adjustment to the correct running clearance.

E-12. Crankshaft

The crankshaft is of drop forged steel. To better control balance the counterweights are independently forged and attached to the shaft with a dowel and cap screw, which is tack welded for safety.

The flywheel is attached to the crankshaft with tapered dowel bolts, the holes for which are taper reamed at assembly. For information regarding the special crankshaft to flywheel bolts required

when a new flywheel or crankshaft is installed, refer to Par. E-22.

The shaft rotates on three steel back babbitt lined bearings with the front bearing taking the end thrust.

Whenever it is necessary to remove the crankshaft or install new crankshaft bearings, the engine must be removed from the frame. Should the flywheel be removed refer to Par. E-22.

The bearings are made to size and do not require line reaming. The running tolerance is .001″ to .0025″ [,0254 to ,0635 mm.]. No adjustment is possible and if they require attention they should be replaced

When it is necessary to install new bearing shells, it is advisable to first use a micrometer to determine if the shaft journals are out of round. Should a check determine an out of round condition in excess of the standard running clearance of the bearings (either main or connecting rod) a satisfactory bearing replacement cannot be made and it will be necessary to regrind the shaft. The following undersize crankshaft main bearings are available:

.001″ [0,025 mm.]	.012″ [0,304 mm.]
.002″ [0,050 mm.]	.020″ [0,508 mm.]
.010″ [0,254 mm.]	.030″ [0,762 mm.]

Before installing the shaft and bearings use a rifle brush to clean out the oil passages thoroughly in both the shaft and crankcase and if possible blow them out with compressed air. Be sure the journals are not nicked or scored and that all parts are thoroughly clean. Give attention to the rear bearing oil seal as outlined in Par. E-13.

After installation check the running clearance to be sure it is standard. A good way to do this is to place a .002″ [,0504 mm.] test shim between the shaft and the shell. With the bearing cap nuts drawn up to the recommended 65 – 75 ft. lbs. [8,98 – 10,3 kg-m.] torque, the shaft should either be locked or there should be a drag when it is turned by hand proving that the clearance is correct. Do not overlook removing the test shim.

The standard end play of the crankshaft is .004″ to .006″ [,1016 to ,1524 mm.] which is adjusted by shims placed between the crankshaft thrust washer and the shoulder on the crank. This clearance may be checked with a dial gauge as indicated in **Fig. 107**. To adjust end play it is necessary to remove the crankshaft gear with a puller, Fig. 106, and the thrust washer. When replacing the washer, be sure the side with the inner beveled edge faces the front bearing.

Never file a main bearing cap or install shims between the cap and block as roundness and alignment of the bearings will be destroyed.

To maintain accurate alignment in manufacture, the bearing caps are machined as an integral part of the cylinder block. To identify the caps as being part of a given crankcase a daub of paint is placed on the center bearing web and each bearing cap is marked with the same color paint. Use care not to interchange the caps with those from any other engine.

When the crankshaft is removed due attention must be given the rear main bearing oil seal which is discussed in the following paragraphs.

E-13. Crankshaft Rear Bearing Seal

Oil leakage through the rear main bearing is prevented by a metal supported neoprene lip type seal which can readily be installed without removing the crankshaft. When installing, coat both halves of the seal with light cup grease excepting the ends of the seal which are treated with sealing compound.

Early production engines are equipped with a wick type packing installed in the crankcase and rear main bearing cap. Should the upper packing require replacement, drop the crankshaft slightly and remove the packing with a bent piece of stiff wire. The new type seal can then be installed.

When installing the rear main bearing cap in the crankcase a little sealer should be placed on the sides and face of the cap to prevent oil leakage.

The rubber packings, Fig. 109, between the bearing cap and the case are cut to a given length and will protrude approximately ¼″ [6,35 mm.] from the case. When the oil pan is installed it will force this packing tightly into the holes and effectively seal any opening between the bearing cap and the crankcase.

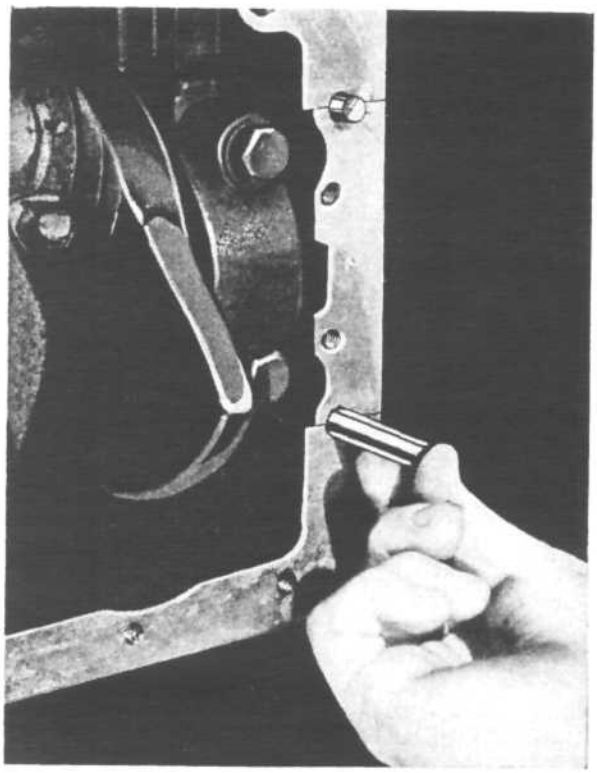


FIG. 109—REAR BEARING CAP PACKING

Should trouble be experienced with oil leaking from the rear main bearing there are several points which should be checked which are listed below.

a. Be sure that the identifying paint daub on the bearing cap is the same as that appearing on the center bearing web.

b. The bearing to crankshaft clearance must not exceed .004″ [,1016 mm.].

c. Place sealer on the faces of the rear bearing cap from the rear oil groove to the oil seal grooves.

d. Be sure the rubber oil seals extend about ¼″ [6,35 mm]. below the bottom face of the cap.

e. Be sure the oil pan gasket is not leaking.

f. Check to be sure the oil leak is not at the camshaft rear bearing expansion plug or from a sand hole in the crankcase.

E-14. Connecting Rods

The connecting rods are drop forged with the wrist pin clamped in the rod. The connecting rod and piston assemblies must be removed through the top of the engine because of the counterweights.

The standard running clearance of the connecting rod bearings is .0005″ to .0025″ [.0127 to,0635 mm.] and the side clearance is .005″ to .009″ [,127 to ,2286 mm.] which may be measured by a feeler gauge as shown in Fig. 110.

The connecting rod bearings are of the precision shell type which require no fitting. When installing new shells, align the oil spray holes in the upper shell with the spray holes in the connecting rods.

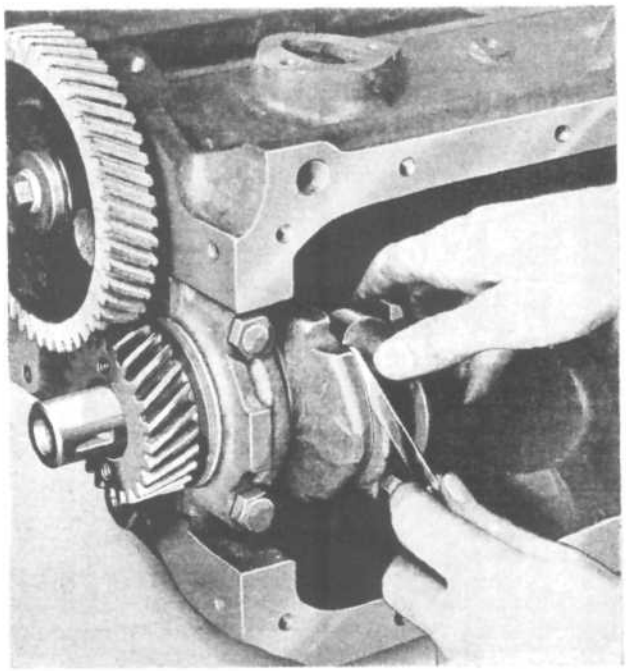


FIG. 110—CONNECTING ROD SIDE PLAY

The running clearance should be checked with a .002″ [,0508 mm.] test shim. Place the shim between the bearing and the shaft journal, tightening the nuts to the recommended torque. Without the test shim in position, the shaft should turn freely. With the test shim installed, the shaft should either be locked or there should be a heavy drag when it is turned by hand proving that the clearance is correct. Do not overlook removing the shim. The following undersize connecting rod bearings are available:

.001″ [0,025 mm.]	.012″ [0,304 mm.]
.002″ [0,050 mm.]	.020″ [0,508 mm.]
.010″ [0,254 mm.]	

The connecting rod cap nuts are locked with stamped nuts which should be renewed when once removed. These nuts should be installed with the flat face toward the connecting rod nut. Turn the locking nut finger tight and then tighten it one half turn only.

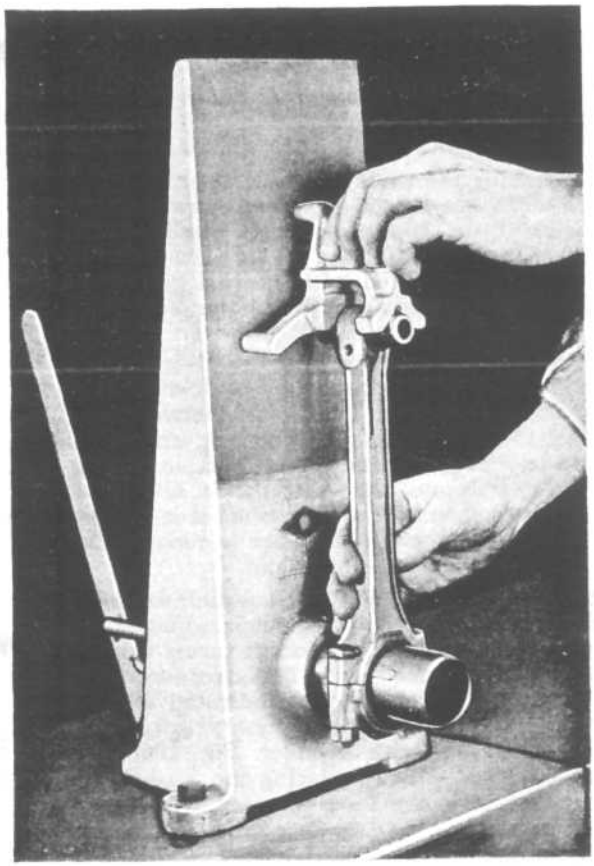


FIG. 111—CONNECTING ROD ALIGNER

Every time a connecting rod is removed from an engine or a new rod is installed, it should be checked for alignment on an aligning fixture, Fig. 111.

When straightening the rod, twist or bend in the opposite direction slightly more than the original twist or bend, then return the rod to true alignment. The rod will then retain correct alignment.

Longer main bearings with greater wearing surfaces are possible through the use of offset connecting rods. When the rods are installed the offset, Fig. 112, is placed away from the nearest main bearing. The oil spray hole should be on the follow side or away from the camshaft, facing the right side of the vehicle. Due to the offset, No. 1 and 2 or No. 3 and 4 connecting rod cannot be interchanged for if they are reversed, the oil spray hole will be on the wrong side. No. 1 and 3 or No. 2 and 4 can be interchanged.

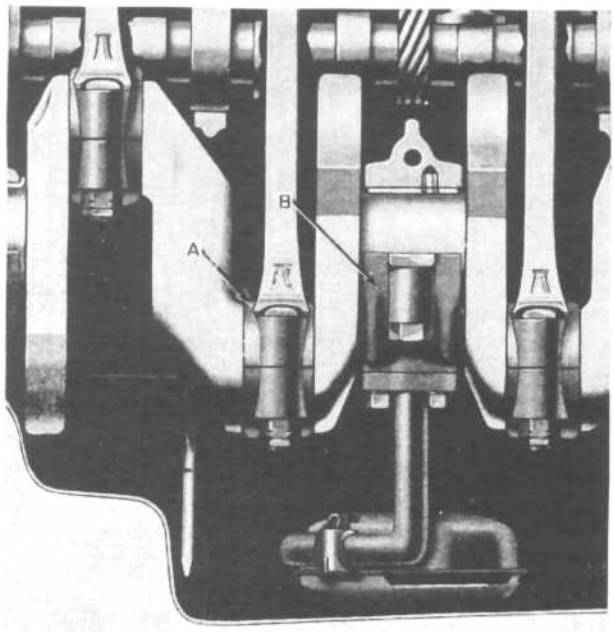


FIG. 112—CONNECTING ROD OFFSET

E-15. Pistons

The engine is equipped with aluminum pistons which are "T" slotted, cam ground, tin plated and have a heat insulating groove at the top in which no ring is installed. The pistons are fitted with .003″ [,0762 mm.] clearance. To determine this clearance use a .003″ [,0762 mm.] feeler gauge ¾″ [19,05 mm.] wide which should give five to ten lbs. [2,27-4,54 kg.] pull when removed, Fig. 113. The gauge should extend the full length of the piston on the thrust side which is opposite the slot. Correct clearances may be secured by selecting pistons of the correct size as there is slight variation in the sizes of standard pistons.

Pistons are available in the following oversizes: .010″, .020″, .030″ and .040″ [,2540, ,5080, ,7620 and 1,016 mm.].

Before any attempt is made to fit new pistons, the cylinder bores should be carefully checked for out of round and taper. See Par. E-19.

If an oversize piston is required, the cylinders must be reconditioned with a cylinder boring machine. See Par. E-19.

The pistons have an extra groove directly above the top ring which acts as a heat dam or insulating groove. In operation pressure is built up in this groove on the power stroke which acts as a baffle

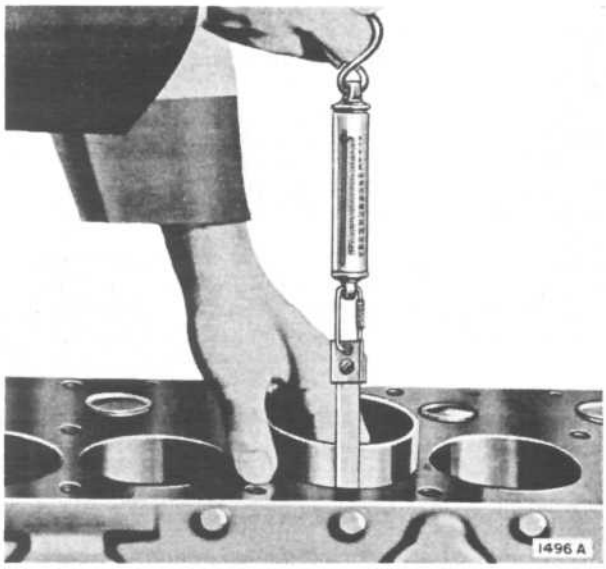


FIG. 113—PISTON FITTING

to reduce the passage of oil into the combustion chamber. This groove also provides more even distribution of heat and better lubrication of the piston rings.

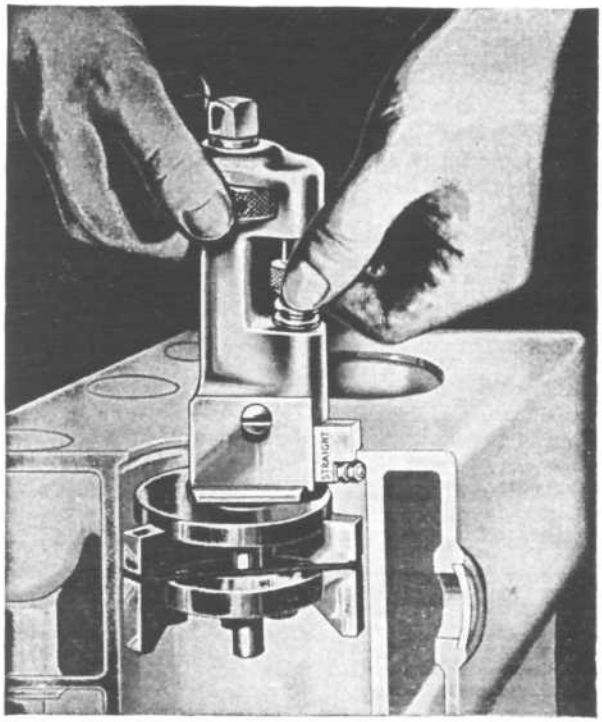


FIG. 114—CYLINDER RIDGE REAMER

E-16. Piston Rings

When installing a new set of piston rings without reconditioning the cylinder bores, always remove the ridge at the top of the cylinder bore with a reliable ridge reamer, Fig. 114. Use care not to cut below the top of the upper ring position in the bore. It is always advisable to remove the ridge before removing the pistons, keeping the piston tops covered with cloth to prevent the cuttings falling

into the engine. When the rings are installed stagger the end gaps around the pistons. A ring compressor is essential for rapid assembly.

The width of the compression rings is 3/32" [2,3812 mm.] and that of the oil control ring is 3/16" [4,7625 mm.]. While the compression rings are of the same size, they are different in construction and must not be interchanged. Install these rings as shown in Fig. 115, which is outlined below.

The upper compression ring has an inside beveled edge which must be installed toward the top. The face of the lower compression ring is tapered approximately .001" [,0254 mm.]. The letters "T" or "TOP" on the upper edge indicate how the ring is installed.

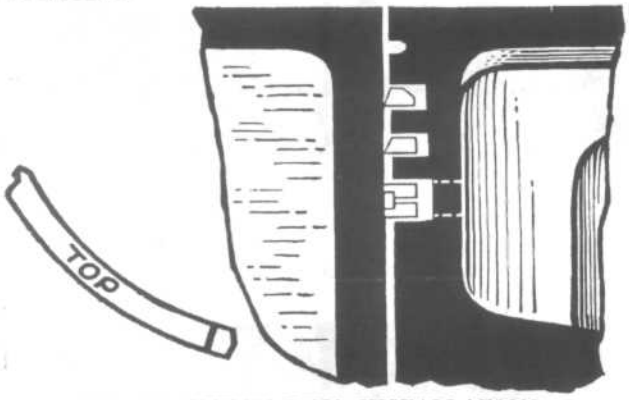


FIG. 115—PISTON RING INSTALLATION

When fitting the rings to the cylinder bores, Fig. 116, the end gap is .008" to .013" [,2032 to ,3302 mm.]. The groove clearance, Fig. 117, of the top compression ring is .002" to .004" [,0508 to ,1016 mm.]. That of the center ring is .0015" to .0035" [,0381 to ,0889 mm.] and that of the bottom ring .001" to .0025" [,0254 to ,0635 mm.].

When a cylinder has been rebored or honed, standard production rings should be installed. If the cylinders have not been rebored or honed so that there is possibly a slight out of round condition not to exceed .005" [,1270 mm.], a service type ring must be installed.

Oversize rings which are available for rebored engines are .010", .020", .030" and .040" [,2540, ,5080, ,7620 and 1,016 mm.].

Service type rings for use when the cylinders have not been rebored or honed are supplied in the following ranges of oversizes: Standard to .009", .010" to .019", .020" to .029", .030" to .039" and .040" to .049" [,2540 to ,4826, ,5080 to ,7366, ,7620 to ,9906 and 1,0160 to 1,2446 mm.).

Note: As much as 4000 miles [6.400 km.] may be required for the chrome flash type compression rings to seat properly. During this piston ring run-in period, oil consumption may be higher than it was before new rings were installed. Oil consumption that is normal for the driving habits and type of operation involved should be evident at 4000 miles.

E-17. Piston Pins

The piston pins are anchored in the rods with lock screws and the manufacturer does not recommend the installation of oversize pins for experience has shown that should a pin be worn sufficiently to require replacement, the piston also should be replaced.



FIG. 116—PISTON RING GAP

The pins are fitted with a clearance of approximately .0001" to .0005" [,00254 to ,01270 mm.] which is equivalent to a light thumb push fit at room temperature. The pin should not fall through its hole in the piston by its own weight. See Fig. 118.

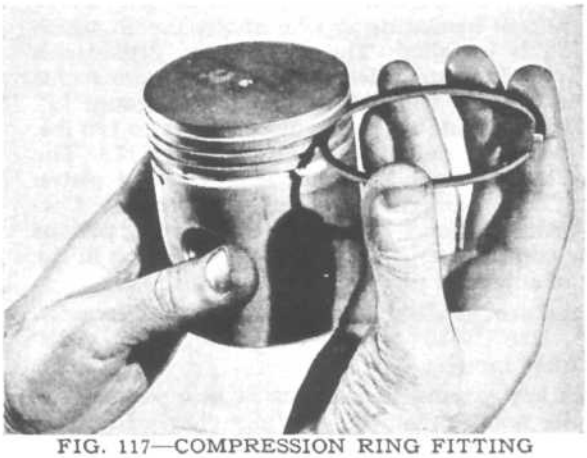


FIG. 117—COMPRESSION RING FITTING

E-18. Assembling Piston to Connecting Rod

Some connecting rod aligning fixtures are designed for checking alignment before the piston is installed and others with the piston assembled. If the fixture available is of the first mentioned type, align the rods following fixture manufacturer's instructions,

after which assemble the piston on the rod as outlined below.

Clamp the connecting rod in a vise using vise jaw shields of soft metal or two pieces of hardwood, one on each side of the rod, approximately three inches from the piston pin end.

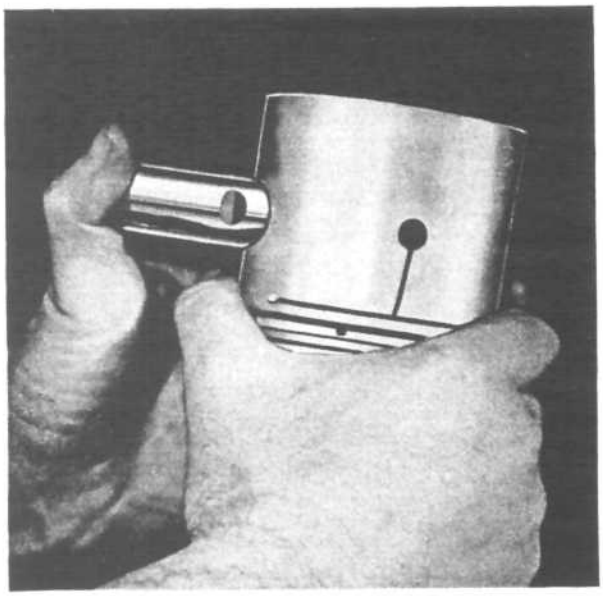


FIG. 118—PISTON PIN FITTING

Start the piston pin in the piston with the lock screw groove facing down. Assemble piston to the connecting rod with slot No. 2, Fig. 119 in the piston, on the opposite side from the oil spray hole, No. 1 in the bearing end of the connecting rod. Install the piston pin clamp screw.

Should the aligning fixture available require the piston assembled before checking, do not overlook aligning the rods after installing the pistons.

E-19. Checking Cylinder Bores

The best method to check the condition of the cylinder bores to determine if reconditioning is necessary is by the use of a dial gauge.

The gauge hand will instantly and automatically indicate the slightest variation of the cylinder bores. To use this gauge simply insert it in the cylinder bores and move it up and down the full length. It is then turned spirally or completely rotated at different points, taking a reading at each point. In this manner all variations in the cylinder bores from top to bottom may be determined.

When cylinders are more than .005″ [.1270 mm.] out of true, it is best to rebore them. The instructions furnished by the manufacturer of the boring equipment should be carefully followed.

After the cylinders have been rebored within .002″ [.0508.) mm of the final size desired, they should be finished or polished with a cylinder hone. Do not attempt to lap them with the piston. In operation the hone is placed in the cylinder bore and run up and down the full length of the cylinder wall. Follow this procedure until the piston running clearance is correct as outlined in Par. E-15.

E-20. Oil Pump Assembly

The oil pump, Fig. 120. is located externally on the left side of the engine. In operation oil is drawn from the crankcase through the floating oil intake, Fig. 123, No. 3, then passes through a drilled passage in the crankcase to the pump from which it is forced through drilled passages to the crankshaft and camshaft bearings.

When it is necessary to remove an oil pump, first remove the distributor cover and note the position of the distributing finger so that the pump may be reinstalled without disturbing the ignition timing. To install the pump without disturbing the timing, the pump gear must be correctly meshed with the camshaft driving gear to allow engagement of the driving key on the distributor shaft with the pump shaft driving slot, without moving the distributing finger. Distributor assembly can be made only in one position as the slot and driving key are machined off-center and it is necessary to correctly install the pump to provide this position.

The pump employs an inner and outer rotor within the pump body and an oil relief valve is mounted on the pump body which controls oil pressure at higher speeds.

To disassemble the pump, Fig. 120, first remove the gear which is retained by straight pin No. 8. It will be necessary to file off one end of the pin before driving it out with a small drift. By removing the cover No. 2, the outer rotor and the inner rotor and shaft No. 4 may be removed through the cover opening.

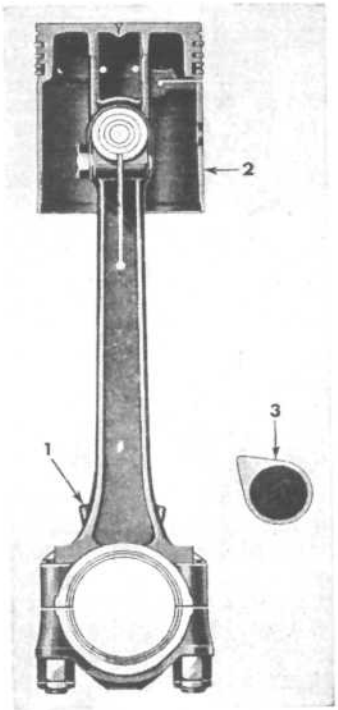


FIG. 119—CONNECTING ROD AND PISTON

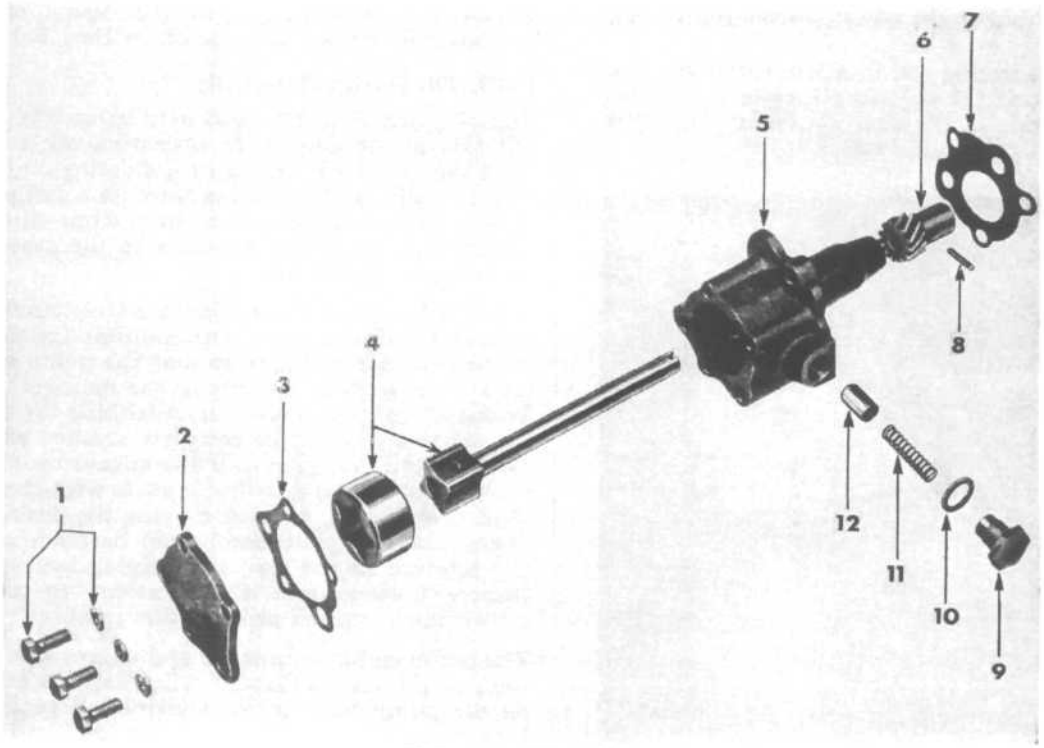


FIG. 120—OIL PUMP

1—Cover Screw
2—Cover
3—Cover Gasket
4—Shaft and Rotors
5—Body Assembly
6—Driven Gear
7—Pump Gasket
8—Gear Retaining Pin
9—Relief Valve Retainer
10—Relief Valve Retainer Gasket
11—Relief Valve Spring
12—Relief Valve Plunger

Failure of the pump to operate at full efficiency may usually be traced to excessive end float of the rotors or excessive clearance between the rotors. The clearance between the outer rotor and the pump body should also be checked.

Match the rotors together with one lobe of the inner rotor pushed as far as possible into the notch of the outer rotor. Measure the clearance between the lobes of the rotors as shown in Fig. 121. This clearance should be .010″ [,2540 mm.] or less. If more replace both rotors.

Measure the clearance between the outer rotor and the pump body as shown in Fig. 122. Should this clearance exceed .012″ [,3048 mm.] the fault is probably in the pump body and it should be replaced.

End float of the rotors is controlled by the thickness of the cover gasket which is made of special material which can be only slightly compressed. Never use other than a standard factory gasket.

Check the cover to be sure the inner surface is not rough or scored and that it is flat within .001″ [,0254 mm.] tested with feeler gauges, Fig. 123. Measure thickness of the rotors which must be within .001″ [,0254 mm.] of each other. Assemble the rotors in the pump body and install the cover without the gasket. When the cover screws are tightened to normal tension, there should be interference between the rotors and the cover making it impossible to turn the pump shaft by hand. Remove the cover and replace it with the gasket in position which should free the rotors and shaft and prove that end float of the rotors is less than the thickness of the gasket when compressed or .004″ (.1016 mm.) which is satisfactory.

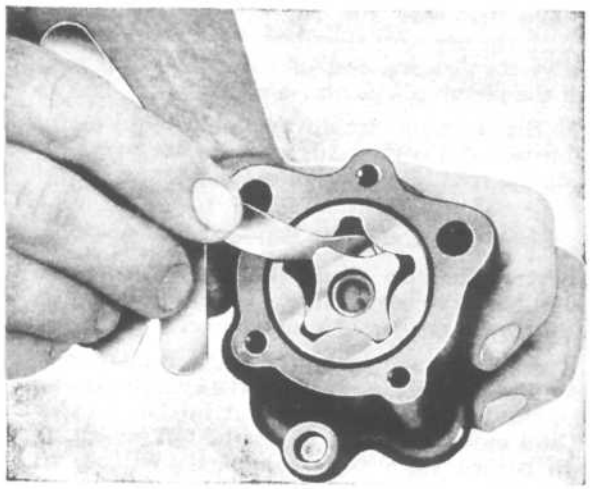


FIG. 121—CHECKING OIL PUMP ROTORS

After assembling the gear on the pump shaft, check the running clearance between the gear and pump body with a feeler gauge. This clearance should be from .003″ to .010″ [,0762 to ,2540 mm.].

The pressure of the pump is controlled by an oil relief valve, Fig. 120, No. 12, and may be altered

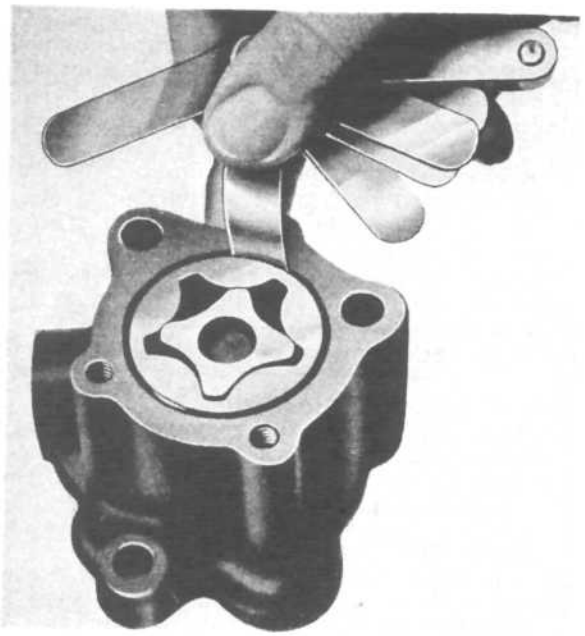


FIG. 122—CHECKING OUTER ROTOR TO OIL PUMP BODY

by installing or removing shims from between retainer No. 9 and the spring. Adding shims increases pressure and removing shims decreases pressure. This adjustment will change the pressure at higher speeds but not at idle speed.

The pressure at which the oil relief valve opens with standard setting is approximately 35 lbs. [2,46 kg./sq. cm.]. Safe minimum pressure is 6 lbs. [,421 kg./sq. cm.] at idle and 20 lbs. [1,406 kg./sq. cm.] at 2000 rpm. (35 mph.) [56 k.].

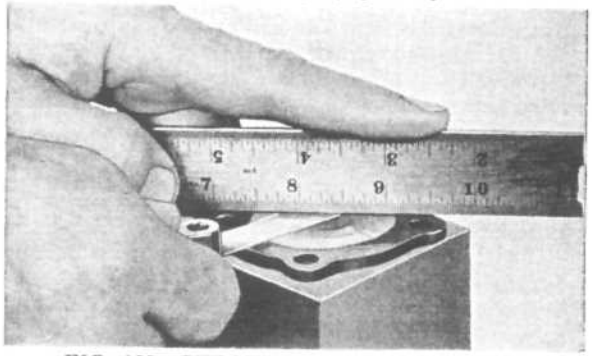


FIG. 123—CHECKING OIL PUMP COVER

E-21. Floating Oil Intake

The floating oil intake, Fig. 124, is attached to the crankcase with two screws. The construction of the float and screen causes it to remain on top of the oil, raising and lowering with the amount of oil in the pan.

This construction prevents water or dirt, which may have accumulated in the bottom of the oil pan from circulating because the oil is drawn horizontally from the top surface.

Whenever removed, the float, screen and tube should be cleaned thoroughly to prevent any accumulation of dirt, also clean the oil pan.

Fluctuating oil pressure can usually be traced to an air leak between the oil float support and the crankcase. Be sure the float support flange, Fig.

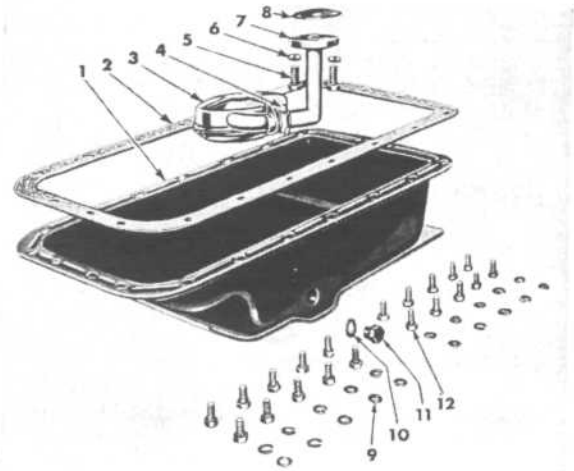


FIG. 124—FLOATING OIL INTAKE AND OIL PAN

124, No. 7, is flat. Clean both the flange and the crankcase surfaces thoroughly before installing a new gasket. Be sure the retaining screws are tight. The oil pan screw torque wrench reading is 9 to 14 lb-ft. [1,24 a 1,94 kg-m.].

E-22. Flywheel

The flywheel is attached to the crankshaft with two tapered dowel bolts and four special head bolts. When the flywheel is assembled to the crankshaft, be sure the "TC" timing mark is correctly located in relation to No. 1 crank throw. The correct location is indicated by arrows stamped on the flywheel center and on the crankshaft flange which should be installed together. Be sure the crankshaft and flywheel are clean and that there are no nicks or burrs to prevent even seating of the flange. After installation check the runout with a dial indicator attached to the engine plate. Fig. 125. This should not exceed .008" [,2032 mm.] on the outer edge of the rear face of the flywheel. Torque wrench reading 35 to 41 lb-ft. [4,84 a 5,67 kg-m.].

When installing a new crankshaft or flywheel replace the tapered dowel bolts with straight snug fitting special bolts furnished with these parts. The crankshaft and flywheel should be assembled in proper relation, then install the straight bolts previously used and tighten securely. Next use a $^{35}/_{64}$" [13,8887 mm.] drill to enlarge the tapered holes. Ream the holes with a $^{9}/_{16}$" [14,2875 mm.] straight reamer and install the two special flywheel bolts with nut and lockwasher instead of the two tapered dowel bolts formerly used. This procedure overcomes the necessity of taper reaming the special tapered holes.

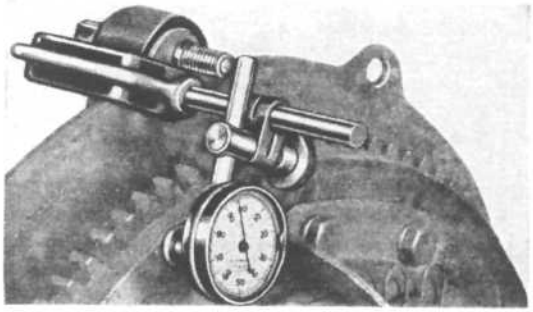


FIG. 125—FLYWHEEL RUNOUT GAUGE

E-23. Oil Pressure Gauge

Early model vehicles are equipped with electric oil pressure gauges. This type of gauge is connected by a single wire to a sender mounted on the left rear side of the cylinder block.

Should the instrument panel unit fail to indicate pressure in the oil circulating system, stop the engine immediately. Failure to register may indicate no oil, a fault in the oil circulating system or in the gauge units, or loose or dirty electrical connections.

Should a gauge or sender be at fault, install a new unit because the gauges are sealed and cannot be repaired.

E-24. Oil Pressure Indicator

Late model vehicles are equipped with a ruby-red telltale lamp, which operates when the ignition switch is turned on. It is lit when there is insufficient oil pressure to properly lubricate the engine. When it goes out, operating pressure is achieved. In normal operation, the light is lit when the ignition is first turned on. It goes out after the vehicle is in motion. If the light does not go out, investigate immediately to avoid serious damage to the engine.

E-25. Oil Filler Tube

Should it be necessary to remove an oil filler tube of the type mounted on the right side of the engine, loop a piece of iron wire several times around the tube below the top and make a loop through which a pry bar may be used to pry over the top of the engine water outlet. Place a pull on the tube, taping it just above where it enters the crankcase. When installing a new tube be sure that the beveled lower end is away from the crankshaft. Place a piece of hard wood over the top of the tube when installing it to prevent damage to the cap gasket seat.

E-26. Engine Support Plate and Mounting

The front engine support is bolted to the front face of the crankcase and becomes the rear panel for attachment of the timing gear cover.

The rubber engine mountings, which are attached to the frame side rail brackets and to the support plate, prevent fore-and-aft motion of the engine yet allow free side wise and vertical oscillation which has the effect of neutralizing vibration at the source.

The rubber surfaces of the engine mountings partially insulate the engine from the frame. A combination engine ground strap and radio suppression mounting strap is provided at the right front engine support bracket, Fig. 126, to bridge this insulation and provide a positive electrical connection for the starting motor and ignition circuits. The attaching screws must be kept tight and the connections clean. A loose or poor connection may result in hard starting of the engine, low charging of the generator, poor radio suppression or sluggish starting motor operation.



FIG. 126—ENGINE GROUND STRAP

The rear engine plate is attached to the rear of the crankcase and provides a means for attachment of the flywheel bell housing.

Note: With the adoption of the 4½" starting motor, a new bell housing, rear engine plate, and flywheel ring gear were required.

The engine is supported at the frame cross member on a mounting under the transmission. The torque wrench reading is 38-42 ft-lb. [5,2554-5,8086 kg. m.] for the mounting stud nuts.

E-27. Engine Removal

Should the engine require overhauling, it is best to remove it from the chassis. This may be accomplished as follows:

- **a.** Disconnect the battery at either terminal to avoid the possibility of a short circuit.
- **b.** Drain the cooling system by opening the drain cock at the bottom of the radiator.
- **c.** Remove the bolts and nuts which attach the hood to the hood hinge, disconnect the hood brace rod and remove the hood.
- **d.** Remove the radiator brace rods.
- **e.** Remove both the upper and lower radiator hoses and the heater hoses if so equipped.
- **f.** Remove the radiator attaching screws and remove the radiator.
- **g.** Disconnect the fuel line at the fuel pump and the flexible windshield wiper hose.
- **h.** Remove the carburetor air cleaner.
- **i.** Disconnect the carburetor choke and throttle controls.
- **j.** Remove the starting motor wires and the starting motor.
- **k.** Disconnect the generator wires.
- **l.** Disconnect the ignition primary wire at the coil and if equipped with an overdrive also the overdrive control wires. Note that the overdrive wires must be reattached to the same terminals from which they were removed, for otherwise the overdrive will not operate. See wiring diagram, Fig. 198. To avoid possibility of error, it is best to mark them.
- **m.** Disconnect the heat indicator and oil gauge wires.
- **n.** Disconnect the exhaust pipe from the exhaust manifold.
- **o.** Remove the two nuts and bolts from each front engine support.
- **p.** Remove the bolts which attach the flywheel bell housing to the engine.
- **q.** Install a suitable lifting sling on the engine. Raise the engine high enough to release the weight from the front engine supports and pull the engine forward, or roll the vehicle back, until the clutch clears the bell housing. Lift the engine from the vehicle.

SERVICE DIAGNOSIS

Poor Fuel Economy
- Ignition Timing Slow or Spark Advance Stuck
- Carburetor Float High
- Accelerator Pump Not Properly Adjusted
- High Fuel Pump Pressure
- Fuel Leakage
- Leaky Fuel Pump Diaphragm
- Loose Engine Mounting Causing High Fuel Level in Carburetor
- Low Compression
- Valves Sticking
- Spark Plugs Bad
- Spark Plug Cables Bad
- Weak Coil or Condenser
- Improper Valve Tappet Clearance
- Carburetor Air Cleaner Dirty
- High Oil Level in Air Cleaner
- Dragging Brakes
- Front Wheels Out of Alignment
- Tires Improperly Inflated
- Inaccurate Odometer
- Faulty Fuel Tank Cap
- Clogged Muffler or Bent Exhaust Pipe

Lack of Power
- Low Compression
- Ignition System (Timing Late)
- Improper Functioning Carburetor or Fuel Pump
- Fuel Lines Clogged
- Air Cleaner Restricted
- Engine Temperature High
- Improper Tappet Clearance
- Sticking Valves
- Valve Timing Late
- Leaky Gaskets
- Muffler Clogged
- Bent Exhaust Pipe

Low Compression
- Leaky Valves
- Poor Piston Ring Seal
- Sticking Valves
- Valve Spring Weak or Broken
- Cylinder Scored or Worn
- Tappet Clearance Incorrect
- Piston Clearance too Large
- Leaky Cylinder Head Gasket

Burned Valves and Seats
- Sticking Valves or too Loose in Guides
- Improper Timing
- Excessive Carbon Around Valve Head and Seat
- Overheating
- Valve Spring Weak or Broken
- Valve Tappet Sticking
- Valve Tappet Clearance Incorrect
- Clogged Exhaust System

Valves Sticking
- Warped Valve
- Improper Tappet Clearance
- Carbonized or Scored Valve Stems
- Insufficient Clearance Valve Stem to Guide

Valves Sticking — Continued
- Weak or Broken Valve Spring
- Valve Spring Cocked
- Contaminated Oil

Overheating
- Inoperative Cooling System
- Thermostat Inoperative
- Improper Ignition Timing
- Improper Valve Timing
- Excessive Carbon Accumulation
- Fan Belt too Loose
- Clogged Muffler or Bent Exhaust Pipe
- Oil System Failure
- Scored or Leaky Piston Rings

Popping-Spitting-Detonation
- Improper Ignition
- Improper Carburetion
- Excessive Carbon Deposit in Combustion Chambers
- Poor Valve Seating
- Sticking Valves
- Broken Valve Spring
- Tappets Adjusted too Close
- Spark Plug Electrodes Burned
- Water or Dirt in Fuel
- Clogged Lines
- Improper Valve Timing

Excessive Oil Consumption
- Piston Rings Stuck in Grooves, Worn or Broken
- Piston Rings Improperly Fitted or Weak
- Piston Ring Oil Return Holes Clogged
- Excessive Clearance, Main and Connecting Rod Bearings
- Oil Leaks at Gaskets or Oil Seals
- Excessive Clearance, Valve Stem to Valve Guide (Intake)
- Cylinder Bores Scored, Out-of-Round or Tapered
- Too Much Clearance, Piston to Cylinder Bore
- Misaligned Connecting Rods
- High Road Speeds or Temperature
- Crankcase Ventilator Not Operating

Bearing Failure
- Crankshaft Bearing Journal Out-of-Round
- Crankshaft Bearing Journal Rough
- Lack of Oil
- Oil Leakage
- Dirty Oil
- Low Oil Pressure or Oil Pump Failure
- Drilled Passages in Crankcase or Crankshaft Clogged
- Oil Screen Dirty
- Connecting Rod Bent

ENGINE SPECIFICATIONS

MODEL:	F4-134	METRIC
Engine:		
Type	F-Head	F-Head
Number of Cylinders	4	4
Bore	3 1/8"	79,375 mm.
Stroke	4 3/8"	111,12 mm.
Piston Displacement	134.2 cu. in.	2199 cm^3
Compression Ratio:		
Standard	6.9 to 1	6,9 a 1
Optional	7.4 and 7.8	7,4 a 1 - 7,8 a 1
Horsepower-Max. Brake	72 @ 4000 rpm.	72 @ 4000 rpm.
Compression	120 to 130 psi.	8,44 a 9,14 $kg-cm^2$
Horsepower (SAE)	15.63	15,63
Maximum Torque	114 ft. lbs. @ 2000 rpm.	15,766 kg-m.
Firing Order	1-3-4-2	1-3-4-2
Crankshaft:		
Counterweights	4	4
Bearing Journals	3	3
Front	2.333"-2.334" 1.64 Nom.	59,26 mm. 41,66
Center	2.333"-2.334" 1.72 Nom.	59,26 mm. 43,69
Rear	2.333"-2.334" 1.66 Nom.	59,26 mm. 42,16
Thrust	Front	.....
End Play	.004"-.006"	0,1016 a 0,1524 mm.
Bearing Clearance	.0003"-.0029"	0,0071 a 0,0736 mm.
Type	Steel Shell-Babbitt Lined	.....
Connecting Rod:		
Center to Center Length	9.187"	23,33 cm.
Upper End	Locked in Rod	.....
Lower Bearing Type	Steel Shell-Babbitt Lined	.....
Lower Bearing Dia. and Length	1 15/16" x 1 5/16"	49,212 x 33,33 mm.
Clearance on Crankshaft	.0001"-.0025"	0,0025 a 0,0634 mm
End Play	.004"-.010"	0,1016 a 0,254 mm.
Installation	From Above	.....
Pistons and Rings:		
Material	Aluminum Alloy	.....
Features	Cam, Tin Plated, "T" Slot, Heat Dam	.....
Length	3 3/4"	9,525 cm.
Clearance:		
Top Land	.018"-.021"	0,457 a 0,533 mm.
Skirt	.003"	0,0762 mm.
Number of Rings	3	3
Compression Rings	Two- .0925"-.0935"	(2) 2,381 mm.
Oil Ring	One- .1860"-.1865"	(1) 4,762 mm.
Ring Gap	.007"-.017"	0,178 a 0,432 mm.
Piston Pin:		
Length	2 25/32"	70,640 mm.
Diameter	.8118"	20,622 mm.
Type	Locked in Rod	.....
Clearance in Piston	.0002"-.0004" Selective Fit	0,005 a 0,010 mm.

ENGINE SPECIFICATIONS—(Continued)

MODEL:	F4-134	METRIC
Camshaft:		
Number of Bearings	4	4
Bearing Journal Diameter:		
Front	2.1860"-2.1855"	55,518 mm.
Front Intermediate	2.1225"-2.1215"	53,898 mm.
Rear Intermediate	2.0600"-2.0590"	52,311 mm.
Rear	1.6230"-1.6225"	41,217 mm.
Thrust Taken	Front	.....
End Play Control	Thrust Plate	.....
Intake Valve:		
Tappet Clearance — Cold	.018"	0,4612 mm.
Seat Angle	45°	45°
Diameter of Head	2"	50,8 mm.
Over All Length	$4\frac{25}{32}$"	121,4 mm.
Stem Diameter	.373"	9,474 mm.
Stem to Guide Clearance	.0007"-.0022"	0,01778 a 0,05588 mm.
Intake Opens	9° BTC (Piston Travel .033")	9° BTC [0,938 mm.]
Intake Closes	50° ABC (Piston Travel 3.563")	50° ABC (90,5 mm.]
Lift	.260"	6,604 mm.
Exhaust Valve:		
Tappet Clearance — Cold	.016"	0,4064 mm.
Seat Angle	45°	45°
Diameter of Head	$1\frac{15}{32}$"	37,31 mm.
Over All Length	$5\frac{29}{32}$"	150,0 mm.
Stem Diameter	.3715"	9,436 mm.
Stem to Guide Clearance	.0025"-.0045"	0,0635 a 0,1143 mm.
Exhaust Opens	47° BBC (Piston Travel 3.822")	47° BBC [97,08 mm.]
Exhaust Closes	12° ATC (Piston Travel .059")	12° ATC [1,498 mm.]
Lift	.351"	8,915 mm.
Intake Valve Spring:		
Free Length	$1\frac{31}{32}$"	50,0062 mm.
Valve Closed	73 lbs. @ $1\frac{21}{32}$"	33,069 kg-m. @ 86,787 mm.
Valve Open	153 lbs. @ $1\frac{13}{32}$"	69,4 kg-m. @ 35,7 mm.
Exhaust Valve Spring:		
Free Length	$2\frac{1}{2}$"	6,35 cm.
Valve Closed	53 lbs. @ $2\frac{7}{64}$"	24,04 kg-m. @ 5,358 cm.
Valve Open	120 lbs. @ $1\frac{3}{4}$"	54,36 kg-m. @ 4,44 cm.
Timing Gears:		
Type	Helical	.....
Material:		
Crankshaft Gear	Cast Iron	.....
Camshaft Gear	Pressed Fibre-Steel Hub	.....
Fan Belt:		
Type	V	V
Angle of V	38°	38°
Width	$1\frac{1}{16}$"	1,746 cm.
Length Outside	$42\frac{5}{8}$"	108 cm.
Oil Pump:		
Type	Internal Rotor	.....
Drive	Camshaft Gear	.....
Minimum Safe Oil Pressure	6 lbs. @ Idle	0,4218 kg-cm^2
	20 lbs. @ 2000 rpm. (35 mph.)	1,406 kg-cm^2 @ 2000 rpm. [56 km.]
Relief Valve Opens	40 lbs.	2,81 kg-cm^2

FUEL SYSTEM

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F-1. GENERAL

The fuel system consists of the fuel tank, fuel lines, fuel pump, carburetor and air cleaner.

The most important attention necessary to the fuel system is to keep it clean and free from water.

It should be periodically inspected for leaks.

CAUTION—Whenever a vehicle is to be stored for an extended period, the fuel system should be completely drained, the engine started and allowed to run until the carburetor is emptied. This will avoid oxidization of the fuel, resulting in the formation of gum in the units of the fuel system. Gum formation is similar to hard varnish and may cause the fuel pump valves or the carburetor float valve to become stuck or the filter screen blocked. Acetone, obtainable in most drug stores, will dissolve gum formation. In extreme cases it will be necessary to disassemble and clean the fuel system, however, often one pint [,6 liter] of acetone placed in the fuel tank with about one gallon [4,5 liters] of gasoline will dissolve any deposits as it passes through the system with the gasoline.

Information pertaining to the operation and servicing of the units of the fuel system are covered in the succeeding paragraphs.

F-2. CARBURETOR

The carburetors that are covered in this section and the vehicle model and serial numbers for which they are effective are all shown here:

Par.	Carburetor	Models	After Serial No.
F-3	YF-951S	All F4-134 Models	
F-17	WGD-2052SA	Early L6-226 Models	
F-23	WCD-2204S	L6-226 4WD Pickup	654-EC2-14773
		L6-226 4WD Stake	654-ED2-10325
		L6-226 4x4 SW	654-FA2-12542
		L6-226 4x4 SD	654-RA2-10218
F-37	YF-2467S	L6-226 4WD	55268-31178
		L6-226 4x4	54168-23628
		L6-226 4x2	54167-12034

F-3. Carter YF-951S Carburetor

All F4-134 Models

This carburetor is covered in Par. F-4 through F-16.

Five separate circuits are used in the carburetor to control and vaporize the fuel. A description of the function and operation of each circuit provides an overall description of the carburetor.

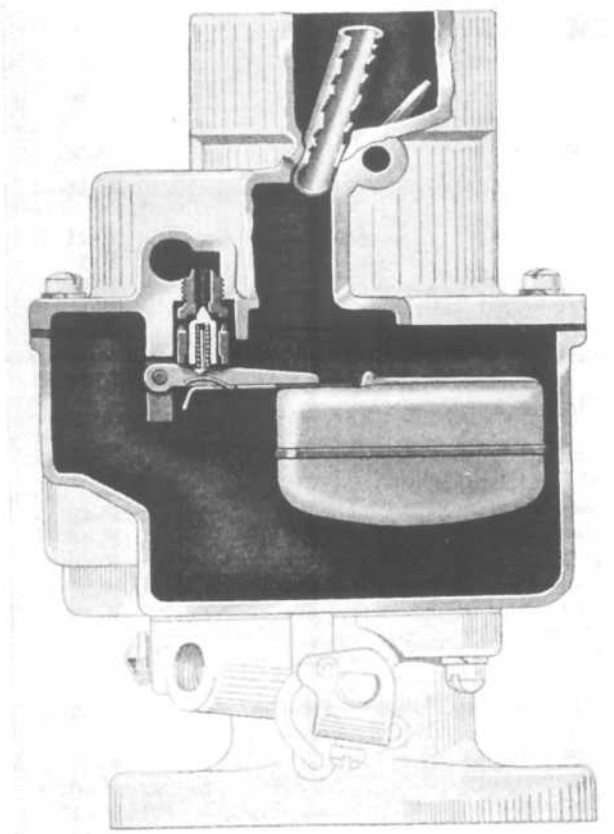


FIG. 127—THE FLOAT CIRCUIT

F-4. Carburetor Circuits

F-5. Float Circuit. The float circuit, Fig. 127, consists of a float, float pin, air horn gasket and the needle and seat assembly. These parts control the fuel level in the carburetor bowl, a supply being maintained for all circuits under all operating conditions.

To prevent float vibration from affecting the fuel level, the inlet or float valve is spring loaded. Should the needle and seat become worn, they must be replaced with a matched set, including the spring, which is the only way they are supplied.

When reinstalling the float be sure to install the float pin with the stop shoulder on the side away from the bore of the carburetor.

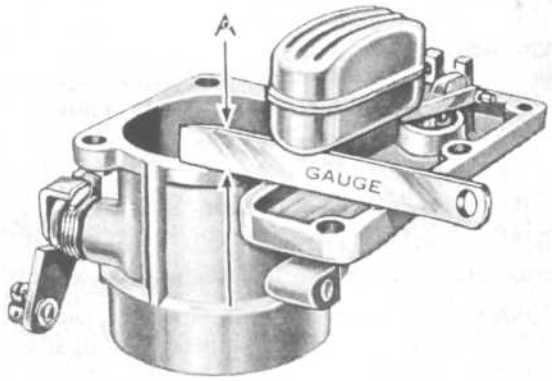


FIG. 128—FLOAT LEVEL GAUGING

F-6. Float Adjustment. The float level must be accurately set to insure accurate metering of fuel in both the low and high speed jets. See Fig. 128.

To set the float level remove the bowl cover assembly and invert it as shown in Fig. 128. Remove the bowl cover gasket and allow the weight of the float to rest on the needle and spring. Adjust the level by bending the float arm lip (not the arm) to provide 5/16" [7,93 mm.] clearance between the float and cover as shown by gauge A. Use care that there is no compression of the spring other than the weight of the float.

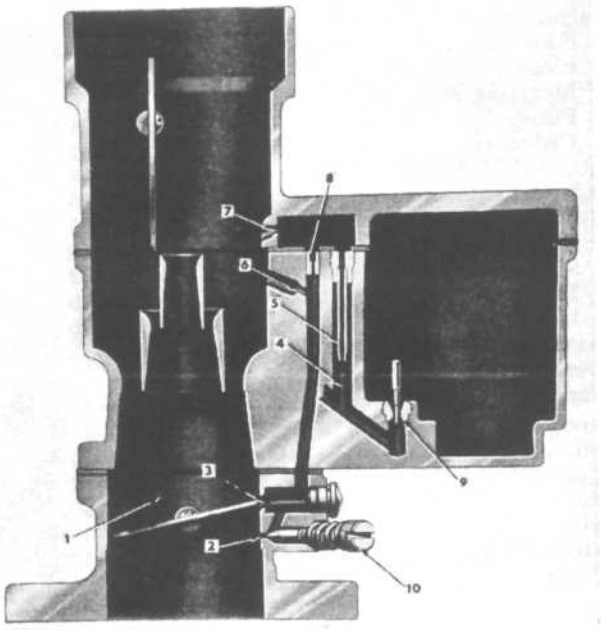


FIG. 129—THE LOW SPEED CIRCUIT

F-7. Low Speed Circuit. Fuel for idle and early part throttle operation is metered through the low speed circuit. It is illustrated in Fig. 129.

Liquid fuel enters the idle well No. 4 through the metering rod jet No. 9. Low speed jet No. 5 measures the amount of fuel for idle and early part throttle operation. The air by-pass No. 7, economizer No. 8 and idle air bleed No. 6 are carefully calibrated orifices which serve to break up the liquid fuel and mix it with air as it moves through the passage to the idle port No. 3 and idle adjustment screw port No. 2.

F-8. Idle Adjustment Screw Setting. Turn screw one to two turns for normal opening. For richer mixture, turn screw out; for leaner mixture turn screw in. Do not idle engine below 600 rpm.

By-pass No. 7, economizer No. 8, idle port No. 3, idle adjustment screw port No. 2 and the bore of the throttle body flange No. 1 must be clean and free from carbon. Obstructions at any of the above points will cause poor low speed engine performance.

A worn or damaged idle adjustment screw No. 10 or low speed jet No. 5 should be replaced.

F-9. High Speed Circuit. Fuel for part throttle and full throttle operation is supplied through the high speed circuit, Fig. 130. The metering rod No. 2 and metering rod jet No. 10 control the amount of fuel admitted through nozzle No. 1 for high speed operation. The lower end of metering rod No. 2 is calibrated in size to accurately meter the fuel required. As the rod is automatically raised and lowered in jet No. 10 the opening in the jet is varied in size to supply fuel proportionate to the requirements through the higher speed and power range. The metering rod is both mechanically and vacuum controlled and is attached to the metering rod arm assembly No. 4.

During part throttle operation, the vacuum in chamber No. 9 pulls the diaphragm assembly No. 8 down holding the metering rod arm assembly No. 4 against the pump lifter link No. 3. Movement of the metering rod is controlled by pump lifter link No. 3, which is attached to the carburetor throttle shaft. At all times the vacuum in chamber No. 9 is strong enough to overcome the tension of pump diaphragm spring No. 7. Upper pump spring No. 6 serves as a bumper upon deceleration and as delayed action spring on acceleration.

Under any operating condition, when the pump diaphragm spring No. 7 overcomes the vacuum in chamber No. 9, the metering rod No. 2 will move toward the wide open throttle or power position.

The nozzle No. 1 is a pressed-in part *and should not be removed.*

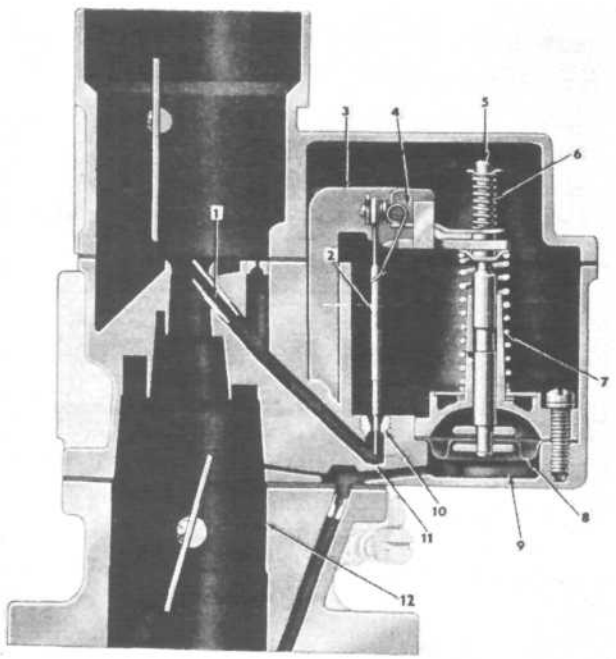


FIG. 130—THE HIGH SPEED CIRCUIT

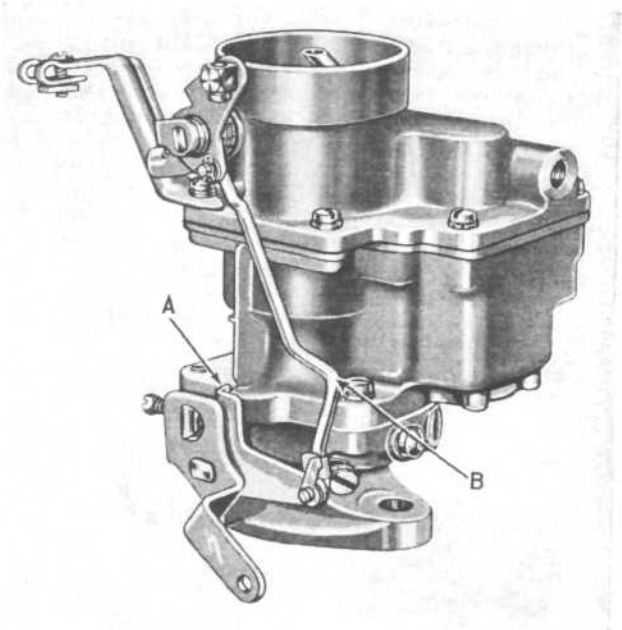


FIG. 131—CARBURETOR FAST IDLE

F-10. Metering Rod Adjustment. Metering rod adjustment is important and should be checked each time the carburetor is reassembled. Before adjustment is made be sure that the flat of the metering rod arm No. 4 is parallel to the flat of the pump lifter link No. 3 as shown in Fig. 130. With the throttle valve seated in the bore of the carburetor at No. 12, press down on the upper end of the diaphragm shaft No. 5 until the diaphragm bottoms in the vacuum chamber. The metering rod should now seat in casting at No. 11 with the metering rod arm flat against the pump lifter link. If the metering rod does not seat in the body casting, or seats before the metering rod arm makes flat contact with the pump lifter link, make adjustment by bending lip on metering rod arm No. 4.

F-11. Choke Circuit. The choke circuit consists of a manually operated choke valve, a fast idle connecting rod and a fast idle arm. The choke valve is of the offset spring loaded type to prevent over choking during the starting warm-up period.

When the choke valve is moved to a closed position for starting, Fig. 131, the fast idle connector rod A revolves the fast idle arm B. This increases the engine idle speed to prevent stalling during the warm-up period. A fast idle connector rod return spring prevents partial closing of the choke valve.

F-12. Fast Idle Adjustment. With the choke held in wide open position, lip A, Fig. 131, on the fast idle arm should contact the boss on the body casting. Adjust by bending the fast idle link at the offset as shown by B.

F-13. Accelerating Pump Circuit. The accelerating pump circuit, Fig. 132, provides a measured amount of fuel for rapid acceleration and smooth engine operation when the throttle is opened at lower speeds. In operation, vacuum is applied to the underside of diaphragm No. 8 at all times when the engine is running. Lower and more uniform vacuum is provided by vacuum restriction No. 10 and vacuum bleed passage No. 11. When the diaphragm No. 8 is in its maximum down position at low throttle due to high vacuum in chamber No. 9, the chamber above the diaphragm is full of fuel which has been admitted through the intake passage No. 7.

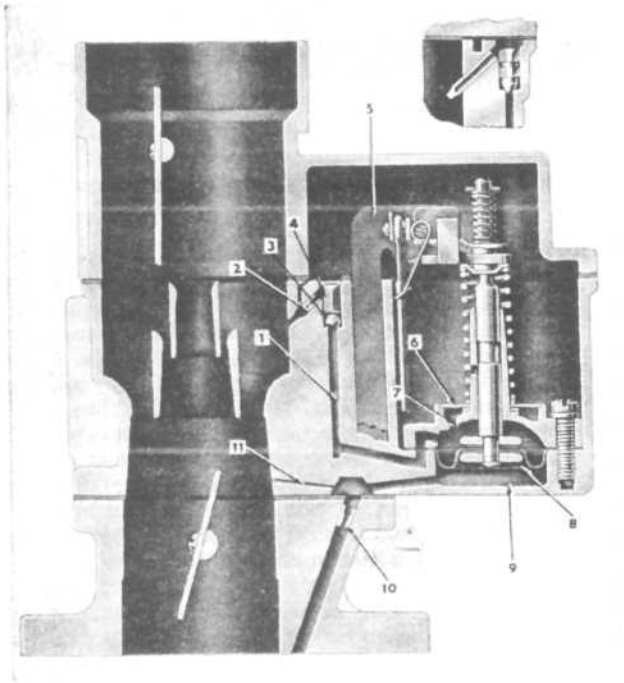


FIG. 132 — THE PUMP CIRCUIT

When the throttle is opened vacuum drops in chamber No. 9 and diaphragm No. 8 is initially forced upward by the spring on the diaphragm shaft. The upward motion is picked up by the accelerator pump lifter No. 5 which is connected to the throttle. This movement forces fuel from the chamber above the diaphragm through the discharge pump check valve No. 3 and discharge pump jet No. 2. This auxiliary discharge of fuel supplies engine requirements for quick acceleration and heavy loads. When the throttle is closed the diaphragm is again pulled down by high vacuum and another measured charge of fuel enters the chamber above the diaphragm through the intake passage No. 7 to be available for the next cycle of operation.

The pump jet No. 2 (see insert drawing in Fig. 132) projects into the air stream and is pressed into the carburetor body. The jet is permanently installed and *should not be removed.* Note that carburetor design makes it impossible to adjust the pump stroke.

F-14. Accelerating Pump Maintenance. If engine acceleration is unsatisfactory, remove the pump diaphragm assembly. Check the diaphragm for wear or damage. Then remove the pump check retainer ring directly above pump check weight and pump ball check. The pump ball check must seat as a leak will cause poor acceleration. Inspect and replace all worn or damaged parts and clean and blow out all passages with compressed air.

Note that when testing the pump for discharge volume when the carburetor is off the engine only approximately one-half of the maximum pump capacity will be discharged. Vacuum, when the engine is operating, controls the balance of discharge.

F-15. Carburetor Disassembly.

a. Remove pin springs No. 43, fast idle connector rod spring No. 40 and fast idle connector rod No. 42. See Fig. 133.

b. Remove the air horn and bowl cover attaching screws Nos. 7, 4 and the choke tube clamp assembly Nos. 51, 52, 53.

c. Remove the air horn assembly No. 8 and gasket No. 14.

d. Remove the pump disc retainer ring No. 45 and pump disc No. 44 using knife tip carefully.

e. Remove the throttle shaft arm assembly No. 28, pump connector link No. 27, shaft seal spring, dust seal washer and felt dust seal.

f. Loosen diaphragm housing attaching screws No. 20 and lift out entire pump and metering rod assembly.

g. Remove diaphragm housing screws No. 20, pin spring, metering rod No. 48, upper pump spring retainer No. 50, upper pump spring No. 15, metering rod arm assembly No. 16 and pump lifter link No. 17.

h. Remove diaphragm spring retainer No. 18, spring No. 19 and pump diaphragm assembly No. 22.

i. Carefully remove pump intake strainer from housing, using tip of knife blade.

j. Remove metering rod jet No. 46.

k. Remove low speed jet assembly No. 47. Do *not* remove pressed-in parts such as: nozzle, pump jet or anti-percolator air bleed.

l. Remove body flange attaching screws No. 29, body flange assembly No. 23 and gasket No. 24.

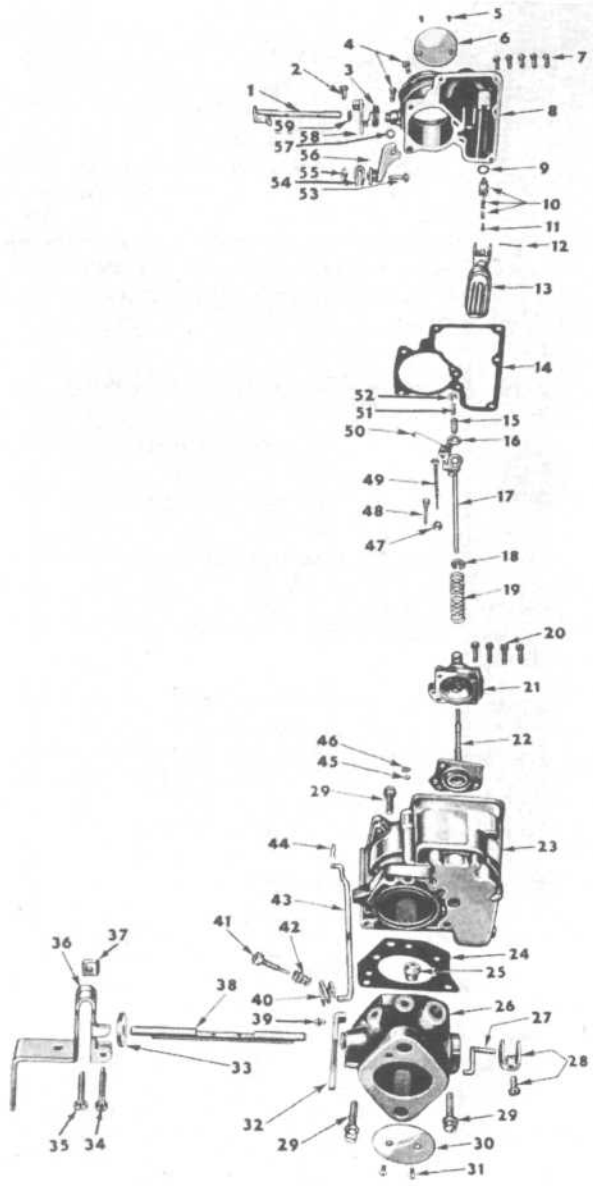


FIG. 133—YF-951S CARBURETOR—F4-134 MODELS

1—Choke Shaft and Lever
2—Screw
3—Choke Lever Spring
4—Screw and Washer
5—Choke Valve Screw
6—Choke Valve
7—Screw and Washer
8—Air Horn
9—Needle Seat Gasket
10—Needle Spring and Seat
11—Needle Pin
12—Float Lever Pin
13—Float and Lever
14—Gasket
15—Outer Pump Spring
16—Metering Rod Arm
17—Pump Link
18—Pump Spring Retainer
19—Vacuum Diaphragm Spring
20—Screw and Washer
21—Diaphragm Housing
22—Diaphragm
23—Body
24—Gasket
25—Idle Port Plug
26—Body Flange
27—Connector Link
28—Throttle Shaft Arm
29—Screw and Washer
30—Throttle Valve
31—Throttle Valve Screw
32—Fast Idle Arm
33—Washer
34—Adjusting Screw
35—Screw
36—Throttle Lever
37—Lever Nut
38—Throttle Shaft
39—Body Flange Plug
40—Clevis Clip
41—Idle Adjusting Screw
42—Idle Screw Spring
43—Fast Idle Connector Rod
44—Pin Spring
45—Check Valve
46—Ball Check Retainer
47—Metering Rod Jet
48—Low Speed Jet
49—Metering Rod
50—Metering Rod Spring
51—Inner Pump Spring
52—Pump Spring Retainer
53—Bracket Tube Screw
54—Throttle Tube Clamp
55—Tube Bracket Nut
56—Choke Tube Clamp
57—Lockwasher
58—Choke Lever
59—Retainer Ring

m. Remove idle adjustment screw No. 41, spring No. 34, idle port rivet plug No. 25, throttle lever assembly No. 37, washer No. 33, fast idle arm No. 32 and throttle shaft No. 39. Then remove throttle shaft seal by prying out seal retainer. Do *not* remove vacuum passage orifice (pressed-in).

n. Remove float pin No. 12, float No. 13 and needle and seat assembly No. 10 from the air horn casting.

o. Remove choke valve screws No. 5 and choke valve No. 6. Unhook choke spring No. 3 and slide shaft No. 1 from housing. *Do not remove balance vent tube.* NOTE: In normal service choke lever assembly will not require replacing. However, if it has been bent or otherwise damaged requiring replacement, proceed as follows: pry off choke lever retainer ring No. 55 and remove lever assembly.

p. Wash all parts in carburetor cleaning solution and blow out passages with compressed air. Do *not* immerse diaphragm assembly, pump check disc or seals in cleaning solution. Inspect all parts for wear or damage—replace if necessary. Always use new gaskets in reassembly.

F-16. Carburetor Assembly.

To expedite reassembly, it is advisable to group all related parts before assembling.

a. Install throttle shaft seal and retainer in flange casting.
b. Install fast idle arm, washer and lever assembly on throttle shaft, slide shaft into place and install throttle valve.
c. Install idle port rivet plug and idle adjusting screw and spring.
d. Attach flange assembly to body casting. Use new gasket.
e. Install low speed jet assembly.
f. Install pump intake strainer in pump diaphragm housing and carefully press into recess. *Caution:* If strainer is even slightly damaged a new one must be installed.
g. Install pump diaphragm assembly in diaphragm housing; then install pump diaphragm spring (lower) and retainer.
h. Install pump lifter link, metering rod arm, upper pump spring and retainer.
i. Install metering rod jet (no gasket used with this jet).
j. Install diaphragm housing attaching screws in the diaphragm housing, making sure that the edges of the diaphragm are not wrinkled. Lower into place, and tighten screws evenly and securely.
k. Install throttle shaft seal, dust seal washer and shaft seal spring.
l. Install pump connector link in the throttle shaft arm assembly. Install throttle shaft arm assembly on throttle shaft guiding connector link into pump lifter link hole. *Caution:* Linkage must not bind in any throttle position. If binding occurs, loosen clamp screw in throttle arm, adjust slightly and retighten screw.
m. Install pump check disc, disc retainer and lock ring.
n. Install metering rod and pin spring. Connect metering rod spring.
o. Metering Rod Adjustment. Be sure flat of metering rod arm is parallel to flat of pump lifter link before proceeding with metering rod adjustment. With the throttle valve seated, press down on upper end of diaphragm shaft. Metering rod should be seated in casting and metering rod arm flat against pump lifter link. If metering rod does not seat in body casting (check by pressing downward on metering rod) or seats before the metering rod arm makes flat contact with pump lifter link, raise or lower by bending the lip on metering rod arm.
p. Install needle seat and gasket assembly needle, float and float pin. The stop shoulder on the float pin must be on the side away from the bore of carburetor.
q. Set float level to specifications. Measure from machined surface of casting (gasket removed). Adjust by bending the lip which contacts needle.
r. Install air horn gasket and air horn assembly. Install attaching screws and lock washers and choke tube clamp assembly. (Tighten center screws first).
s. Slide choke shaft and lever assembly into place and connect choke lever spring. Install choke valve. Center valve by tapping lightly and hold in place with fingers when tightening screws.
t. Install fast idle connector rod with offset portion of the rod to top and pin spring to the outside. Install fast idle connecting rod spring.

F-17. Carter WGD-2052SA Carburetor

Early L6-226 Models

This carburetor is covered in Par. F-18 through F-23.

Early production 1954 Model 6-226 utility vehicles were equipped with Carter Carburetor No. 2052S or SA. Some vehicles equipped with this carburetor may have a tendency to develop hard starting, flooding or high fuel consumption when operated in rugged off-the-road service or in extremely hilly terrain.

To correct these conditions, the manufacturer has made available a spring loaded needle and seat, Kit No. 25-173-S, which can be procured from any Carter Distributor. When this spring loaded needle and seat is installed in a 2052S carburetor, the float level setting must be changed to 7/32" [5,5 mm.].

F-18. Float Adjustment

With bowl cover gasket removed, bowl cover inverted and needle seated, there should be 9/32" [7,14 mm.]between top of float and bowl cover. Gauge T109-126 may be used here. Adjust by bending float arm.

F-19. Pump Adjustment

Back out throttle lever set screw until throttle valves seat in bores of carburetor. Place Universal pump travel gauge, T109-117S inverted on edge of dust cover boss of bowl cover. Turn knurled knob of gauge until finger on gauge just touches top of plunger shaft. The distance from the dust cover boss to the top of the plunger shaft should be 1/2" [12,7 mm.]. This is the distance from base to tip of finger on gauge. Adjust by bending throttle connector rod at upper angle.

F-20. Metering Rod Adjustment

The metering rods must be adjusted after the pump adjustment or when leaner than standard rods are installed. No metering rod gauges are necessary. Procedure is as follows: With the throttle lever set screw backed out and throttle valves seated in bores of carburetor, press down on vacumeter link until metering rods bottom. With rods held in this position, remove metering rod arm until lip contacts vacumeter link. Hold in place and carefully tighten metering rod arm set screw.

F-21. Fast Idle Adjustment

With the thermostatic coil housing, gasket and baffle plate removed, crack throttle valve and hold choke valve closed. Then close throttle. There should now be .018 to .023 inch clearance (Gauge T109-29) between throttle valve and bore of carburetor (side opposite idle port). Adjust by bending the choke connector rod at lower angle.

F-22. Unloader Adjustment

Must be made after fast idle adjustment. Hold throttle valve wide open and close choke valve as far as possible without forcing; there should now be 9/64" [3,57 mm.] clearance between upper edge of choke valve and inner wall of air horn. Use Gauge T109-34. Adjust by bending arm on choke trip lever.

F-23. Carter WCD-2204S Double-throat Carburetor

L6-226
4WD Pickup....654-EC2-14773 to 55268-31178
L6-226
4WD Stake.....654-ED2-10325 to 55368-11162
L6-226 4x4 UW...654-FA2-12542 to 54168-23628
L6-226 4x4 UD....654-RA2-10218 to 54268-11543

Model WCD 2204S is a dual down-draft carburetor with climatic control designed especially for use on 6-226 utility vehicles. Disassembly and assembly procedures as well as adjustments are given below.

F-24. Carter Carburetor 2204S—Disassembly

a. Remove air horn and climatic control assembly with all parts attached.

b. Remove bowl cover with all parts attached.

c. Remove body flange assembly and body flange gasket.

d. Remove all parts from air horn and choke.

e. Remove all parts from bowl cover.

f. Remove all parts from carburetor body **except nozzles**. Do not, under any circumstances, attempt to remove nozzles from body casting.

g. Remove all parts from body flange assembly. Check throttle shaft for wear, loose lever and throttle rod holes in lever for wear.

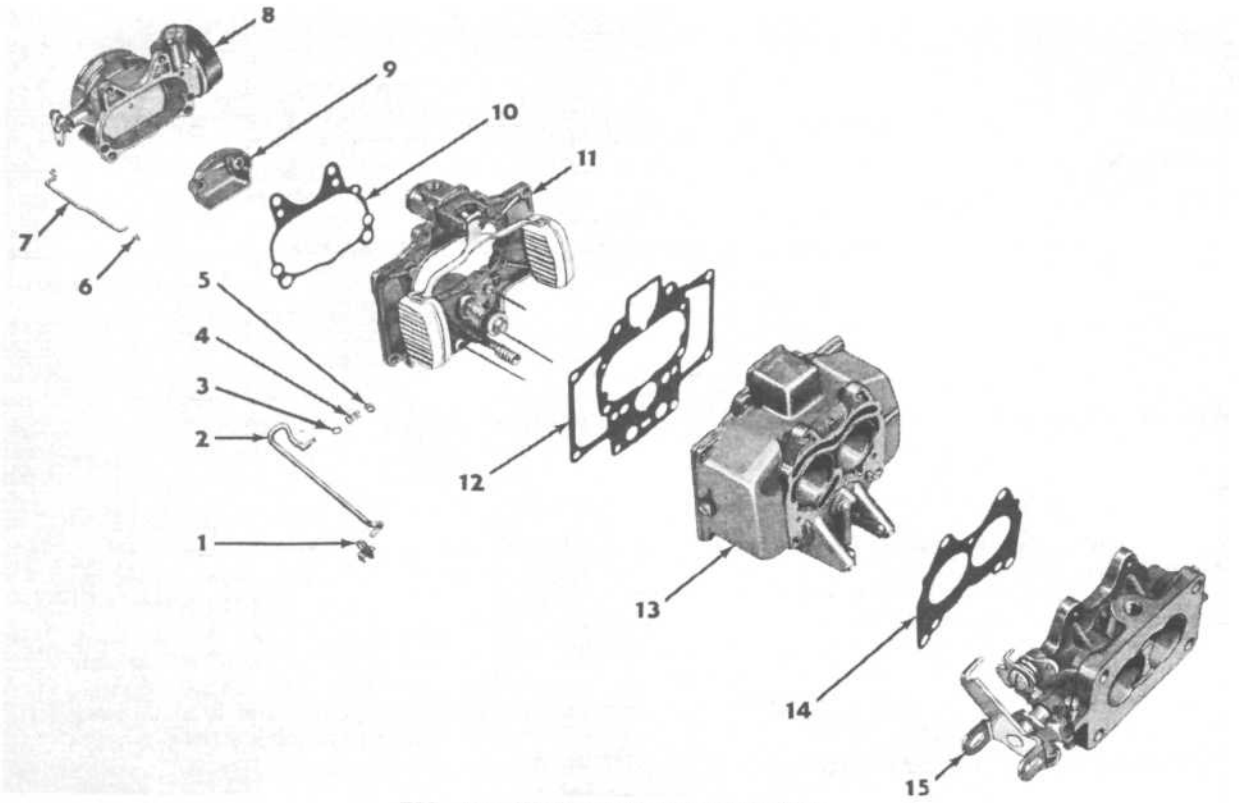


FIG. 134—WCD 2204S CARBURETOR

1—Throttle Connector Rod Retainer
2—Throttle Connector Rod
3—Connector Rod Washer
4—Connector Rod Spring
5—Connector Rod Spring Retainer
6—Pin Spring
7—Choke Connector Rod
8—Air Horn Assembly
9—Dust Cover
10—Air Horn Gasket
11—Bowl Cover Assembly
12—Bowl Cover Gasket
13—Body Assembly
14—Body Flange Gasket
15—Body Flange Assembly

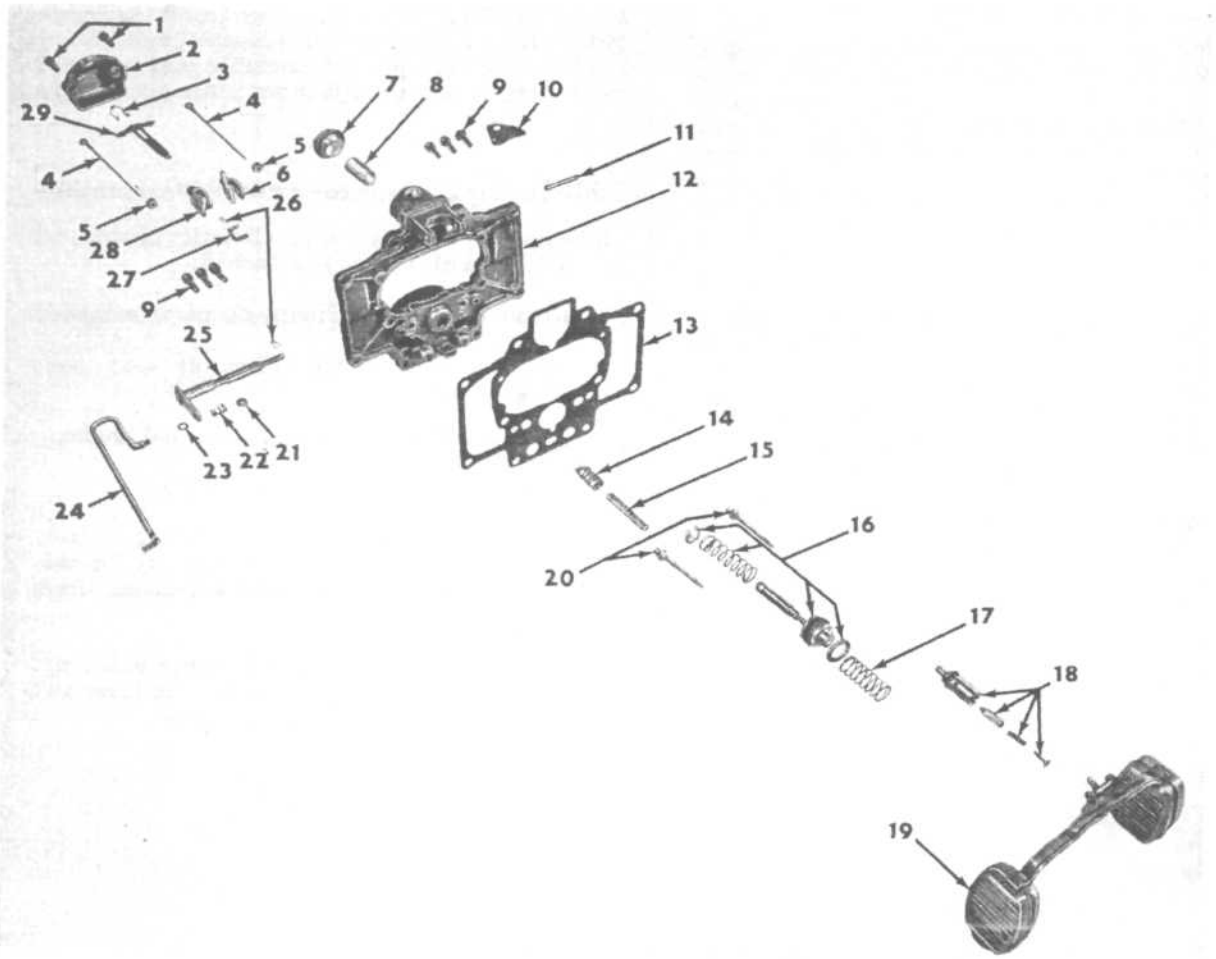


FIG. 135—2204S CARBURETOR BOWL COVER AND ATTACHING PARTS

1—Attaching Screws
2—Dust Cover
3—Metering Rod Spring
4—Metering Rods
5—Metering Rod Washers
6—Pump Arm and Screw Assembly
7—Strainer Nut Assembly
8—Bowl Cover Strainer
9—Bowl Cover Retaining Screws
10—Model Identification Tag
11—Float Lever Pin
12—Bowl Cover
13—Bowl Cover Gasket
14—Vacuum Piston
15—Vacuum Piston Spring
16—Pump Plunger Rod, Spring and Retainer Assembly
17—Lower Pump Spring
18—Spring Loaded Needle and Seat Assembly
19—Float and Lever Assembly
20—Low Speed Jets
21—Connector Rod Spring Retainer
22—Connector Rod Spring
23—Washer
24—Throttle Connector Rod
25—Pump Operating Lever and Countershaft Assembly
26—Pin Spring
27—Pump Connector Link
28—Metering Rod and Screw Assembly
29—Vacumeter Piston Link

h. Wash all parts in clean gasoline **except coil and housing assembly.** Blow out all passages with compressed air and replace all worn or damaged parts.

F-25. Carter Carburetor 2204S— Reassembly and Adjustments

In these reassembly procedures, consult Figs. 134 thru 138.

To expedite reassembly, it is advisable to group all related parts before assembling.

F-26. Idle Circuit

a. Install throttle shaft and lever assembly. Back out throttle lever adjusting screw.

b. Install throttle valve. Small "c" in circle should be toward idle port when viewing casting from manifold side. Center throttle valves by tapping lightly and hold in place with fingers before tightening screws. Always use new screws.

c. Install idle port rivet plugs, then idle adjustment screws and springs. Open adjustment screws 1 to 2 turns until a precise adjustment can be made with engine running.

d. Install low speed jet assemblies. No gaskets are used.

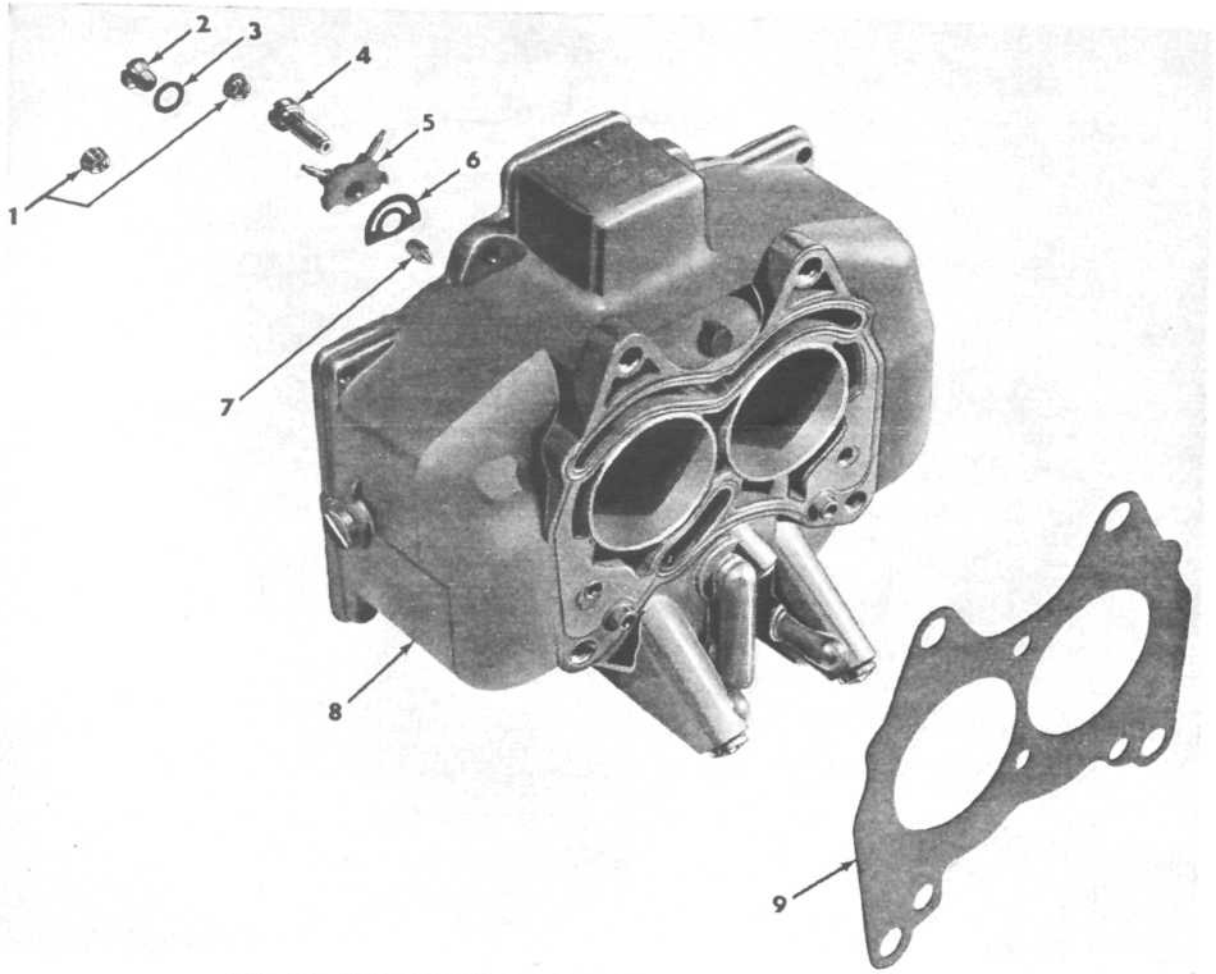


FIG. 136—2204S CARBURETOR BOWL AND ATTACHING PARTS

1—Main Metering Jets
2—Pump Passage Plug
3—Pump Passage Plug Gasket
4—Pump Jet Housing Attaching Screws
5—Pump Jet Housing
6—Pump Jet Housing Gasket
7—Pump Check Needle
8—Body
9—Body Flange Gasket

F-27. Pump Circuit

a. Install pump weight, new pump gasket, pump jet housing and pump jet housing screw.

b. Install pump spring and plunger assembly.

F-28. Float Circuit

a. Install bowl strainer gauze and nut and gasket assembly.

b. Install needle and seat assembly.

c. Install float and lever assembly.

F-29. Float Adjustments

Use Gauge T109-28

a. Lateral Adjustment. With bowl cover assembly inverted, bowl cover gasket removed and float lip resting on seated needle, place float gauge directly under float with notched portions of gauge fitted over edges of casting. Sides of floats should barely touch the vertical uprights of float gauge. Adjustment should be made by bending arms of floats.

b. Vertical adjustment. With float gauge in same position, floats should just clear the horizontal portion of gauge. Vertical distance between top of float and machined surface of casting must be $\frac{3}{16}$" [4,76 mm.]. Adjust by bending float arms.

c. Carefully remove float, install bowl cover gasket, then replace float.

F-30. High-speed Circuit

a. Assemble body flange assembly to body casting. Use new gasket.

b. Install metering rod jets. Jets must be installed snugly but not so tightly as to cause distortion.

c. Install vacumeter piston link and metering rod spring. Start pump countershaft assembly.

d. Install pump arm and collar assembly, metering rod arm and screw assembly.

e. Install pump arm link on pump arm and plunger shaft.

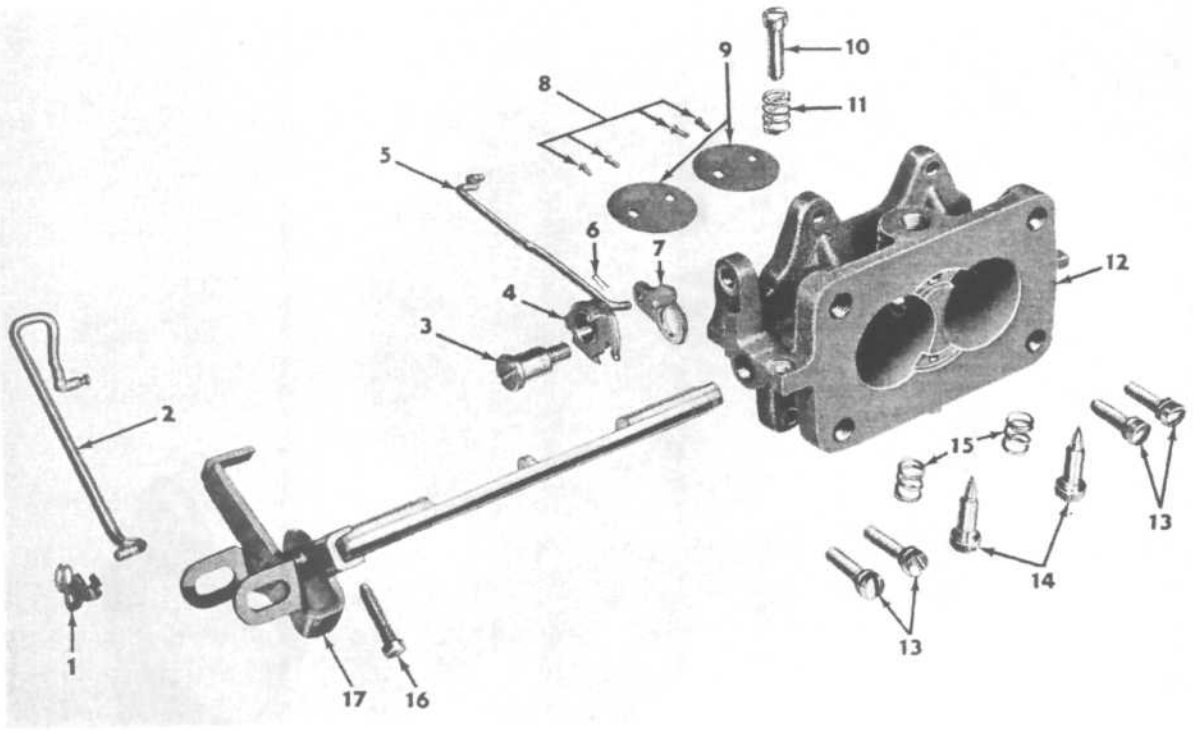


FIG. 137—2204S BODY FLANGE AND ATTACHING PARTS

1—Throttle Connector Rod Retainer
2—Throttle Connector Rod
3—Fast Idle Cam Attaching Screw
4—Fast Idle Cam
5—Choke Connector Rod
6—Pin Spring
7—Cam Trip Lever
8—Throttle Valve Attaching Screws
9—Throttle Valves
10—Throttle Lever Adjusting Screw
11—Throttle Lever Adjusting Screw Spring
12—Body Flange
13—Body Flange Attaching Screws
14—Idle Adjustment Screws
15—Idle Adjustment Screw Springs
16—Fast Idle Adjustment Screw
17—Throttle Shaft and Lever Assembly

f. Install vacuum piston and pin assembly, and vacuum piston spring on piston link.

g. Install body on bowl cover as assembled. Use new gasket.

h. Install throttle shaft lever and throttle connector rod. Do not forget throttle shaft washer.

i. Make pump adjustment. Adjust metering rods (See Par. F-33.).

j. Install nozzle passage rivet plugs.

F-31. Pump Adjustment

Install pump connector link in outer hole (long stroke) of pump arm with ends extending away from countershaft arm. Back out throttle lever set screw until throttle valves seat in bores of carburetor. Be sure fast idle adjusting screw does not hold throttle open. Place Universal pump travel gauge, T109-117S, inverted on edge of dust cover boss of bowl cover. Turn knurled nut of gauge until finger just touches upper end of plunger shaft. Number indicated on gauge should be 33. Hold the gauge vertical to insure correct reading. Adjust by bending the throttle connector rod at upper angle. Use Tool T109-213.

F-32. Optional Adjustment

With the throttle valves seated in bores of carburetor, the distance from the top of the plunger shaft to the top of the dust cover boss should be $11/32$" [8,73 mm.]. Adjust as mentioned above.

F-33. Metering Rod Adjustment

The metering rods must be adjusted after the pump adjustment. No metering rod gauges are necessary. Procedure is as follows: With the throttle lever set screw backed out and throttle valves seated in the bores of carburetor, press down on vacumeter link until metering rods bottom. With rods held in this position, revolve the metering rod arm until lip contacts the vacumeter link. Hold in place and carefully tighten metering rod arm set screw.

F-34. Choke Circuit

a. Install air horn casting.

b. Install choke piston, lever, link and shaft assembly and piston.

c. Install choke valve. Use new screws. Seat choke valve by tapping lightly, hold in place with finger before tightening screws. Valve or shaft must not bind in any position.

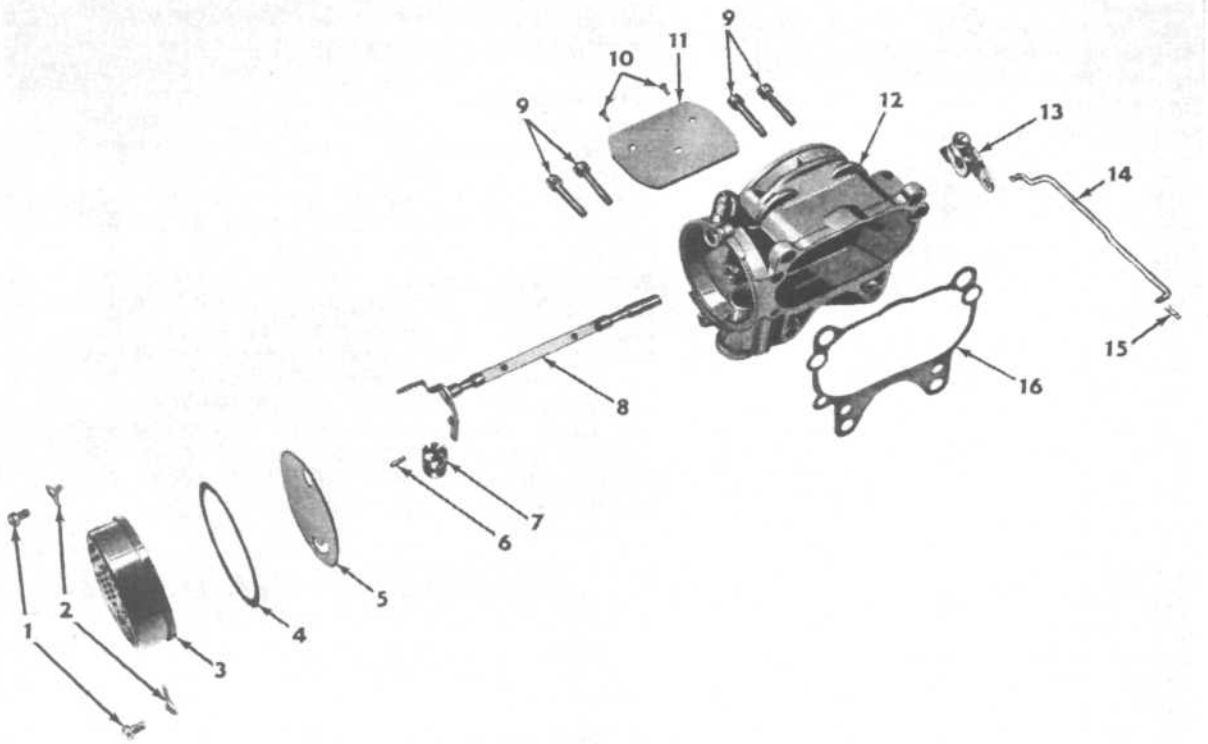


FIG. 138—2204S CARBURETOR AIR HORN AND ATTACHING PARTS

1—Coil Housing Attaching Screws
2—Coil Housing Retainers
3—Thermostatic Coil and Housing Assembly
4—Coil Housing Gasket
5—Choke Baffle Plate
6—Choke Piston Pin
7—Choke Piston
8—Choke Piston Lever, Link and Shaft Assembly
9—Air Horn Attaching Screws
10—Choke Valve Attaching Screws
11—Choke Valve
12—Air Horn
13—Choke Lever and Screw Assembly
14—Choke Connector Rod
15—Pin Spring
16—Air Horn Gasket

d. Install coil housing, baffle plate and coil housing gasket.

e. Install thermostatic coil and housing assembly. Install housing with indicator marks at bottom. Revolve housing clockwise and set indicator on index mark. Tighten attaching screws.

f. Install choke lever and screw assembly and fast idle connector rod.

g. Install fast idle cam assembly. Make fast idle and unloader adjustments. See below.

F-35. Fast Idle Adjustment

a. Loosen choke lever clamp screw on choke shaft. Insert a .040″ [1,01 mm.] feeler gauge (T109-193) between lip of fast idle cam and boss of flange casting. Hold choke valve tightly closed and take slack out of linkage by pressing choke lever toward closed position. Hold in place and tighten clamp screw.

b. With choke valve tightly closed, tighten fast idle adjusting screw until there is .016″ [,406 mm.] opening (Gauge T109-29 may be used here) between throttle valve and bore of carburetor (side opposite idle port). Be sure fast idle adjusting screw is on high step of cam while making this adjustment.

F-36. Unloader Adjustment

With throttle wide open, there should be 1/8″ [3,17 mm.] (Gauge T109-36) clearance between the upper edge of choke valve and inner wall of air horn. Adjust by bending unloader lip on throttle shaft lever. Use bending Tool T109-41.

F-37. Carter YF-2467S Single-throat Carburetor

L6-226 4WD Pickup after 55268-31178
L6-226 4WD Stake after 55367-11162
L6-226 4x4 UW after 54168-23628
L6-226 4x4 UD after 54268-11543
L6-226 4x2 UW after 54167-12034
L6-226 4x2 UD after 54267-10508

YF-2467S is so similar to the Carter YF carburetor that no difficulty should be experienced with the disassembly, assembly or adjustment, if the instructions for the YF carburetor starting with Par. F-3 are followed.

The float adjustment and idle screw setting are performed in the same manner as explained in

Par. F-6 except the distance between the top of float and the bowl cover (Fig. 128) should be 9/32". The idle screw setting (Fig. 129) is from 1½ to 2½ turns out for idle adjustment. For richer mixture turn screw out.

The metering rod jet size is .098" [2,48 mm.] in diameter.

Metering rod assembly and adjustment are the same as described in Par. F-10.

F-38. FUEL AND VACUUM PUMPS

The fuel and vacuum pump used on L6-226 models is described starting with Par. F-46.

The fuel and vacuum pump used on F4-134 models is described starting with Par. F-39.

F-39. Fuel and Vacuum Pump

All F4-134 Models.

The fuel pump is of the diaphragm type and is mechanically operated by a rocker arm, one end of which is attached to the diaphragm assembly, the other end resting against an eccentric on the engine camshaft. It is mounted on the lower left side of the engine block.

The rotation of the camshaft eccentric operates the rocker arm and pulls the diaphragm assembly upward against spring pressure. This forms a vacuum in the fuel chamber and allows fuel to enter the fuel chamber through the intake valve from the sediment bowl. On the return stroke spring pressure forces the diaphragm downward forcing the fuel in the fuel chamber out through the outlet valve and through the pump outlet to the carburetor.

When the carburetor bowl is full, the float in the carburetor closes the needle valve and pressure is formed in the pump fuel chamber. This pressure will hold the diaphragm up against spring pressure where it will remain inoperative until the carburetor needs more fuel, the needle valve opens and pressure is relieved in the fuel chamber.

Some AC models have a sediment bowl and filtering screen which is attached to the bottom of the pump by a wire clamp and thumb nut. The screen and sediment bowl should be cleaned at least twice yearly to prevent trouble due to a blocked screen or water freezing. The bowl should be washed and wiped dry and the screen dried and then cleaned with a stiff brush. When reassembling the bowl make certain that the cork gasket is not broken; reverse it and position it flat on the seat, then install the bowl and tighten the thumb nut securely. After cleaning, start the engine and carefully inspect the bowl for leakage.

F-40. Disassembly

Loosen the thumb nut on the sediment bowl clamp. Push clamp aside and remove bowl, gasket, and strainer screen.

Mark the two castings at the diaphragm with a file to assure reassembly in the same position and remove the screws attaching the fuel cover to pump body. Remove the cover, diaphragm and spring. Remove rocker arm pin and rocker arm and rocker arm spring. Remove the valve plate screw and separate the valve plate retainer, valve gaskets and valves.

Wash all parts thoroughly in cleaning solvent and examine them for wear or damage. Blow out all openings with compressed air.

F-41. Assembly

Install valve gaskets, valves, valve plate retainer and secure them with the valve plate retainer screw. Make sure that the inlet and outlet valves are in their proper positions. Place the diaphragm spring retainer in position on the diaphragm pull rod and install diaphragm spring.

Position the diaphragm assembly in pump body and attach the cover to pump body, with file marks aligned, with the attaching screws. Do not draw the screws up tight. Install rocker arm spring, rocker arm spacers, rocker arm and rocker arm pin. With rocker arm positioned on the diaphragm rod, draw the pump body screws up evenly and securely. Install the filter screen, cork gasket and sediment bowl or cover plate and secure them firmly with the thumb screw on the bowl clamp or cover plate screw.

F-42. Fuel Pump Testing

Correct fuel pump pressure is essential to satisfactory engine performance. Pressure that is too low will affect proper carburetion. Pressure that is too high will cause fuel leakage at the carburetor intake valve.

Connect a pressure checking gauge to the outlet of the fuel pump. Pump pressure should be within the specifications listed at the end of this section. For a test of volume, the pump should prime itself in 18 seconds at 120 rpm. engine speed. For a test of vacuum, the pump should pull a minimum of 8" [20,32 cm.] of mercury at 1800 rpm. engine speed.

F-43. Vacuum Pump

All F4-134 Models.

The operation and function of the vacuum pump are similar to the pump described in Par. F-53. The only differences are that the valves in the pump covered here are removable and the position of the air filter screen is different.

F-44. Disassembly

Unscrew cover plate cap screw and remove cover plate, gasket, filter screen retainer and filter screen from vacuum pump body. Mark the two castings with a file and then unscrew the attaching screws from the vacuum pump body. Separate the vacuum pump body from the fuel pump body. Remove the vacuum diaphragm and spring.

Unscrew the valve plate screw and remove the valve plate retainer, the valves and valve gaskets. Wash all parts in cleaning solvent and blow out with compressed air. Inspect all parts and replace those worn or damaged, especially the gaskets. Assemble in reverse order of disassembly.

F-45. Vacuum Pump Test

Disconnect the vacuum line at the intake manifold and plug the manifold fitting hole. With the engine idling, if the windshield wipers operate even at a slow speed, the vacuum pump operation is satisfactory.

F-46. Fuel and Vacuum Pump

All L6-226 Models

The fuel pump is mounted on the lower left side of the engine block. It is operated by its cam lever contacting an eccentric on the engine camshaft. Upward movement of the pump diaphragm is accomplished by cam rotation against the lever which pulls the diaphragm upward and compresses the diaphragm spring. This action induces a low pressure within the fuel chamber, allowing fuel to be forced through the intake valve from the supply tank. As the cam continues to rotate, the cam lever allows the diaphragm spring to exert pressure on the diaphragm. This action forces fuel from the fuel chamber through the discharge valve to the carburetor.

The cam lever is of one piece construction, hinged by a full floating pin. One end of the lever contacts the camshaft eccentric and the other end is connected to the diaphragm shaft so that camshaft action on the lever pulls the diaphragm up, but downward movement of the diaphragm is accomplished only through spring action. The pump delivers the fuel to the carburetor only when the fuel pressure in the outlet line is less than the pressure maintained by the diaphragm spring. If fuel is not needed in the carburetor, the carburetor needle valve is closed by the buoyance of the float and the pump builds up pressure until it overcomes the tension of the diaphragm spring. This stops the flow of fuel from the pump.

Two air domes are built integrally in the pump, an intake air dome and discharge air dome. A small pocket of air is maintained in the intake side of the pump body. This air is decompressed during the intake stroke, allowing atmospheric pressure on the fuel in the supply tank to force fuel to the pump in a steady flow. This provides a ready supply of fuel to the intake valve at all times. Another pocket of air built into the discharge side of the pump body is sealed from the fuel by a second diaphragm. This eliminates any possibility of air being absorbed by the outgoing fuel. The discharge air dome dampens pulsations in fuel pressure and allows the pump to provide a more constant supply of fuel during the pump intake cycle.

F-47. Disassembly

Before disassembly, the outside of the pump should be washed with dry cleaning solvent and blown dry with compressed air to remove all dirt and grease.

a. Mark pump body and valve housing with a file or hacksaw which will allow the pump parts to be reassembled in the same relative position.

b. Remove cam lever return spring, Fig. 140, cam lever pin retainer, cam lever pin plug and cam lever pin. The cam lever will now slide freely out of pump body.

c. Remove valve housing attaching screws and separate the pump housing from the valve housing. Remove diaphragm assembly.

d. Remove the two cover attaching screws and separate valve housing assembly from the valve housing cover. Remove outlet air dome diaphragm.

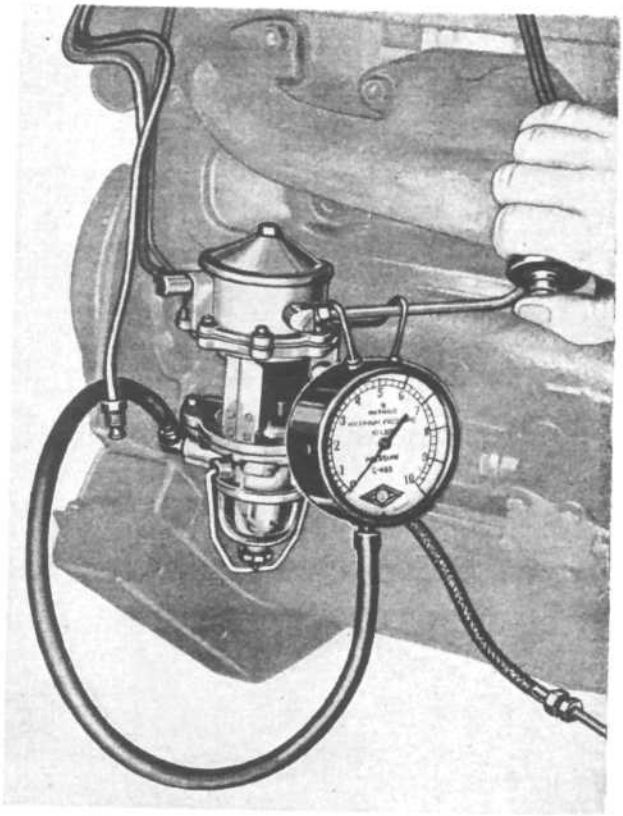


FIG. 139—FUEL PUMP PRESSURE TEST

F-48. Cleaning and Inspection

Clean all parts in dry cleaning solvent and blow out with compressed air. *Valves should not be removed from the valve housing assembly.* Check all parts to see that they have not been cracked or broken and that screw threads have not been stripped or cross threaded.

F-49. Assembly

a. Assemble outlet air dome diaphragm on valve housing assembly and install valve housing cover. The strainer should be installed before installing cover. Install attaching screws.

b. Install diaphragm assembly in pump housing.

c. Install valve housing assembly on pump housing with marks aligned. Start screws but do not tighten.

d. Install cam lever, cam lever pin, cam lever pin plug and cam lever pin retainer in pump body.

e. Flex diaphragm assembly to full up position. Hold in place while tightening valve housing, attaching screws. Install cam lever return spring.

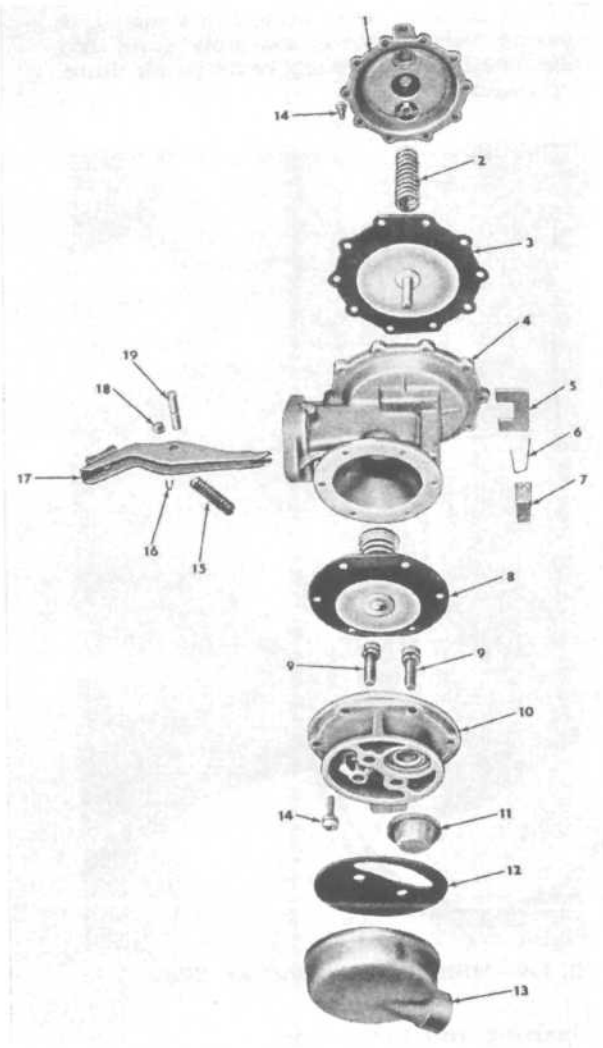


FIG. 140—FUEL AND VACUUM PUMP—L6-226 MODELS

1—Vacuum Valve Housing
2—Vacuum Diaphragm Spring
3—Vacuum Diaphragm
4—Pump Body
5—Breather Vent Plate
6—Filler Vent Breather Retainer Spring
7—Breather Vent Filler
8—Pump Diaphragm
9—Housing Cover Screw and Washer
10—Valve Housing
11—Fuel Strainer
12—Outlet Air Dome Diaphragm
13—Valve Housing Cover
14—Valve Housing Screw and Washer
15—Cam Lever Return Spring
16—Pin Retainer
17—Cam Lever and Shoe
18—Cam Lever Shaft Seal Plug
19—Cam Lever Pin

F-50. Testing Fuel Pump — Bench Test

a. Clamp pump in vise. Use soft jaws to protect the gasket surface of the pump flange.

b. Hook up a mercury manometer or suitable vacuum gauge to the intake side of the pump.

c. Actuate pump lever (full stroke) at approximately 60 strokes per minute. Pump should pull at least 10 inches [25,4 cm] of mercury.

F-51. Testing Fuel Pump — On Engine

a. Volume Test: one quart of fuel in one minute or less, at 500 rpm. engine speed.

b. Vacuum Test: at least 10 inches Hg. (vacuum) at 500 rpm. engine speed.

c. Pressure Test: pressures should be between the maximum and minimum shown in the specification table at end of this section. This test should be made with a pressure gauge connected to a "T" fitting at the carburetor, or directly to the fuel pump fitting as shown in Fig. 139 if the length of tubing used equals carburetor height. The length of the hose on the pressure gauge should not exceed six inches [15,2 cm] when connected to the carburetor fitting. Inaccurate pressure readings may result if a longer hose is used between the "T" connection and the pressure gauge.

F-52. Vacuum Pump

All L6-226 Models

The vacuum section of the pump serves as a booster to the intake manifold vacuum to provide uniform windshield wiper operation at all engine speeds and loads. The booster diaphragm shaft is not attached to the cam lever. It is merely pushed up during vacuum pump operation. The vacuum booster may be serviced as a separate unit. See Fig. 140.

Under normal engine operation the vacuum booster diaphragm is held down by intake manifold vacuum. The booster operates only when needed (low intake manifold vacuum caused by acceleration, high speed or engine load). The decrease in vacuum in the booster air chamber allows the spring to push the diaphragm up. This induces sufficient vacuum in the air chamber to continue wiper operation. The return of the diaphragm is accomplished by the cam lever pushing up on the end of the diaphragm shaft.

F-53. Disassembly

a. Mark castings at vacuum diaphragm with file.

b. Remove the vacuum valve housing cover attaching screws Fig. 140, No. 14, and separate the vacuum valve housing cover No. 1, vacuum diaphragm spring No. 2 and the diaphragm assembly No. 3.

c. Pry the vacuum oil seal and breather vent plate No. 5 from body casting.

d. Remove the breather vent filter retainer spring No. 6 and the filter No. 7 from vacuum pump body.

F-54. Cleaning and Inspection

Wash the body casting and the valve cover assembly in cleaning solvent. Blow out with compressed air. A new diaphragm assembly, oil seal, or vent filter must not be immersed in gasoline or cleaning solvent. Special care should be exercised when cleaning the valves. Do not attempt to remove the valves from the cover assembly.

F-55. Assembly

Assemble the parts in reverse order of disassembly. When installing the breather vent plate, stake it with a small chisel or punch. Align the file marks on the castings and tighten the diaphragm screws evenly and securely.

F-56. Vacuum Pump Test

It is not advisable to test the vacuum booster pumps on hand-operated test stand as the booster diaphragm spring is usually quite strong and considerable physical effort will be required to pulsate the diaphragms.

With the vacuum booster on the engine and with the engine idling,

a. Turn on vacuum windshield wipers to make certain the wiper motor is in operating condition.

b. Disconnect the line to vacuum booster at the intake manifold and plug the manifold fitting hole.

c. With engine idling, the windshield wipers should operate. If they slow down slightly but do not stop, the booster is satisfactory.

F-57. Accelerator and Linkage

The accelerator linkage is properly adjusted when the vehicle leaves the factory however, in time component parts will become worn and require adjustment to maintain a smooth even control of engine speed.

Adjust the length of the throttle rod so that when the carburetor throttle valve is wide open the accelerator treadle will just strike the toe board or the overdrive kick-down switch. Tighten the lock nuts on the adjusting block. This adjustment is important on vehicles equipped with overdrive transmissions. See "Transmission" section.

F-58. Air Cleaner

Servicing of the air cleaner is properly taken care of as part of the periodic lubrication and servicing of the vehicle. For this reason, air cleaner servicing information is given in the Lubrication Section. Refer to and follow the instructions given there.



FIG. 141—FUEL AND VACUUM PUMP — L6-226 MODELS

F-59. Fuel Gauge

For information regarding the Fuel Gauge see the "Electrical Section".

FUEL SYSTEM SPECIFICATIONS

MODEL	F4-134	L6-226		
Carburetor:				
Make	Carter	Carter	Carter	Carter
Model	YF-951S	WGD-2052SA	WCD-2204S	YF-2467S
Flange	1¼" [3,17 cm.]	1¼" [3,17 cm.]	1¼" [3,17 cm.]	1½" [3,81 cm.]
Primary Venturi	11/32" [8,73 mm.]	11/32" [8,73 mm.]	11/32" [8,73 mm.]	11/32" [8,73 mm.]
Main Venturi	1¼" [3,17 cm.]	1 1/16" [2,70 cm.]	1⅛" [2,85 cm.]	1 5/16" [3,33 cm.]
Float Setting	5/16" [7,93 mm.]	See note	3/16" [4,76 mm.]	9/32" [7,13 mm.]
Fuel Intake	Vertical Spring Loaded	Vertical Spring Loaded	Vertical Spring Loaded	Vertical Spring Loaded
Idle Air Bleed	No. 56 Drill	No. 54 Drill	No. 55 Drill	.....
Idle Port	.184" x .030" [4,6 x 0,762 mm.]	.160" x .030" [4,06 x 0,762 mm.]	.156" x .030" [3,96 x 0,762 mm.]	.190" x .040" [4,82 x 1,01 mm.]
Low Speed Jet	No. 70 Drill	No. 70 Drill	No. 68 Drill	No. 70 Drill
Metering Rod	No. 75-806	No. 75-901	No. 75-1129	No. 75-1279
Jet Size	.096" [2,43 mm.]	.086" [2,18 mm.]	.086" [2,18 mm.]	.098" [2,48 mm.]
Accelerating Pump:				
Discharge Jet	No. 72 Drill	No. 74 Drill	No. 72 Drill	No. 70 Drill
Intake Ball Check	No. 72 Drill	No. 40 Drill	.115"-.120" [2,9-3,0 mm.]	No. 40 Drill
Discharge Check	.....	No. 50 Drill	No. 50 Drill	.....
Vacuum Restriction	No. 55 Drill	.....	.....	No. 55 Drill
Diaphragm Bleed	No. 65 Drill	.....	.....	No. 56 Drill
Vacuum Spark Port	.055" [1,39 mm.]	.045" [1,14 mm.]	.063" [1,6 mm.]	.125" x .041" [3,17 x 1,04 mm.]

NOTE: WGD-2052SA with solid needle: 9/32" [7,15 mm.]; with spring loaded needle: 7/32" [5,56 mm.].

	F4-134	L6-226
Air Cleaner:		
Make	Donaldson	AC
Model	E-6532	1552707
Type	Oil Bath	Oil Bath
Oil Capacity	1¼ pts. [0,591 ltrs.]	1 pt. [0,473 ltrs.]
Fuel Pump:		
Make	AC	Carter
Model	5594080	M957S
Type	Camshaft	Camshaft
Pressure	2½-3¾ lbs. @ 16" above outlet @ 1800 rpm. [0,176 a 0,264 kg-cm² @ 40,6 cm.]	3½-5½ lbs. @ 16" above outlet @ 1800 rpm. [0,246 a 0,385 kg-cm² @ 40,6 cm.]
Fuel Tank:		
Capacity	15 gals. [56,7 ltr.]	15 gals. [56,7 ltr.]
Location	Right Side Rear	Right Side Rear

EXHAUST SYSTEM

Contents

SUBJECT	PAR.
Manifolds—F4-134	G-2
Manifolds—L6-226	G-3
Exhaust Pipe, Muffler, Tail Pipe	G-4

G-1. GENERAL

The exhaust system includes the manifolds, exhaust pipe, muffler, and tail pipe. Separate paragraphs describe the manifolds for F4-134 models and for L6-226 models with single- and double-throat carburetors.

G-2. Manifolds

All F4-134 Models

On F4-134 engines, the exhaust and intake manifolds are separate units. The intake manifold is cast as an integral part of the cylinder head and is completely water jacketed. This construction transfers heat from the cooling system to the intake riser and assists in vaporizing the fuel when the engine is cold.

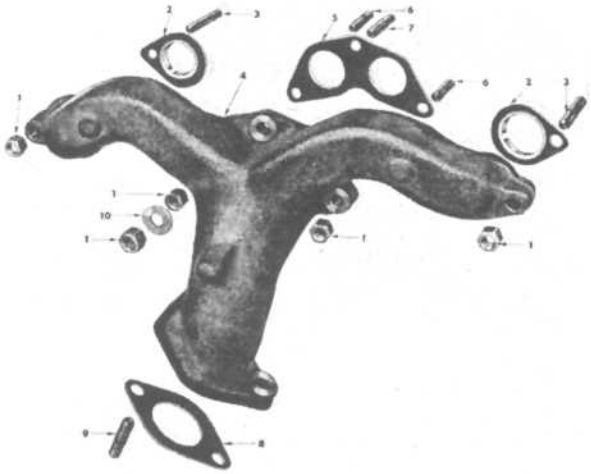


FIG. 142—MODEL F4-134 EXHAUST MANIFOLD

1—Stud Nut
2—End Gasket
3—Stud
4—Manifold
5—Center Gasket
6—Stud
7—Stud
8—Gasket
9—Stud
10—Washer

When assembling the manifolds to the cylinder block, new gaskets should be installed, and the nuts drawn up evenly until they are tight, to avoid leakage. Torque wrench reading, 29-35 ft. lbs. [4,01-4,84 kg-m.].

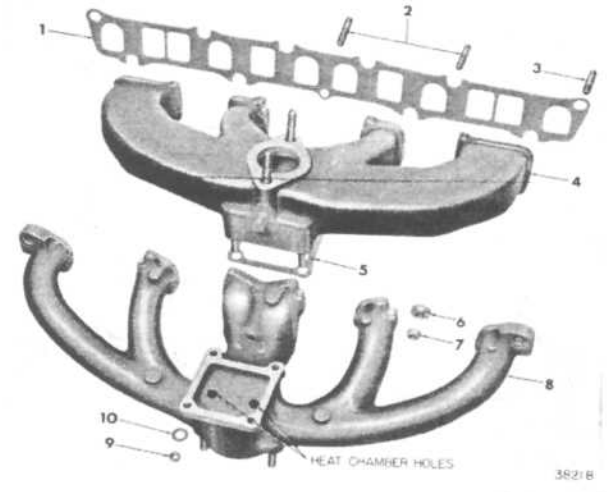


FIG. 143—MODEL L6-226 INTAKE AND EXHAUST MANIFOLD (Single-throat Carburetor)

1—Gasket
2—Stud
3—Stud
4—Intake Manifold
5—Gasket
6—Washer
7—Nut
8—Exhaust Manifold
9—Nut
10—Washer

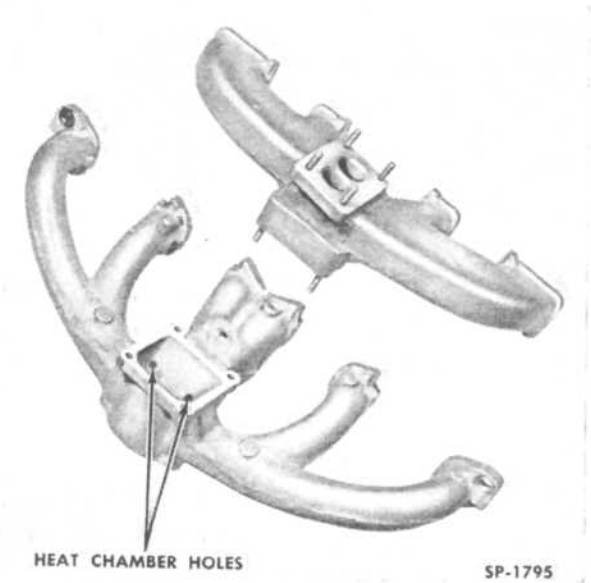


FIG. 144—MODEL L6-226 INTAKE AND EXHAUST MANIFOLD (Double-throat Carburetor)

G-3. Manifolds

All L6-226 Models.

The exhaust manifolds used on Model L6-226 engines are shown in Fig. 143 and 144. Earlier models used a double-throat carburetor, later models used a single-throat carburetor. For effective serial numbers see Par. F-3. The information given below applies equally to both types.

The heat chamber operates on a pulsating principle. When the engine is started cold and is allowed to idle, the rhythmic exhaust from number 3 and 4 cylinders will "pulse" a portion of the hot exhaust gases through the two machined holes in the bottom of the heat chamber to aid in warming the incoming fuel-air mixture. After the engine is warmed up and the throttle is opened, the increased velocity of the exhaust gases reduces the tendency to pulse, thereby reducing heat to the heat chamber.

When installing manifolds use new gaskets. Have mating surfaces clean and smooth. If stud threads are badly coated or damaged clean up with a thread die, or replace studs. Proceed as follows:

a. Using a new gasket, assemble the intake and exhaust manifolds tightening nuts securely to 18–23 foot pounds torque (2.5–3.1 kg. m.).

b. Place new manifold gasket and the manifold carefully over studs against cylinder block. Place clamps or washers over studs and start stud nuts. Starting at center and working toward ends tighten nuts carefully. Torque to 30–35 foot pounds (4.1–4.8 kg. m.).

G-4. Exhaust Pipe, Muffler, Tail Pipe

This system should be checked periodically and all loose or broken hangers and supports should be tightened or replaced. Also check for any dents or restrictions in the tail pipe or muffler as these can cause faulty engine performance.

Typical exhaust systems from the exhaust manifold to the tail pipe and including all attaching parts are shown in Fig. 145 and 146.

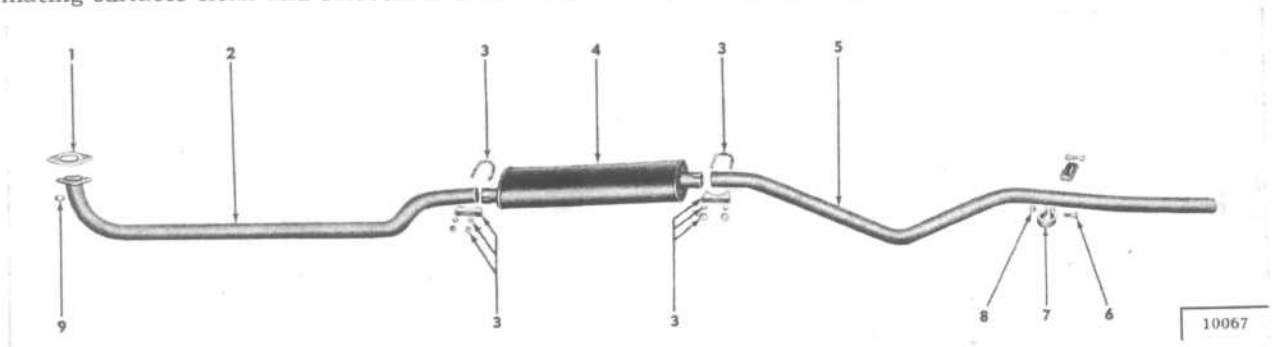


FIG. 145—EXHAUST PIPE AND MUFFLER
(Typical for L6-226 Models)

1—Gasket
2—Exhaust Pipe
3—Clamp
4—Muffler
5—Tail Pipe
6—Bolt
7—Clamp
8—Nut
9—Nut

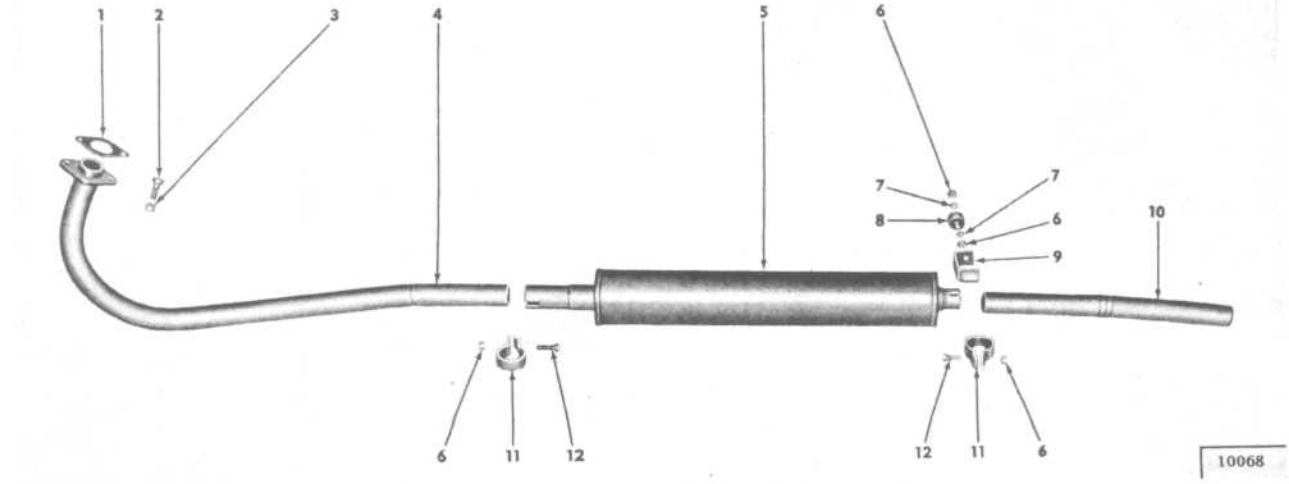


FIG. 146—EXHAUST PIPE AND MUFFLER
(Typical for F4-134 Models)

1—Gasket
2—Bolt
3—Nut
4—Exhaust Pipe
5—Muffler
6—Nut
7—Washer
8—Insulator
9—Support Strap
10—Tail Pipe
11—Clamp
12—Bolt

COOLING SYSTEM

Contents

SUBJECT	PAR.
Antifreeze Solution	H-13
Draining Cooling System	H-3
Fan Belt	H-14
Heat Indicator	H-5
Radiator Filler Cap	H-2
Thermostat	H-4
Water Pump—L6-226	H-9
Water Pump—F4-134	H-6

H-1. GENERAL

The satisfactory performance of an engine is controlled to a great extent by the proper operation of the cooling system. The engine block is full length water jacketed which prevents distortion of the cylinder walls. Directed cooling and large water holes, properly placed in the cylinder head gasket cause more water to flow past the valve seats (which are the hottest parts of the block) and carry the heat away from the valves, giving positive cooling of valves and seats.

On the F-head engines, the intake manifold is cast as an integral part of the cylinder head and is completely water jacketed. This construction transfers heat from the cooling system to the intake riser and assists in vaporizing the fuel when the engine is cold.

To quickly warm up the engine and hold the cooling fluid to the maximum efficient temperature a thermostat is installed in the water outlet on the cylinder head.

There is always the possibility that the air passages in the radiator core may become blocked, especially when using the 4-wheel drive models for off-the-road service. The cooling system cannot operate efficiently unless air can pass freely through the air passages in the radiator. Keep the air passages clean, using either compressed air or water pressure from the rear, forcing the dirt out through the front of the radiator.

H-2. Radiator Filler Cap

All models are equipped with pressure caps which reduce evaporation of cooling solution and make the engines more efficient by permitting slightly higher operating temperatures. Early production vehicles were equipped with 7 lb. [0,50 kg-cm^2] pressure caps; later vehicles with 9 lb. [0,63 kg-cm^2] caps.

Current production Model L6-226 4WD and 4x4 vehicles are equipped with 13 lb. [0,91 kg-cm^2] pressure caps; all others with the 9 lb. caps.

Vacuum in the radiator is relieved by a valve which is built into the cap and which opens at ½ to 1 lb. [0,035 a 0,07 kg-cm^2] vacuum.

The filler cap should be free of all foreign matter. It should be inspected periodically for free operation of the springs and valves. Inspect the gasket for good sealing properties. If any part proves faulty, the cap must be replaced.

NOTE: A cap must be replaced by one of the same pressure rating. The filler pipe flange should be inspected for foreign matter or dents. The flange must be in good condition to make a tight seal with the filler cap gasket.

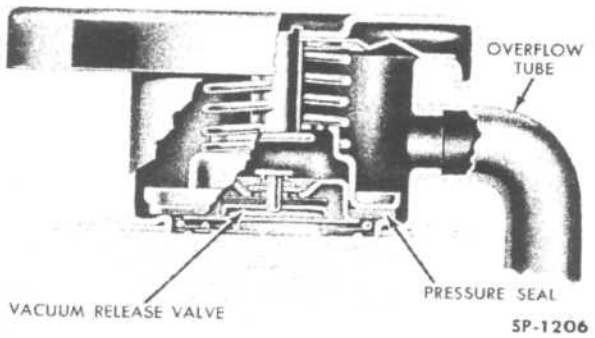


FIG. 147—RADIATOR FILLER CAP

H-3. Draining the Cooling System

To completely drain the cooling system it is necessary to open the drain in the bottom of the radiator and also a drain on the right side (left side on 6-226 models) of the cylinder block. Remove the radiator cap to break any vacuum that may have developed.

When refilling the system with anti-freeze do not overfill. The solution should be maintained 1" [25 mm.] below the bottom of the filler neck otherwise an appreciable amount of the solution will be lost through the overflow due to expansion when heated.

Should the cooling solution be lost from the system and the engine become overheated do not refill the system immediately but allow the engine to cool or refill slowly while the engine is running. If cold solution is poured into the radiator while the engine is overheated there is danger of cracking the cylinder block and head.

H-4. Thermostat

The cooling system is designed to provide adequate cooling under most adverse conditions; however, it is necessary to employ some device to provide quick warming and to prevent overcooling during normal operations. This is accomplished by use of a thermostat No. 8, Fig. 12, which is located in the

water outlet on top of the cylinder head. The thermostat opening is set by the manufacturer and cannot be altered. It opens at a temperature of 163° to 168° Fahr. (72.8° to 75.5°C.) To test the thermostat submerge it in water heated to 188° Fahr. (86.6° C.) at which temperature the control valve should open fully. Should the valve fail to open, a new thermostat will be required.

Do not operate an engine without a thermostat installed as there is no control of engine temperature. This practice results in uneven cooling and usually the engine runs too cool, which causes the rapid accumulation of sludge. Moisture within the engine, due to condensation, may mix with unburned fuel to form sulphurous acid which will cause serious damage by etching. Usually repeated valve spring breakage may be traced to acid etching of the springs due to a faulty thermostat or operation of the engine without a thermostat installed.

H-5. Heat Indicator

The heat indicators used on all models discussed here are of the electric type. For service information refer to the "Electrical" section.

H-6. Water Pump

All F4-134 Models.

The information for the water pumps used on these models is covered in Par. H-6 through H-8.

The water pumps used on these models are basically the same. Minor changes have been made in the seals and in the shape of the impellers; otherwise, the disassembly and assembly procedure outlined below applies to all models covered here.

Should a pump require overhauling it is recommended that a new assembly be installed for usually the cost is less than the rebuild expense. The rebuild procedure is given for use should it be necessary to rebuild a unit.

This pump is a centrifugal impeller type of large capacity to circulate water in the entire cooling system. Figs. 148 and 149.

The double row bearing is integral with the shaft, and is packed at assembly with a special high-melting point grease which will last the life of the bearing. The bearing is sealed to retain the lubricant and prevent dirt and dust from entering.

The bearing and shaft is retained in the housing by retaining wire lock No. 4 between the bearing and water pump body. The seal washer No. 5 has four lugs which fit into slots in the end of impeller No. 7. One side of the seal washer bears against the ground seat on the pump housing and the other side against seal No. 6. The rubber seal bears against the inside of the impeller. This seal maintains a constant pressure against the seal washer and impeller preventing leakage. On later model pumps, the seal washer is eliminated and the seal bears directly against the ground seat on the pump body and the inside of the impeller. A drain hole in the bottom of the housing precludes any water seepage past the seal from entering the bearing.

The impeller and fan pulley, or, in later models, the pulley hub, are pressed on the shaft under high pressure.

H-7. Dismantling Water Pump

When water pump repairs are necessary, we recommend the installation of a new pump assembly; however, should it be necessary to repair the old assembly, follow the sequence outlined below:

Remove the fan belt and fan assembly and water pump from the engine.

Remove bearing retaining snap wire No. 4, Fig. 148.

Remove the pump impeller with a puller, as shown in Fig. 150.

Remove the seal washer No. 5 and seal No. 6.

Remove the fan pulley with puller Tool No. W-115 as shown in Fig. 151.

H-8. Assembling Water Pump

Before assembling the water pump, examine the seal washer seat in the housing and should it be rough, reface it with a housing seat reamer, as shown in Fig. 152, or install a new housing.

To reassemble the unit, install the long end of the shaft No. 2, in the pump body No. 3, from the front end until the outer end of the bearing is flush with the front end of the pump body.

Dip the seal and seal washer in brake fluid and position them on the impeller shaft. Place the impeller on an arbor press and press the long end of the shaft into the impeller, until the end of the shaft is flush with the hub of the impeller.

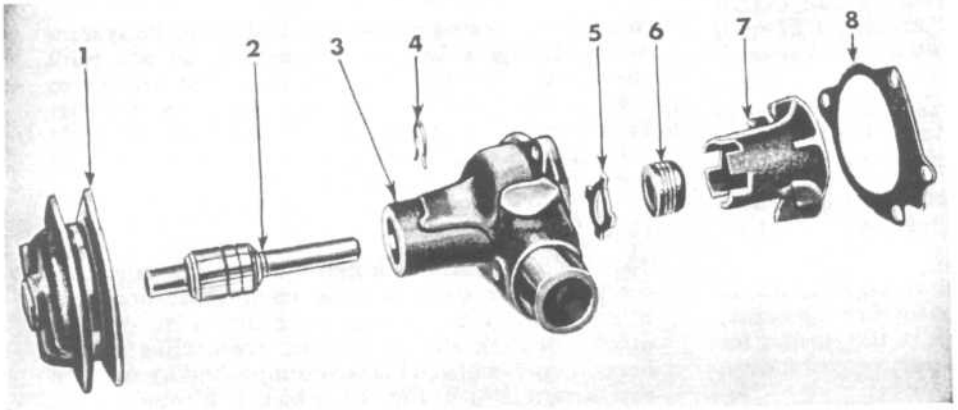


FIG. 148—WATER PUMP MODEL F4-134

1—Fan and Water Pump Pulley
2—Bearing and Shaft
3—Pump Body
4—Bearing Retaining Wire
5—Seal Washer
6—Seal Assembly
7—Impeller
8—Gasket

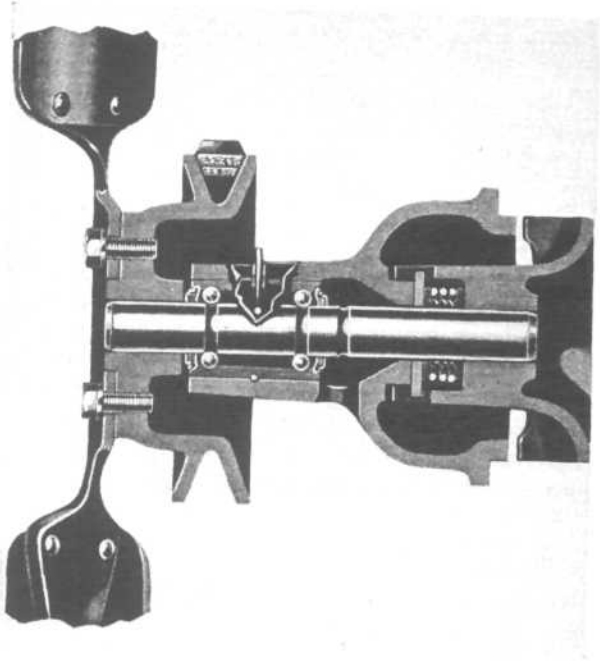


FIG. 149—WATER PUMP—MODEL F4-134

Support the assembly on the impeller end of the shaft and press the fan pulley on the shaft until the shaft end is flush with the face of the pulley. Move the shaft in the pump body to align the retaining wire grooves in the bearing and pump body and place the bearing retaining wire No. 4 in position.

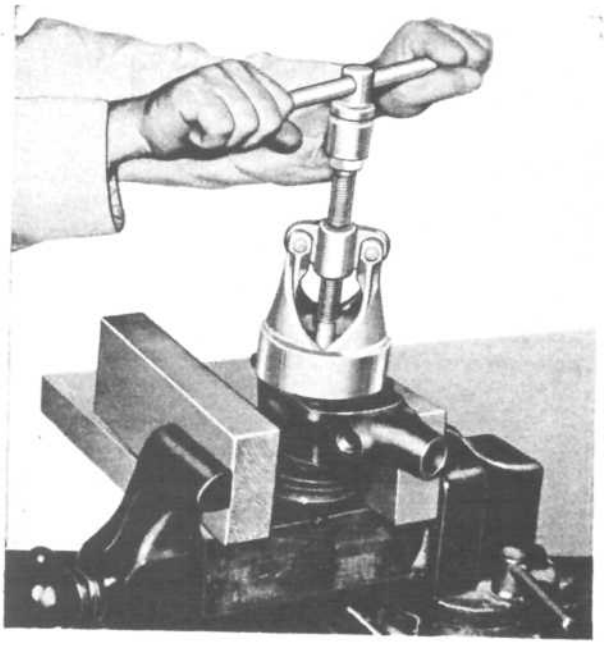


FIG. 150—WATER PUMP IMPELLER PULLER

H-9. Water Pump

All L6-226 Models.

The information for the water pump used on these models is covered in Par. H-9 through H-12.

This pump, Fig. 153, is a centrifugal impeller type of large capacity having a hardened and ground shaft supported by sealed, life-time lubricated ball bearings. The shaft also has a brass sleeve extending through the seal to protect against corrosion. The fan pulley hub and the cast iron impeller are both pressed onto the pump shaft. The pump seal is a self-contained unit pressed into the pump body. Its carbon composition graphite impregnated seal washer is held by the spring in contact with the finished face of the impeller hub.

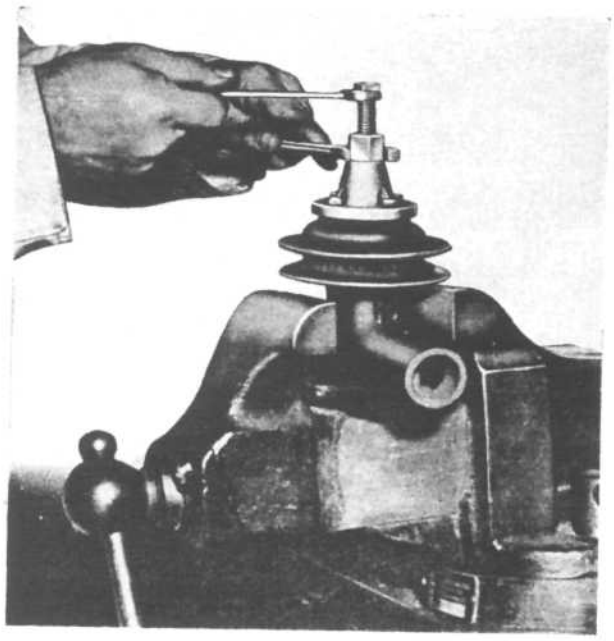


FIG. 151—WATER PUMP FAN HUB PULLER

H-10. Pump Removal

a. Drain cooling system.
b. Disconnect hose at pump inlet.
c. Detach the generator adjusting link (fan belt tension adjuster) from the pump by removing pump bolt.
d. Remove fan belt.
e. Remove remaining pump mounting bolts.
f. Lift out pump.

H-11. Pump Overhaul

It is recommended that either the special tools mentioned below or an arbor press be available before overhauling the water pump. Proceed as follows:

a. Remove fan belt and pulley from pulley hub.
b. Remove pump to block gasket from pump cover.
c. Remove pump cover and gasket from pump body.
d. Remove pump impeller from pump shaft. Use an arbor press to push the shaft from both the impeller and housing after first removing the bearing retainer ring.
e. If the impeller puller has been used and pump shaft is still in housing, remove retainer ring and drive or press the shaft from housing.

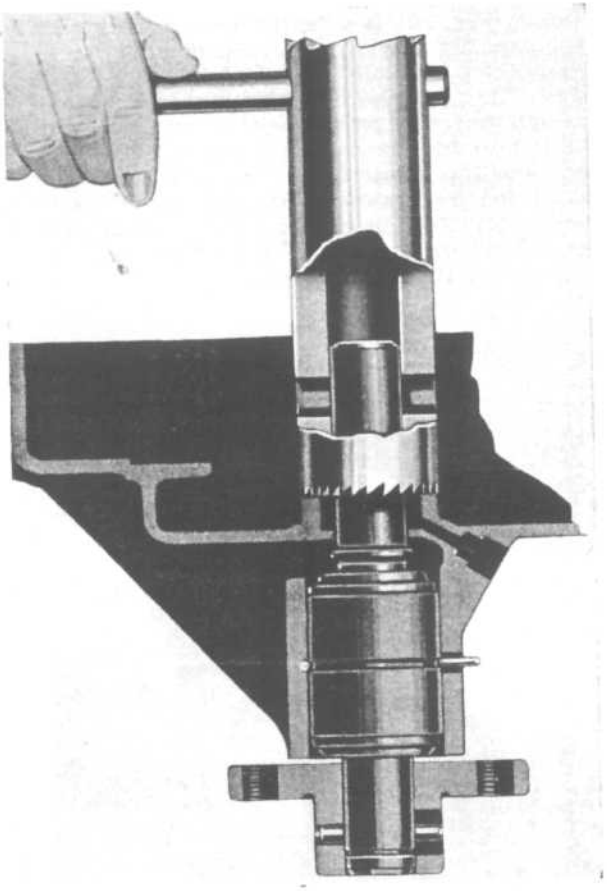


FIG. 152—WATER PUMP HOUSING SEAT REFACER

f. Check pump shaft for free turning and for bearing play. If wear is evident, replace shaft and bearing assembly.

g. Press or drive the complete seal unit from the pump body.

h. Inspect the seal seat surface on the pump impeller. If the impeller hub seat surface is rough or scored, the impeller should be replaced. Apply a small amount of fine graphite or oil to the seat before assembling pump. Always install a new seal or new seal washer.

i. Press the pump seal assembly carefully into the bore in pump housing. Apply oil or graphite to the face of the carbon impregnated seal washer. Use suitable seal driver against seal to prevent distortion when driving the seal.

j. Press pump shaft and bearing assembly into pump housing, carefully, just far enough for insertion of retainer ring. Insert ring.

k. Press impeller onto pump shaft until it is flush with shaft end.

l. Press the fan pulley hub onto the pump shaft, supporting the pump on the impeller end.

NOTE: To secure alignment of the fan pulley with the generator and crankshaft pulleys, the hub must be pressed on the shaft so that the fan mounting face of the hub is $5\frac{7}{32}$" [13,25 mm.] from the rear face of the rear cover plate.

m. Install cover gasket and cover. Use new cover gasket.

H-12. Pump Installation

Install the pump assembly on the engine as follows:

a. Place pump in position on engine using a new pump to cylinder block gasket. Install pump mounting bolts.

b. Install fan pulley and fan on pump.

c. Install fan belt and adjust as described in Par. H-14.

d. Install hose at water pump inlet. Fill the cooling system.

H-13. Antifreeze Solution

When alcohol is used as an anti-freeze, use care not to spill any on the finished portions of the vehicle; if so it should be washed off immediately with a good supply of cold water without wiping or rubbing.

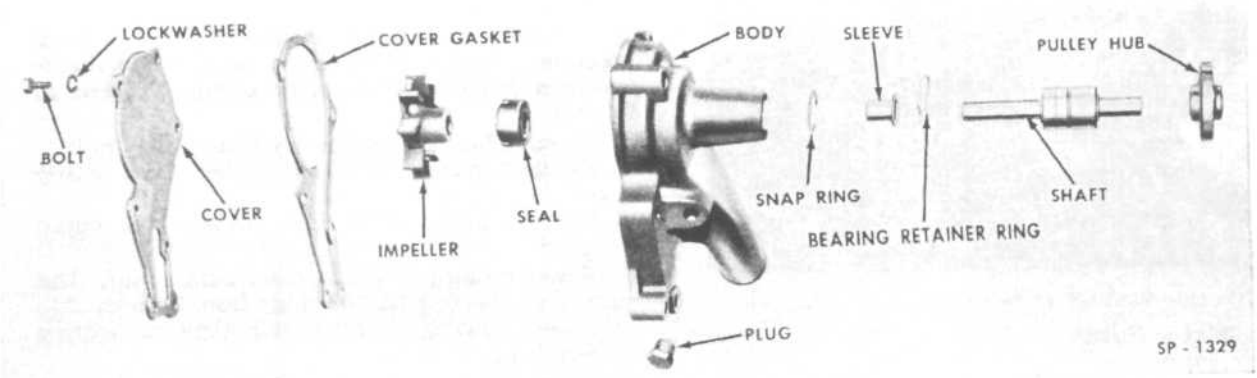


FIG. 153—WATER PUMP—MODEL L6-226

The distillation or evaporation point of water and alcohol is approximately 170° Fahr. (76.7° C.) therefore when the engine is operated in warmer weather with alcohol solution in the cooling system, the solution should be checked at regular intervals.

The operating temperature of 4-wheel drive models when used in off-the-road service or with power take-off is usually somewhat higher than 170° (76.7°C.).

As a result alcohol is not satisfactory to use due to rapid evaporation.

Ethylene glycol anti-freeze solution has the advantage of possessing a higher point of distillation than alcohol and may be operated at higher temperatures without loss of the solution. In a tight cooling system only water need be installed to replace evaporation losses. Any solution lost mechanically through leakage or foaming must be replaced. Under ordinary conditions ethylene glycol is not injurious to the vehicle's finish.

The cooling system capacity of F4-134 Models is 11 quarts without heater and 12 quarts with heater; for L6-226 Models it is 12 quarts [11,3 ltrs.] without heater and 13 quarts [12,3 ltr.] with heater. An antifreeze chart is given in the Specifications at the end of this section.

Before installing antifreeze, inspect the cooling system to be sure it is clean, leak-tight, and otherwise in proper operating condition. Drain the cooling system. See Par. H-3. Pour in 3 quarts [3 ltr.] of clean water, add the required quantity of antifreeze, then add clean water to within 1" [2,54 cm.] of the top. Run the engine until it is warm. Then check the solution level and antifreeze protection.

WARNING: Drinking ethylene glycol antifreeze or its solutions can be harmful or fatal. Do not use antifreeze containers for food or beverages.

Rust and scale forms in every cooling system, therefore advise owners to have the cooling system flushed twice a year, preferably before and after using anti-freeze. There are a number of flushing solutions and the instructions of the manufacturer should be closely followed when they are used.

Reverse flushing will aid greatly in removing scale especially when used with a flushing solution. Air impulses agitate the water for more efficient cleaning. Before flushing, remove the thermostat and disconnect both radiator hoses. Flush the block and radiator separately. Flush the block through the upper hose and the radiator through the lower hose.

After flushing it is advisable to tighten the cylinder head to prevent the possibility of water leaking into the engine. Inspect the radiator hoses, replacing if deteriorated and be sure there is no leakage at the clamps.

H-14. Fan Belt

The fan is driven by a "V" type belt. To install a fan belt loosen the clamp bolt on the generator brace, Fig. 154, and swing the generator toward the engine. Place the belt over the crankshaft pulley, up

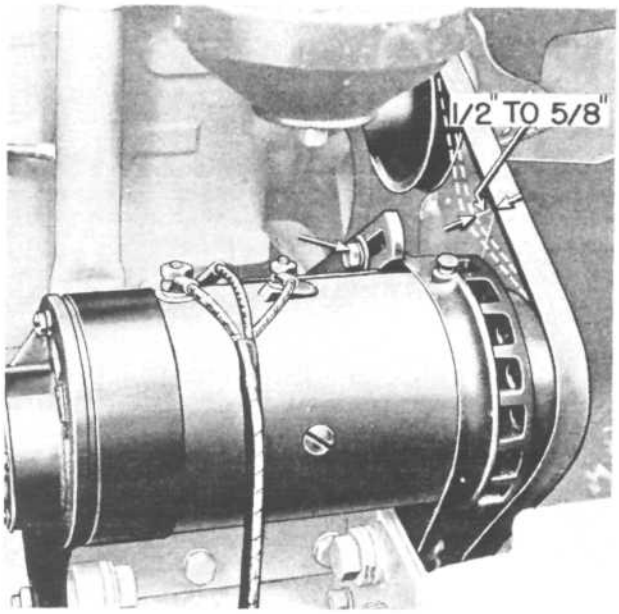


FIG. 154—GENERATOR BRACE

through fan blades and over the fan pulley, then over the generator pulley. Adjust belt tension by swinging the generator away from the engine until the fan belt can be depressed ½"–⅝" (12.7–15.9 mm.) with thumb pressure midway between the fan and generator pulleys then lock it in position with the clamp bolt. The drive of the fan and generator is on the sides of the belt, therefore it is not necessary to have the belt too tight, which might cause excessive wear of the generator and water pump bearings. If too loose, the belt may slip causing the engine to overheat or prevent the generator from properly charging. Replace a frayed belt to avoid delay during vehicle operation.

SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Overheating	
Lack of Water	Refill Radiator
Thermostat Inoperative	Replace
Water Pump Inoperative	Overhaul or Replace
Incorrect Ignition or Valve Timing	Set Timing
Excessive Piston Blowby	Check Pistons, Rings and Cylinder Walls
Fan Belt Broken	Replace
Radiator Clogged	Reverse Flush
Air Passages in Core Clogged	Clean With Water and Air Pressure
Excessive Carbon Formation	Remove
Muffler Clogged or Bent Exhaust Pipe	Replace
Loss of Cooling Liquid	
Loose Hose Connections	Tighten
Damaged Hose	Replace
Leaking Water Pump	Replace
Leak in Radiator	Remove and Repair
Leaky Cylinder Head Gasket	Replace
Crack in Cylinder Block	Small Crack Can Be Closed with Radiator Sealer
Crack in Cylinder Head	Small Crack Can Be Closed with Radiator Sealer

COOLING SYSTEM SPECIFICATIONS

	F4-134 Models	L6-226 Models
Cooling Capacity—Without Heater	11 Qts. [10,4 ltr.]	12 Qts. [11,3 ltr.]
With Heater	12 Qts. [11,3 ltr.]	13 Qts. [12,3 ltr.]
Radiator	Harrison	Modine
Filler Cap	Pressure Type	Pressure Type
Fan	4 Blades — 15″ dia. [38,1 cm.]	4 Blades — 17″ dia. [43,1 cm.]
Fan Belt:		
Length	42 5/8″ [108,3 cm.]	41″ [104,1 cm.]
Width	11/16″ [1,74 cm.]	7/16″ [1,11 cm.]
Angle of V	38°	36°
Water Pump:		
Type	Centrifugal	Centrifugal
Location	Front Cylinder Block	Front Cylinder Block
Drive	Fan Belt	Fan Belt
Bearing	Permanent Sealed Lubricated Ball	Permanent Sealed Lubricated Ball
Thermostat:		
Location	Water Outlet	Water Outlet
Starts to Open at	163°F. to 168°F. [73°C. a 76°C.]	163°F. to 168°F. [73°C. a 76°C.]
Fully Open at	188°F. [87°C.]	188°F. [87°C.]

ANTIFREEZE CHART

ANTIFREEZE			PROTECTION TO TEMPERATURE SHOWN			
			Methyl Alcohol		Ethylene Glycol	
Quarts U.S.	Quarts Imperial	Liters	Fahr.	Cent.	Fahr.	Cent.
11-Quart System						
2	1 2/3	2	13°	10,5°	18°	– 7,6°
3	2 1/2	2 3/4	0°	–17,7°	8°	–13,3°
4	3 1/3	3 3/4	–18°	–27,7°	– 6°	–21,1°
5	4 1/4	4 3/4	–38°	–38,8°	–23°	–30,5°
6	5	5 2/3	....	.....	–47°	–43,8°
12-Quart System						
2	1 2/3	2	15°	– 9,5°	19°	– 7,2°
3	2 1/2	2 3/4	3°	–16,1°	10°	–12,2°
4	3 1/3	3 3/4	–12°	–24,4°	0°	–17,7°
5	4 1/4	4 3/4	–31°	–35,0°	–15°	–26,1°
6	5	5 2/3	–50°	–45,5°	–34°	–36,6°
13-Quart System						
2	1 2/3	2	16°	– 8,9°	21°	– 6,1°
3	2 1/2	2 3/4	6°	–14,4°	13°	–10,5°
4	3 1/3	3 3/4	– 8°	–22,2°	3°	–16,1°
5	4 1/4	4 3/4	–23°	–30,5°	–10°	–23,3°
6	5	5 2/3	–40°	–40,0°	–25°	–31,6°
7	5 3/4	6 1/2	....	.....	–44°	–42,2°

ELECTRICAL SYSTEM

Contents

SUBJECT	PAR.
Battery	I-2
Directional Signals	I-66
Distributor	
Cap	I-12
Condenser	I-14
Governor	I-16
Points	I-15
Removal—L6-226	I-11
—F4-134	I-10
Rotor	I-13
Generator	I-19
Armature	I-22
Assembly	I-26
Brushes	I-24
Disassembly	I-21
Field Coils	I-23
Maintenance	I-20
Headlamps	I-7
Headlamp Aiming	I-8
Ignition System	I-9
Indicators and Gauges	I-3
Lighting System	I-4
Regulator—Current-Voltage	I-27
Circuit Breaker	I-29
Current Regulator	I-31
Inspection	I-32
Test	I-33
Voltage Regulator	I-30
Quick Checks	I-34
Starting Motor	I-49
Assembly	I-61
Disassembly	I-55
Drive	I-63
Maintenance	I-50
Test	I-62
Switch—Main Light	I-5
—Starting	I-65
—Stoplight	I-6
Timing-Ignition—L6-226	I-18
—F4-134	I-17

I-1. GENERAL

Early production vehicles were all equipped with 6-volt electrical systems. Later domestic production vehicles were all changed to 12-volt electrical systems. For a quick check to see which system the vehicle has, look at the battery. As the electrical circuits remain the same, the wiring diagrams represent both 6- and 12-volt wiring. However, bulbs and electrical components are not interchangeable and a replacement item of the correct voltage rating must be secured. Use caution around the higher voltage of the 12-volt system as accidental short circuits are more capable of damaging electrical units. Also, arcs around the 12-volt battery are more apt to ignite any gas that may be escaping from it.

I-2. Battery

The battery acts as a storage reservoir of electrical energy produced by the generator. To store sufficient energy for operation of the electrical system (starter, lights, etc.) when the generator is not producing, the battery and battery wiring must receive regular attention. The principle attention is to maintain the electrolyte at the correct level, regularly check with a hydrometer and maintain the cable connections tight and clean. Also be sure the battery is held snugly in position to avoid damage due to bouncing.

At each 1,000 miles (1600 km.) or when the vehicle is lubricated check the battery condition with a hydrometer. This practice will result in increased battery sales and service and protect the owner from costly delays due to battery failure. The Dealer is also protected from service complaints and possible loss of a customer.

A hydrometer reading of 1.260 indicates that the battery is fully charged. Should the reading fall below 1.225 it will be necessary to recharge or replace the battery. Unless the cause of the battery discharge is definitely known it is advisable to load test each cell to check for an internal short. A shorted battery will not hold a charge and must be repaired or replaced.

After testing with the hydrometer check the electrolyte level adding distilled water to maintain the solution 3/8" (9.5 mm.) above the plates. Avoid over filling. Do not fail to replace the filler caps and tighten them securely.

Check the battery cable connections at the battery terminals to be sure they are tight and clean. Copper sulphate which builds up on the terminals may be quickly removed by using a strong solution of baking soda and water. After cleaning, coat the terminals with grease to reduce formation of sulphate. The negative terminal is grounded by a cable bolted to the frame or body. Be sure a good tight connection is made at this point.

If the terminal connections of the engine ground cable, which connects the front engine support plate with the frame, are loose or dirty, hard starting or failure to start may result. Check the connection of the ground cable as a part of each vehicle inspection and each tune-up.

I-3. Indicators and Gauges

Early production vehicles are equipped with four gauges (fuel, oil, ammeter, and temperature). Later production vehicles are equipped with two gauges (fuel and temperature) and two indicators (oil pressure and battery charge). A voltage regulator maintains a constant voltage to the gauges. On

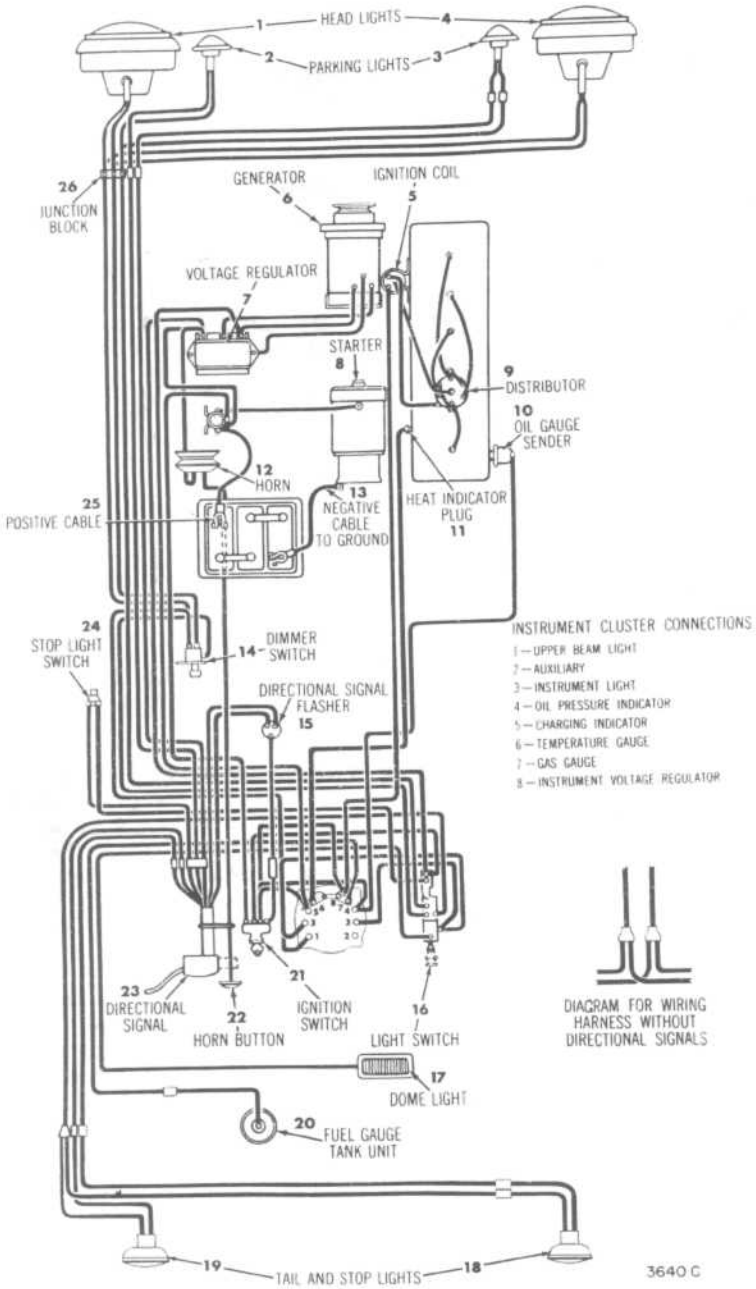


FIG. 155—WIRING DIAGRAM—L6-226 4WD

early production vehicles, the voltage regulator is mounted at the rear of the instrument panel; on later production vehicles, on the rear of the instrument cluster. On current production vehicles, the voltage regulator is integral with the fuel gauge.

The fuel gauge is connected by a single wire to a float-and-slide-rheostat sending unit in the fuel tank. The temperature gauge is connected by a single wire to a sealed bulb unit mounted in the rear of the cylinder head. The oil pressure indicator (or gauge) is connected by a single wire to a diaphragm-type unit located at the rear of the cylinder block. The battery charge indicator lamp is lit when energy is being supplied by the battery; the lamp goes out when the required energy is supplied by the generator.

Should trouble develop in the gauges, first check the regulator (fuel gauge on current production vehicles). If the voltage to the regulator is below 10 volts in a 12-volt system or 5 volts in a 6-volt system low gauge readings will result. Voltage in excess of 16 volts in a 12-volt system or 8 volts in a 6-volt system will not affect gauge readings but may result in premature wear of the regulator contacts. If the voltage to the regulator is within the above limits, check the electrical connections to the regulator (or fuel gauge), especially the ground connection. If the readings of all the gauges

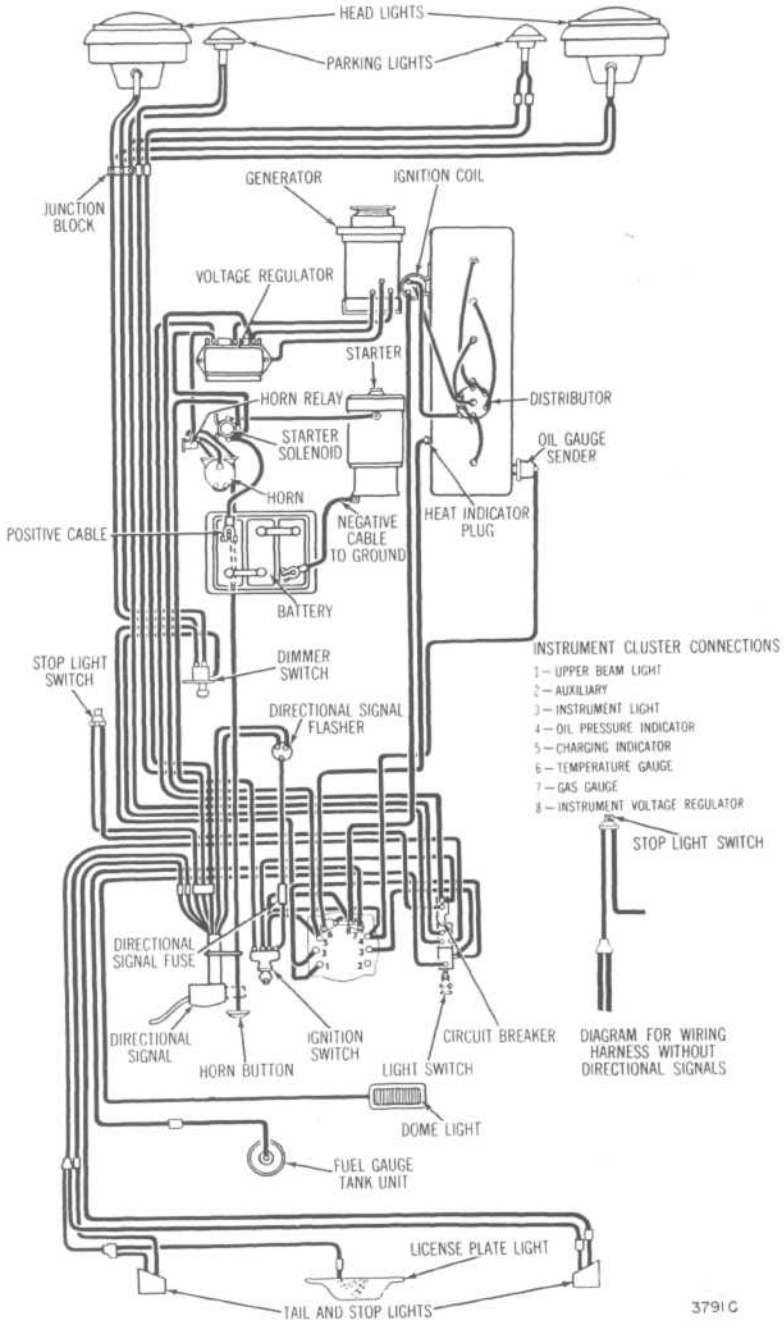


FIG. 156—WIRING DIAGRAM—L6-226 4x4 AND 4x2

is too high, or they all read too low, replace the regulator (or fuel gauge).

If the temperature gauge or heat indicator in the instrument cluster have failed, the cause may originate from the jumper bar shorting out against the instrument case. Check the jumper bar between the temperature gauge and heat indicator at the rear of the instrument case. On later production vehicles, the jumper bar is covered with an insulating sleeve to protect it from shorting out against the instrument case. If the jumper bar does not have this sleeve, either install one or wrap the bar with plastic electrical tape to half an inch [1 cm.] from each end. When installing the jumper bar, be sure the curved segment is closest to the fuel gauge.

Should only one of the gauges register incorrectly, disconnect the lead wire at the sending unit. Connect a new fuel tank unit to the lead wire and ground the unit. With the ignition switch on and the float in the empty position, the gauge should have a zero reading. With the float in the full posi-

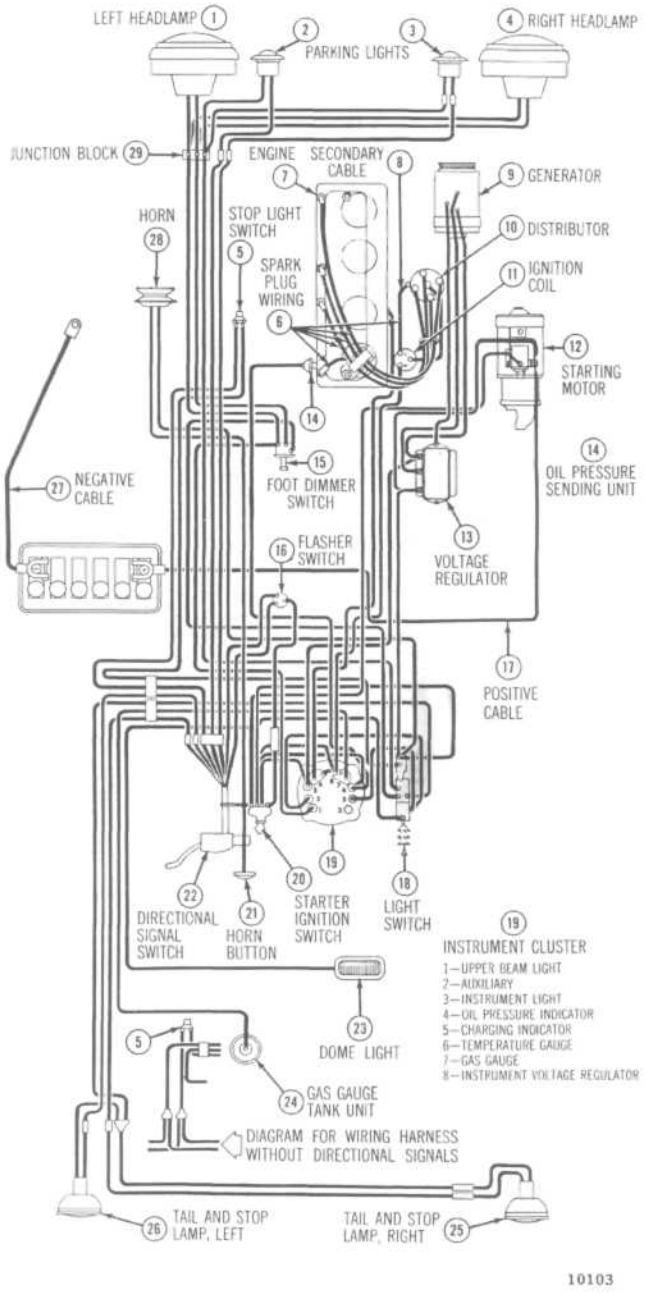


FIG. 157—WIRING DIAGRAM—F4-134 4WD

tion, the gauge should read at the top of the scale. Correct readings from these tests indicate the gauge and lead wire are in good working order. If the readings are still incorrect, use a substitute lead wire and repeat the tests. Correct readings now indicate that the lead wire is at fault and should be replaced. Should the gauge readings be incorrect, replace the gauge.

If the regulator and gauges test correctly, the sending unit is inoperative and should be replaced by a new one.

Should a new fuel tank unit not be available for testing, use a 6-12v., 1 c.p. test light in its place. When the gauge is operating correctly, the pointer will move three-quarters or more across the dial.

If the oil pressure indicator does not indicate correctly, first check the light bulb. Next, check all connections and lead wires. If, after all possible

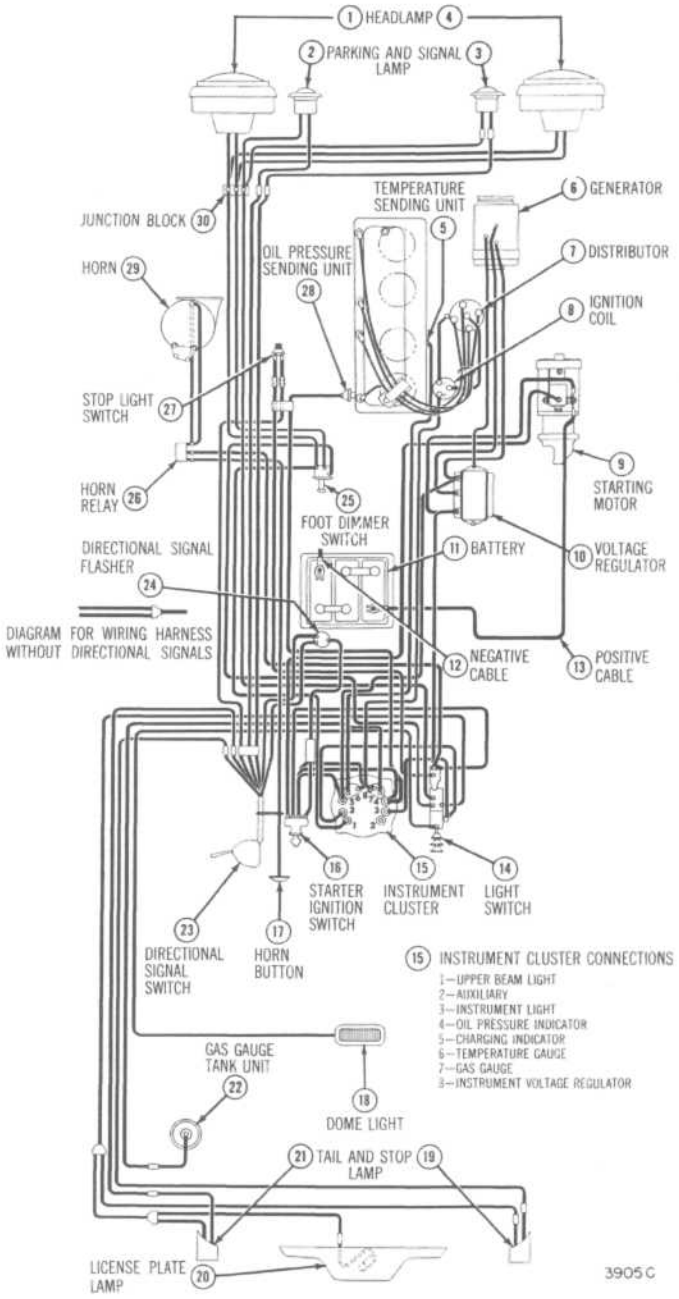


FIG. 158—WIRING DIAGRAM—F4-134 4x4 AND 4x2

defects are corrected, the indicator light does not go on and off properly, then diaphragm type unit in the cylinder block should be replaced.

Do not attempt to repair any of the gauges, sending units or the regulator; replacement is the only procedure.

I-4. Lighting System

The wiring of the lighting systems is shown in wiring diagrams, Fig. 155 through Fig. 158, which indicate the various units in relation to the position in which they are found. While not so indicated in the diagrams the wires in the various circuits are of different colors or are marked by tracers woven in the insulation which is of great assistance when checking individual circuits.

The lighting circuits of all models are protected by an overload circuit breaker mounted on the back of the main light switch and no replaceable fuse is required.

The upper and lower headlight beams are controlled by a foot switch located on the toe board to the left of the clutch pedal.

I-5. Main Light Switch

This switch is a dual functioning unit having two push-pull positions and a rotary action. When pulled out to the first position, the front parking and tail lights are turned on. When pulled all the way out to the second position, the headlights and tail lights are turned on. Rotating the switch to the right dims the instrument cluster lighting. Rotating it to the extreme left, lights the dome light.

The switch may be removed from the instrument panel by first loosening the set screw in the control knob and removing the knob. The retaining nut may then be removed and the switch removed through the rear of the instrument panel.

Extra electrically operated equipment — radio, heater, etc. — should be connected to the auxiliary terminal of the switch.

I-6. Stoplight Switch

The stoplight switch used on all models is of the diaphragm type and located in the front end of the brake master cylinder. Should the switch become inoperative, it is necessary to install a new one.

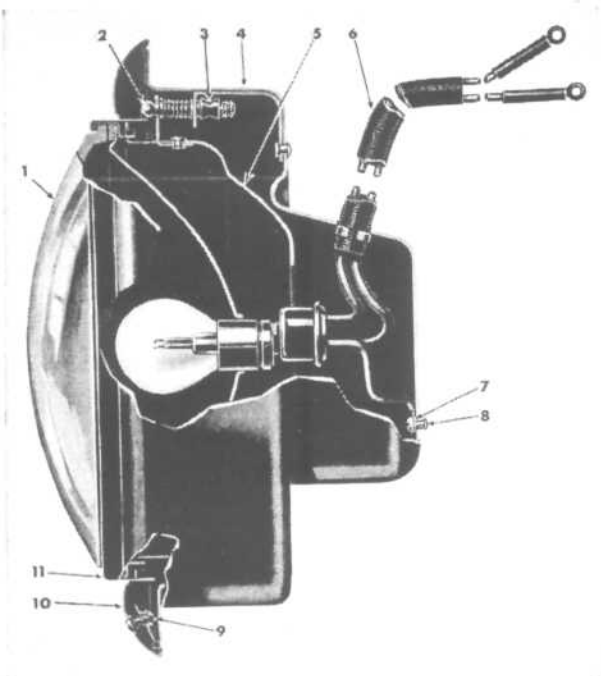


FIG. 159—HEADLAMP

1. Sealed Beam Unit
2. Adjusting Screw
3. Adjusting Nut
4. Housing Assembly
5. Mounting Ring
6. Wire Assembly
7. Lockwasher
8. Ground Wire Screw
9. Door Screw
10. Door
11. Retaining Ring

I-7. Headlamps

All models are of the sealed beam type in which the bulb and reflector form a sealed unit and can be replaced only as a unit. Correct bulb or sealed beam unit type and number may be determined by reference to the Specification Section.

The headlight bulbs have two filaments; the lower filament is for the up-beam and the upper filament is for the down-beam.

To remove a sealed beam unit remove the door clamp screw No. 9, Fig. 159, and remove the door. Remove the three screws holding the unit in the mounting ring and remove the unit. Disconnect the connector at the rear of the unit. Install a new unit by reversing the above operation.

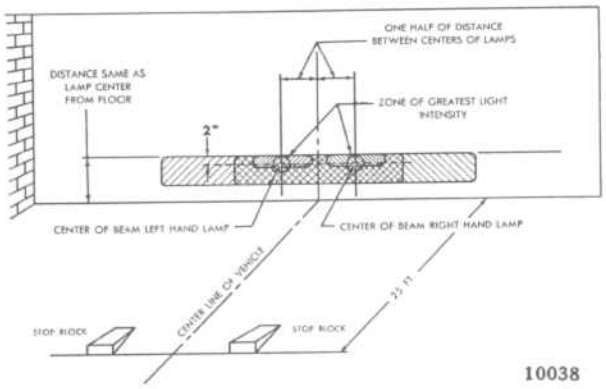


FIG. 160 — HEADLIGHT AIMING CHART

I-8. Headlamp Aiming

Headlamps may be aimed by using an aiming screen or wall, Fig. 160, providing a clear space of 25 feet (7.62 m.) from the front of the headlights to the screen or wall is available.

The screen should be made of a light colored material and should have a black center line for use in centering the screen with the vehicle. The screen should also have two vertical black lines, one on each side of the center line at a distance equal to the lamp centers.

Place the vehicle on a level floor with the tires inflated to recommended specifications as shown in the Wheel Section. Set the vehicle 25 feet (7.62 m.) from the front of the screen or wall so that the center line of the vehicle is in line with the center line on the screen. To position the vehicle, stand at the rear and sight through the windshield down across the cowl and hood.

Measure from the floor to the center of the headlamp and mark a horizontal line on the screen. To aim the lamps used on these models this line should be marked 2″ (5.08 cm.) lower than the height of the headlamp centers.

Turn on the headlight upper beam, cover one lamp and check the location of the upper beam on the screen. The center of the hot spot should be centered on the intersection of the vertical and horizontal lines.

If aim is incorrect, remove the headlamp door to make adjustment the method of which is obvious. Cover the headlamp aimed and adjust the other lamp in the same manner.

I-9. IGNITION SYSTEM

NOTE: Although Auto-Lite equipment is standard on Willys utility vehicles, at the start of 1954 production a few utility vehicles were equipped with Delco-Remy distributors and starting motors. However, if replacement of a Delco-Remy unit becomes necessary, the unit should be replaced with a like Delco-Remy unit and not with an Auto-Lite unit.

The power in an internal combustion engine is derived from burning a fuel and air mixture in the engine cylinders under compression. To ignite these gases a spark is made to jump a small gap in the spark plug within each combustion chamber.

The ignition system furnishes this spark. The spark must occur in each cylinder at exactly the proper time and the spark in the various cylinders must

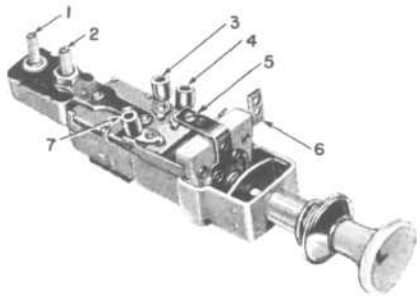


FIG. 161— MAIN LIGHT SWITCH

1—Battery
2—Auxiliary
3—Parking Lights
4—Headlights
5—Dome Light
6—Instrument Panel Lamp
7—Rear Lights

follow each other in sequence of firing order. To accomplish this the following units are required:

The battery, which supplies the electrical energy;

The ignition coil, which transforms the battery low-tension current to high-tension current which can jump the spark plug gap in the cylinders under compression;

The distributor, which delivers the spark to the proper cylinders and incorporates the mechanical breaker, which opens and closes the primary circuit at the exact time;

The spark plugs, which provide the gap in the engine cylinders;

The wiring, which connects the various units; The ignition switch which controls the battery current when it is desired to start or stop the engine.

I-10. Distributor Removal

All F4-134 Models

The distributor is mounted on the right side of the engine and is operated by a coupling on the oil pump shaft which is driven by a spiral gear on the camshaft.

To remove the distributor assembly the following procedure should be followed:

a. Remove high-tension wires from the distributor cap terminal towers, noting the order in which they are assembled to assure correct reassembly. No. 1 spark plug terminal tower in the distributor is the lower right hand tower at the distributor cap spring clip, starting with this tower the wires are installed in a counter-clockwise direction 1-3-4-2 on the four cylinder engines as shown in Fig. 163 and 1-5-3-6-2-4 on six cylinder engines — Fig. 164.

b. Remove the primary lead from the terminal post at the side of the distributor.

c. Disconnect the vacuum tube.

d. Unlatch the two distributor cap springs and remove the cap.

e. Note the position of the rotor in relation to the base. This should be remembered to facilitate reinstalling and timing.

f. Remove the screw holding the distributor to the crankcase and lift the assembly from the engine.

g. Wash all parts thoroughly in a suitable cleaning fluid.

I-11. Distributor Removal

All L6-226 Models

This distributor is mounted on top of the cylinder head. The drive consists of a short distributor shaft which meshes with an off-set slot in the top of the main drive shaft. This main drive shaft is driven by the oil pump. To remove this distributor, disconnect the vacuum tube and the low tension cable (which leads to the coil) and remove the distributor cap. Remove the bolt and lockwasher that hold the advance arm to the adapter. Lift out the distributor.

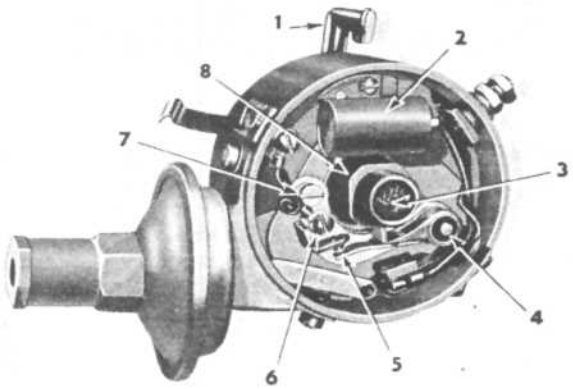


FIG. 162—DISTRIBUTOR

1—Oiler
2—Condenser
3—Lubricating Wick
4—Breaker Arm Pivot
5—Distributor Points
6—Adjustment Lock Screw
7—Adjusting Screw
8—Breaker Cam

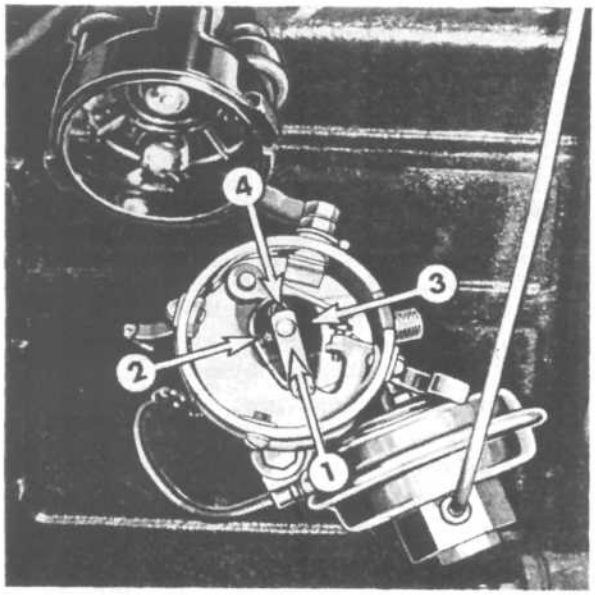


FIG. 163—FIRING POSITIONS — FOUR CYLINDER

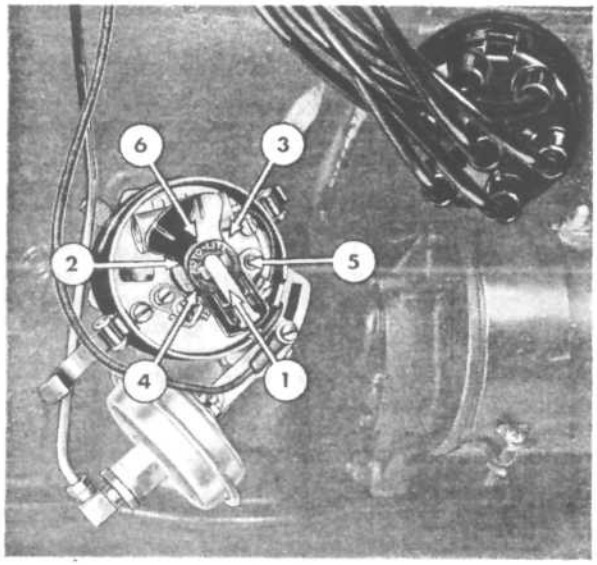


FIG. 164—FIRING POSITIONS—SIX CYLINDER

I-12. Distributor Cap

The distributor cap should be inspected for cracks, carbon runners and evidence of arcing. If any of these conditions exist, the cap should be replaced. Clean any corroded high tension terminals.

I-13. Rotor

Inspect the rotor for cracks or evidence of excessive burning at the end of the metal strip.

After a distributor rotor has had normal use the end of the rotor will become burned. If burning is found on top of the rotor, it indicates the rotor is too short and needs replacing. Usually when this condition is found, the distributor cap segment will be burned on the horizontal face and the cap will also need replacing.

I-14. Condenser

The condenser prolongs the life of the distributor points by preventing arcing at the contacts. It also provides a hotter spark by creating a reverse surge of current which rapidly breaks down the magnetic field of the coil by demagnetizing the core. Should the condenser be leaky a weak spark will be experienced.

Check the condenser lead for broken wires or frayed insulation. Clean and tighten the connections on the terminal posts. Be sure the condenser is mounted firmly on the distributor for a good ground connection.

Should a condenser tester be available the condenser capacity should check from .21 to .25 microfarads. In the absence of a tester check by substituting a new condenser.

I-15. Distributor Points

The contact points should be checked for burning and build-up of metal. If build-up does not exceed 1/64" [about 0,4 mm.] file or grind the points clean, bend into perfect closing alignment.

The contact points should be clean and not burned or pitted. The contact gap should be set at .020" (.508 mm.), measured with a wire gauge. After adjusting, tighten the lock and recheck the gap. If new contacts are installed they should be aligned to make contact at the center of the contact surfaces. Bend the stationary contact bracket to be sure of proper alignment and then recheck the gap.

The contact spring pressure is very important and should be between 17 and 20 ounces (.482–.567 kg.) Check with a spring scale hooked on the breaker arm at the contact and pull in a line at right angles to the breaker arm. Make the reading just as the points separate. This pressure should be within the above limits for if it is too low, missing will occur at high speeds and if too high the cam, block and points will wear rapidly. Adjust the point pressure by loosening the stud holding the end of the contact arm spring and slide the end of the spring in or out as necessary. Retighten the stud and recheck the pressure.

I-16. Governor Mechanism

Distributors equipped with vacuum type spark advance control are also equipped with centrifugal control. The centrifugal unit governs the spark advance proportionate to engine speeds giving maximum advance for power at high engine speeds. Under some operating conditions however, greater advance is required at lower engine speed to provide better operation and greater fuel economy. Under these conditions the vacuum control advances the spark in proportion to the vacuum in the carburetor throat. Should the throttle be fully opened for power, vacuum drops in the carburetor throat so that the vacuum control retards the spark timing and the centrifugal governor correctly adjusts the advance for maximum power requirements.

Check the vacuum chamber and connecting tube for leaks and clean the linkage and clamps.

Inspect the distributor shaft bearing in the housing and replace if worn. Check the friction spring mounted on the end of the shaft at the drive coupling and replace it if worn or damaged.

I-17. Setting Ignition Timing
All F4-134 Models.

If the engine crankshaft has been rotated with the distributor cap off, remove all the spark plugs except No. 1. Rotate the crankshaft until the No. 1 piston is coming up on the compression stroke. Remove No. 1 spark plug and rotate the crankshaft slowly until the 5° before top center mark on the flywheel is in the center of the timing hole or, on later four-cylinder engines, the 5° before top center mark on the timing gear cover is in alignment with the mark on the crankshaft pulley.

Oil the distributor to cylinder block bearing surface and install the distributor on the cylinder block. Mount the rotor on the distributor shaft and turn the shaft until the rotor points toward No. 1 spark plug terminal tower position (when cap is installed) with the contact points just breaking. See Par. D-112.

Move the rotor back and forth slightly until the driving lug on the end of the shaft enters the slot cut in the oil pump gear and slide the distributor assembly down into place. Rotate the distributor body until the contact points are just breaking. Install the hold-down screw being sure the body is free to oscillate in the mounting socket for vacuum spark advance control. The late type distributor housing does not turn in the mounting socket as advance and retard is controlled through an arm which extends through the housing and rotates the plate.

Connect the primary wire from the coil to the distributor. Install the spark plugs. Install the spark plug wires placing them in the distributor cap terminal towers starting with No. 1 and installing in counter-clockwise direction in the firing sequence which is 1-3-4-2 for four-cylinder engines. Fig. 163. Start the engine and run it until thoroughly warm and then recheck the timing with a neon timing light. When using the neon light disconnect the vacuum tube otherwise the distributor may advance slightly resulting in a false setting. Do not fail to reconnect the tube.

Accelerate the engine and check the automatic advance action by noting the movement of the timing indicator mark.

I-18. Setting Ignition Timing
All L6-226 Models.

The procedure for setting the ignition timing on 6-226 models is given in Section C.

I-19. GENERATOR
The generator is an air-cooled, two-brush unit which cannot be adjusted to increase or decrease output.

It is rated at either 12 volts, 30-amp. capacity on later vehicles or 6 volts on earlier vehicles. Par. I-1 explains the change to the 12-volt system.

The 6-volt generators are rated at either 35-amp. capacity or 45-amp. capacity. A 45-amp. generator and voltage regulator were placed in production in place of the former 35-amp. generator and regulator. For replacement, voltage regulator and generator must be matched. Otherwise, either a loss of ampere capacity or a burned out generator will result. The 45-amp. units went into production with the vehicle serial numbers listed below:

Model		Serial Number
All L6-226 Models		Start of production
F4-134 4WD Pickup		453-EC2-17878
	Stake	453-ED2-10293
F4-134 4x4		453-FA2-13341
F4-134 4x2	Utility Wagon	453-AA2-12481
	Utility Delivery	453-CA2-11065

The service procedures and tests are the same for all units except where noted and are given in Par. I-20 through I-26.

I-20. Generator Maintenance (without disassembly)
A periodic inspection should be made of the charging circuit. The interval between these checks will vary depending upon type of service. Dust, dirt and high speed operation are factors which contribute to increased wear of bearings and brushes.

Under normal conditions a check should be made each 6,000 miles (9600 km.).

A visual inspection should be made of all wiring, to be sure there are no broken or damaged wires. Check all connections to be sure they are tight and clean.

Should the commutator be rough or worn the armature should be removed and the commutator turned and undercut. See Par. I-22.

The brushes should slide freely in their holders. Should they be oil soaked or if they are worn to less than one-half their original length they should be replaced. When new brushes are installed they should be sanded to provide full contact with the commutator. Generators should not be checked for output until the brushes are seated.

Brush spring tension is important. High tension causes rapid brush and commutator wear while low tension causes arching and reduced output. Test the tension with a spring scale. The tension is 35 to 53 oz. [0,992 a 1,502 kg.] for the 6-volt generators and 18 to 36 oz. [0,510 a 1,020 kg.] for the 12-volt generator.

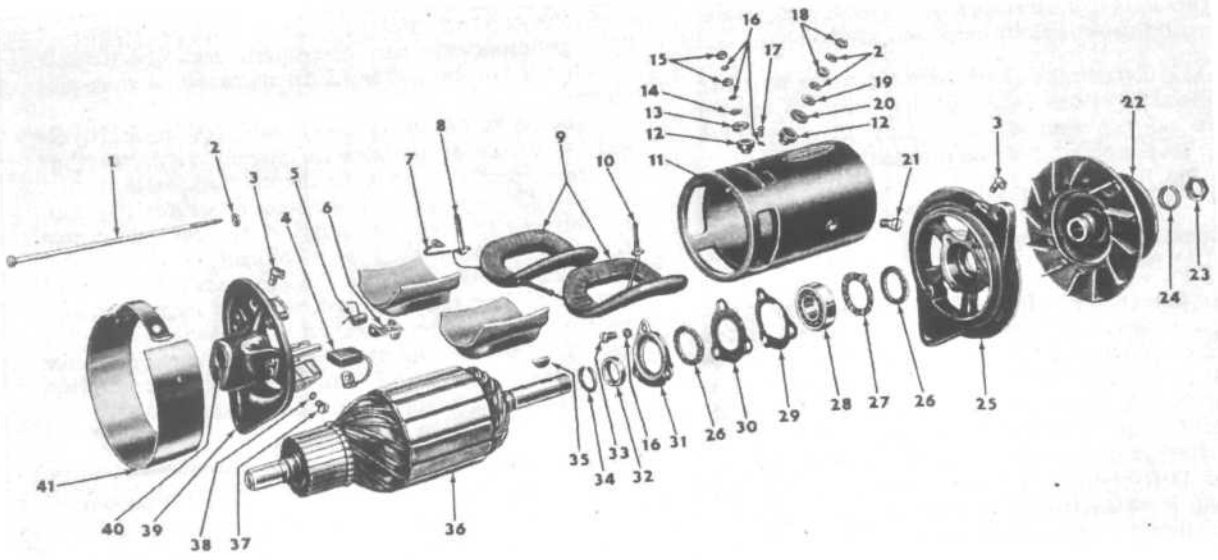


FIG. 165—TYPICAL GENERATOR

1—Thru Bolt
2—Lockwasher
3—Oiler
4—Brush Set
5—Brush Spring
6—Brush Arm
7—Lead
8—Stud
9—Left and Right Field Coil
10—Stud
11—Dowel Pin
12—Insulating Bushing
13—Insulating Washer
14—Washer
15—Hex Nut
16—Lockwasher
17—Ground Screw
18—Hex Nut
19—Washer
20—Insulating Washer
21—Pole Shoe Screw
22—Drive Pulley
23—Shaft Nut
24—Lockwasher
25—Drive End Head
26—Felt Washer
27—Gasket
28—Ball Bearing
29—Outer Retainer
30—Inner Retainer
31—Bearing Retainer
32—Felt Washer Retainer
33—Retainer Screw
34—Snap Ring
35—Woodruff Key
36—Armature
37—Brush Lead Screw
38—Lockwasher
39—Commutator End Head
40—Bearing
41—Band Cover

I-21. Dismantling Generator

Due to the fact that the regulator and battery are part of the generator circuit, and the generator output is extremely low when the battery is fully charged, it is advisable to check the generator circuit to determine definitely if the generator is at fault. Should this check prove that no current is passing to the battery, the fault must be localized either in the generator or regulator. Two tests to localize the trouble are given in Par. I-32b.

If it is definitely determined that trouble exists within the generator, which necessitates dismantling, remove the generator support bolts which will permit removing the generator assembly from the engine.

On 6-volt generators, remove the generator band. To facilitate removal of the commutator end plate and avoid damage to the brushes, the tension of the springs should be released from the brushes. Use a wire hook to lift the brush spring and at the same time pull the brushes partly out of the brackets. Let the spring down against the sides of the brushes to hold them up in the brackets.

On all generators, remove the two frame screws in the commutator end plate and remove the end plate assembly.

Next pull the armature and drive head complete from the generator housing. Remove the generator pulley from the armature by removing the nut and washer. Do not lose the Woodruff key when the pulley is removed. After this, remove the drive end head assembly which includes the oil seal and bearing. To remove the bearing, remove the three screws and lockwashers in the grease retainer and remove the retainer and felt washer, after which, remove bearing, oil guard and felt washer.

I-22. Armature

If the commutator is rough or worn, turn it down in a lathe. After turning, the mica insulation between the segments should be undercut to a depth of $\frac{1}{32}$" (.794 mm.).

To test the armature for a ground, connect one prod of a test lamp to the core or shaft (not on bearing surface) and touch each commutator segment with the other prod. If the lamp lights, the armature segment is grounded and the armature must be replaced.

To test for short in armature coils, a growler, Fig. 166, is necessary. Place the armature on the growler and lay a thin steel strip on the armature core. The armature is then rotated slowly by hand and if a coil is shorted, the steel strip will vibrate. Should a coil be shorted the armature must be replaced.

If precision test equipment is available, the customary accurate tests can be made in accordance with instructions furnished with the testing equipment.

I-23. Field Coils

Inspect the field coils for chafed wires and using test lamp prods check for both open and grounded circuits. To test for open coil, connect the prods to the two leads from each coil. If the lamp fails to light, the coil is open and must be repaired or replaced.

To test for ground, place one prod on ground and the other on the field coil terminal. If a ground is present the lamp will light and the coil must be repaired or replaced.

If accurate test equipment is available, check the field coils for current draw which should be within the limits of 1.60 to 1.78 amperes at 6 volts for both coils (6-volt generators) or 1.2 to 1.3 amperes at 10 volts for both coils (12-volt generator).

A shorted coil will of course show a much higher draw, while an open coil will show no draw. In either case the generator output will be below normal.

To replace a field coil, disconnect the field terminals, use a heavy screwdriver to remove the field pole piece screws, then the coils together with the pole pieces may be removed. When replacing the coils, set the pole piece screws by staking with a center punch.

I-24. Brushes

For service information regarding brushes see Par. I-20.

I-25. Brush Holders

With test prods check the insulated brush holder to be sure it is not grounded. Touch the brush holder with one prod and the end plate with the other prod. If the lamp lights, a grounded brush holder is indicated.

Inspect the brush holders for cracks, distortion and improper alignment. The brushes should slide freely and should be in perfect alignment with the commutator segments.

I-26. Reassembling Generator

Install the felt grease retainer and washer in the drive end head. Check the bearing to be sure it is clean and fill it one-half full with a high melting point grease. Install the bearing and also install the inside felt washer and attach the bearing retainer with the lockwashers and screws. Place the drive end head over the front end of the armature shaft. Install the Woodruff key in the armature shaft and install the drive pulley, being sure the key is in position. Secure in position with the washer, nut and cotter pin.

Place the assembly on end so it rests on the pulley with the commutator end up.

6-volt Generator:

Place generator housing and field coils assembly in position, turning front end bracket so the dowel pin in housing enters hole in end head. Place commutator end plate, including brushes held in a raised position, on shaft and connect field coils. Install the long frame screws. Seat the brushes with 00 sandpaper and install cover band.

12-volt Generator:

While holding brushes clear of commutator with the thumbs, place generator housing and field coils assembly in position, turning front end bracket so the dowel pin in housing enters hole in end head. Place commutator end plate on shaft and install long frame screws.

When reinstalling the generator on the engine, the bracket bolt torque wrench reading is 25–35 ft. lbs. (3.46–4.84 kg. m.).

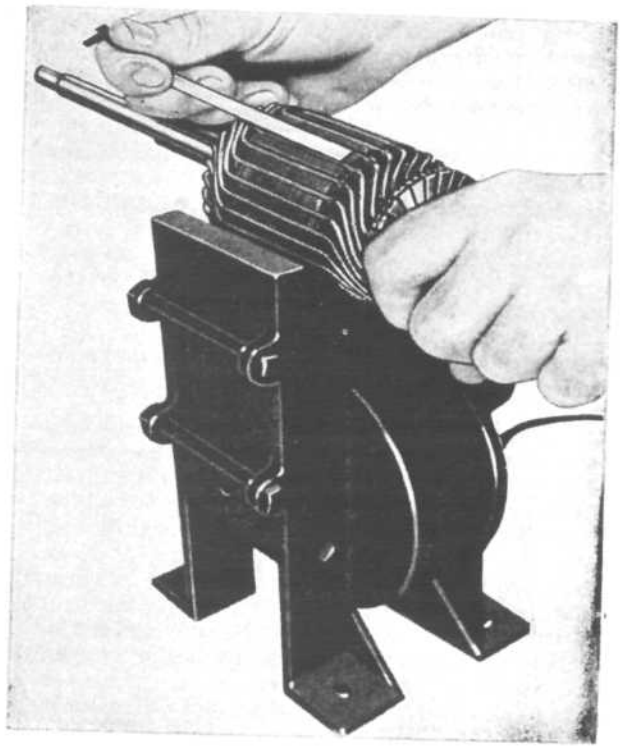


FIG. 166—GROWLER

I-27. CURRENT-VOLTAGE REGULATORS

I-28. Description and Operation

These regulators are used with shunt type generators and have three units each with a separate function to perform. These units, Fig. 167, are the circuit breaker unit, No. 3, the voltage regulator unit No. 1, and the current limiting regulator unit, No. 2.

I-29. Circuit Breaker

It consists of an electromagnet and a set of contacts. The contacts are mounted with one on a stationary bracket, and the other on a movable armature which is controlled by the electromagnet. The movable contact is mounted on a spring arm so that as the contacts open and close a slight wiping action is produced.

The electromagnet of the circuit breaker has two windings, one, the shunt coil which is connected across the generator output like a voltmeter and the other a series coil connected in series with the generator output like an ammeter. These two coils are wound in the same direction so that when the generator is charging the battery, the magnetism of the series coil increases the total magnetism. When the battery discharges back through the generator, the magnetism of the series coil is reversed and the magnetism of the two coils is opposed. This results in a decreased pull on the armature and spring action opens the contacts.

The sequence of operation of the circuit breaker is as follows:

When the generator is not running, the contacts are open. When the generator is started, the voltage builds up at the armature terminal and in the shunt coil and as soon as it reaches the value for which the circuit breaker is calibrated, there is sufficient magnetism created by the shunt coil to pull down the armature, closing the contacts which automatically connects the generator to the battery. With the contacts thus closed the current in the series coil is flowing from the generator to the battery or in the same direction as the current in the shunt coil, so that the pull on the armature is increased by the magnetism of the series coil.

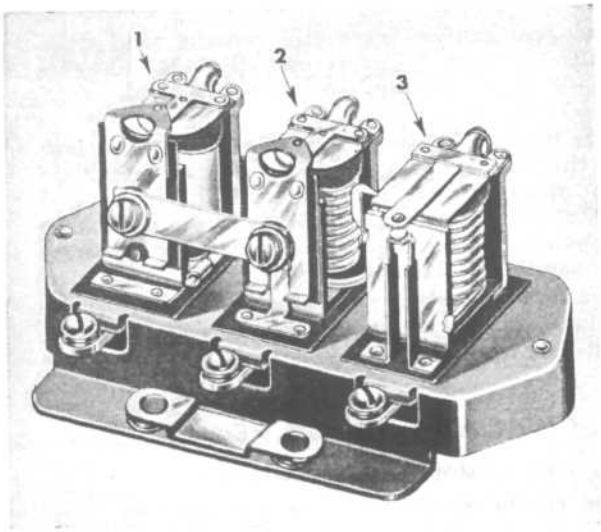


FIG. 167—VOLTAGE REGULATOR

When the engine is stopped and the generator loses speed, the voltage falls, and as soon as the generator voltage drops below the battery terminal voltage, the current flows from the battery to the generator, reversing the direction of current in the series coil so that the magnetism created by the series coil opposes and reduces the magnetism of the shunt coil. This reduces the pull on the armature to a point where spring action opens the contacts.

I-30. Voltage Regulator

The function of the voltage regulator is to hold the generated voltage at a predetermined value as long as the circuit values allow the voltage to build up to the operating voltage.

The electromagnet of the voltage regulator unit has a winding of many turns of fine wire and is connected across the charging circuit so that the system voltage controls the amount of magnetism.

The contacts of the voltage regulator unit are connected in the generator field circuit so that the field circuit is completed through the contacts when they are closed and through a resistor when the contacts are opened.

When the voltage rises to a predetermined value there is sufficient magnetism created by the regulator winding to pull the armature down. This opens the contacts and inserts resistance in the field circuit of the generator thus reducing the field current. The generated voltage immediately drops, which reduces the pull on the armature to the point where the spring closes the contacts. The output again rises and the cycle is repeated.

These cycles occur at high enough frequencies to hold the generated voltage at a constant value and will continue as long as the voltage of the circuit is high enough to keep the voltage regulator unit in operation. With the addition of a current load great enough to lower the battery voltage below the operating voltage of the unit, the contacts will remain closed and the generator will maintain a charging rate as limited by its speed or the current limiting regulator.

Due to the effect of heat on the operating characteristics of regulator windings it is necessary to compensate for the changes in coil resistance when the regulator is operating under varying temperature conditions. This is accomplished through the use of a nickel iron magnetic by-pass on the voltage regulator unit. This shunt by-passes some of the magnetic flux when the unit is cold and allows most of the flux to act on the armature when the unit is hot. Thus when the coil is hot and not as efficient, the magnetic shunt reduces the amount of flux needed to vibrate the armature.

The compensation is usually more than enough to offset the changes in regulator coil resistance due to heat. The excess compensation allows the regulator to operate at higher voltages under cold operating conditions than under hot conditions. This is necessary as it requires a higher voltage to charge a battery with its internal resistance increased by low temperatures.

I-31. Current-Limiting Regulator

The function of the current-limiting regulator is to limit the output of the generator to its maximum safe output.

The electromagnet of the current regulator unit consists of a winding of heavy wire that is connected in series with the generator output. When the generator output reaches a predetermined value, the current in the winding produces enough magnetism

to overcome the spring tension and pull the armature down. This opens the contacts and inserts resistance in the field circuit of the generator. With the field current reduced by the resistance, the generator output falls and there is no longer enough magnetism to hold the contacts open. As soon as the spring closes the contacts, the output rises and the cycle is repeated. These cycles occur at high enough frequencies to limit the output to a minimum fluctuation.

I-32. Preliminary Inspection

a. Wiring
Check the wiring to see that it is properly connected to the generator.

b. Generator Performance
Make sure the generator operates correctly without the regulator in the circuit. Remove the armature and battery leads from the regulator and connect an ammeter between them. Remove the field lead from the regulator and while operating at idle speed touch the field lead to the regulator base. Increase the speed slowly noting the charging rate. DO NOT INCREASE THE OUTPUT ABOVE THE RATED OUTPUT OF THE GENERATOR. If the generator output will not build up inspect the wiring harness for shorts and opens and remove the generator for an overhaul.
To check the generator circuit when a suitable ammeter is unavailable, Fig. 168, disconnect the armature cable at the regulator. Connect one lead of a 6-12 v test lamp to the regulator terminal marked "armature" and with the engine running, ground the other lead. Should the test light fail to burn there is a fault either in the generator or regulator. To localize the

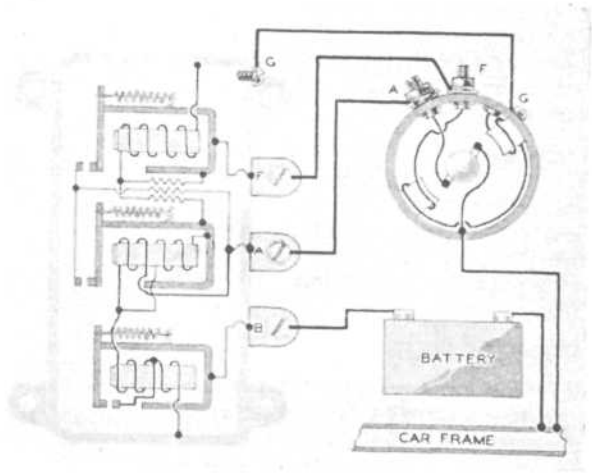


FIG. 168—GENERATOR WIRING DIAGRAM

fault, disconnect both the "Field" and "Armature" cables at the generator. Connect a wire from the "Field" terminal to ground and use a 60 watt, 110 volt test lamp to ground the "Armature" terminal. If the generator is charging satisfactorily the test lamp will glow at approximately 1500 rpm. engine speed and the fault will be definitely localized in the regulator.

c. Incorrect Regulator
Make sure the regulator is the correct type for use with the generator.

d. Battery
Check the specific gravity and terminal voltage of the battery. If the battery is not up to specifications substitute temporarily for test purposes a fully charged battery of the same type and capacity.

e. High Resistance Connections
Inspect the wiring between the generator, regulator and battery for broken wires and high resistance connections. Pay special attention to the ground connections at all three units.
Connect a reliable ammeter with 1 ampere graduations in series with the regulator "B" terminal and the lead removed from this terminal. Run the generator at a medium speed and turn on the lights or accessories until the ammeter shows a 10 ampere charging rate. At this charging rate measure the voltage drop between the following points using an accurate voltmeter graduated in .1 volt divisions. The voltmeter should not show a reading above the maximum noted.
Generator "A" terminal to regulator "A" terminal — .1 volt max.
Generator "F" terminal to regulator "F" terminal — .05 volt max.
Battery terminal to regulator "B" terminal — .1 volt max.
Regulator ground screw to generator frame — .03 volt max.
Regulator ground screw to battery ground post — .03 volt max.
Generator frame to battery ground post — .03 volt max.

I-33. Test Procedure

a. Circuit Breaker (End unit — with heavy wire winding), Fig. 167, No. 3.
Connect a reliable ammeter in series with the regulator "B" terminal and the lead removed from the terminal. Connect an accurate voltmeter from the regulator "A" terminal to the regulator base and place a reliable thermometer near the regulator (about 2 inches from the regulator cover but not touching the regulator).
Disconnect the field lead from the regulator "F" terminal and insert a variable resistance (3 amp. — 50 ohm capacity) between the lead and the regulator terminal.
Run the generator at about 1000 generator R.P.M. Insert all the resistance in the field circuit, then slowly reduce the resistance noting the voltage reading just before the change caused by the closing of the circuit breaker. Increase the charging rate to the

figure specified for the regulator being tested then reduce the charging rate by inserting resistance in the field circuit. Note the voltmeter and ammeter reading just before the circuit breaker opens and the ammeter reading drops to zero. The closing voltage and the opening voltage or current should be within the limits specified.

An accurate method for noting the exact instant of the opening or closing of the circuit breaker is to connect a headphone (2000 ohms or higher) to the battery and armature terminals of the regulator. When the contacts open or close a click will be heard in the headphone. To adjust the closing voltage change the armature spring tension by bending the hanger at the lower end of the spring. Increase the spring tension to raise the closing voltage or decrease the tension to lower the voltage. To adjust the opening voltage raise or lower the stationary contact keeping the contacts perfectly aligned. Increasing the contact gap lowers the opening voltage. Change the contact gap by expanding or contracting the stationary contact bracket, keeping the contacts aligned. Do not adjust the gap between the contacts to less than the specified minimum.

b. Voltage Regulator (end unit — with fine wire winding), Fig. 167, No. 1.

Connect the ammeter as noted above and connect the voltmeter from the regulator "B" terminal to the regulator base. Remove the variable resistance from the field circuit.

Run the generator at ½ maximum output for 15 minutes to make sure the regulator is at normal operating temperature. Have the cover on the unit during this warm up period and when taking readings.

Stop the engine then bring it up to approximately 2500 generator R.P.M. Adjust the amperage to ½ maximum output by turning on lights or accessories and then note the voltmeter reading. This reading should be within the limits specified for the voltage regulator operation. To adjust the operating voltage change the armature spring tension by bending the hanger at the lower end of the armature spring. After each adjustment stop the engine then restart it. Bring it up to speed and adjust the current before taking a reading. In order to obtain an accurate indication of the operation of the voltage regulator unit connect a headphone (2000 ohms or higher) between the "F" terminal and ground to pick up the sound of the opening and closing of the contacts. The clicks should be regular and clear without irregularities or missing. If the tone is not clear and regular remove the regulator cover and inspect the contacts. The contacts should be flat and not burned excessively and should be aligned to make full face contact. If the contacts need cleaning refer to paragraph d for the method.

c. Current regulator (center unit — with heavy wire winding), Fig. 167, No. 2.

Connect the regulator and instruments as described above for the voltage regulator (paragraph b) and run the generator at approximately 3000 generator R.P.M. Turn on lights and accessories so that the generator must charge at its maximum rate. The ammeter should show a reading within the limits specified. To adjust the opening amperage change the armature spring tension by bending the hanger at the lower end of the armature spring. After each adjustment stop the engine then restart it. Bring the engine up to speed and take an ammeter reading. Have the cover on the unit when taking readings.

In order to obtain an accurate indication of the operation of the current regulator unit connect a headphone (2000 ohms or higher) between the regulator "F" terminal and ground to pick up the sound of the opening and closing of the contacts. The clicks should be clear and regular without irregularities or missing. If the tone is not clear and regular remove the regulator cover and inspect the contacts. The contacts should be flat and not burned excessively and should be aligned to make full face contact. If the contacts need cleaning refer to paragraph d for the method.

d. Contacts

Inspect the contacts on all three units. In normal use the contacts will become grayed. If the contacts are burned or dirty or if they are not smooth, file the contacts with a #6 American, Swiss cut, equalling file. Move the file parallel and lengthwise to the armature. File just enough so that the contacts present a smooth surface toward each other. It is not necessary to remove every trace of pitting. After filing, dampen a piece of linen or lintless bond tape in refined carbon tetrachloride and draw the tape between the contacts. Repeat with a dry piece of tape. Use clean tape for each set of contacts.

e. Recheck

Operate the unit at ½ maximum output for 5 minutes with the cover on the regulator. Repeat the testing procedure for all units as described in paragraphs a, b, and c above. Be sure cover is on regulator when taking readings.

I-34. QUICK CHECKS

I-35. Low Charging Rate with a Fully Charged Battery

A fully charged battery and a low charging rate indicates normal regulator operation.

A further check of the regulator operation can be made by using the starting motor for 5 to 10 seconds with the ignition switch in the "off" position. Then start the engine and operate at a generator speed of 2500 to 3000 R.P.M. The charging rate should rise to its maximum value then taper off to a minimum charge as the battery becomes charged.

I-36. High Charging Rate with a Fully Charged Battery

This is usually an indication that the voltage regulator is not operating correctly. The high voltage will cause the battery to gas excessively and will shorten the life of the ignition contacts and, in general, will have a detrimental effect on all connected load.

Connect an ammeter in series with the regulator "B" terminal and the lead removed from the terminal. Run the generator at a medium speed and perform the following operation. After each test is completed reconnect whatever leads have been opened.

I-37. Test One

Disconnect the field lead at the generator.
a. Output drops to zero—shorted field circuit in regulator or in wiring harness. See test 2, Par. I-38.
b. Output does not drop—shorted field circuit in generator. Inspect generator.

I-38. Test Two

Disconnect the field lead at the regulator.
a. Output drops to zero—shorted field in regulator. See test 3, Par. I-39.
b. Output does not drop—shorted wiring harness. Repair or replace wiring harness.

I-39. Test Three

Remove the regulator cover and hold the voltage regulator contacts open.
a. Output drops to zero—regulator contacts sticking, regulator out of adjustment, or regulator inoperative. Check operation (test 5, Par. I-41), check for high resistance (test 4, Par. I-40), and clean contacts per instructions in Par. I-42.
b. Output does not drop—shorted field circuit in the regulator. Clean the regulator contacts and inspect the regulator visually for incorrect wiring between units and shorted leads.

I-40. Test Four

Operate the units at 10 amperes output and measure the voltage drop from the regulator base to the generator frame.
a. Voltage reading below .03 volts—ground circuit is satisfactory. See test 5, Par. I-41.
b. Voltage reading above .03 volts—Inspect ground circuit for poor connections and eliminate the high resistance. See test 5, Par. I-41.

I-41. Test Five

Connect a headphone from the regulator field terminal to the base and hold the current regulator contacts closed.
a. A steady beat is heard—voltage regulator operating. Reset regulator as in the operation test, Par. I-33.
b. An unsteady beat is heard—dirty or sticking contacts. Clean contacts per instructions in Par. I-42.
c. No beat is heard—inoperative voltage regulator unit. Adjust regulator operation as in the operation test. If the regulator cannot be adjusted within limits, remove for overhaul.

I-42. Cleaning of Contacts

Clean the voltage regulator contacts with a #6 American Swiss cut equalling file. File lengthwise and parallel to the armature and then clean the contacts with clean linen tape. First draw a piece of tape that has been wet with carbon tetrachloride between the contacts then follow with dry tape. Reset the regulator operation as in the operation test, Par. I-33.

I-43. Low Battery and a Low or No Charging Rate

Check all wiring for loose connections, frayed insulation and high resistance connections and correct any fault.

Make sure the generator operates correctly without the regulator in the circuit. Remove the "A" and "B" leads from the regulator and connect an ammeter between them. Remove the field lead from the regulator and while operating at idle speed touch the field lead to the regulator base. Increase the speed slowly noting the charging rate. Do not increase the output above the rated output of the generator. If the generator output will not build up, inspect the wiring harness for shorts and opens and remove the generator for an overhaul.

Connect an ammeter between the battery lead and the regulator "B" terminal. Connect the field lead to the regulator "F" terminal and connect the armature lead to the regulator "A" terminal. Connect a voltmeter from the regulator "A" terminal to the regulator base. Operate the generator at a medium speed and perform the following tests:

I-44. Test One

Read the voltmeter.
a. Voltage builds up—open series circuit. See test 2, Par. I-45.
b. Voltage does not build up—regulator out of adjustment, field circuit open, grounded series circuit. See test 3, Par. I-46.

I-45. Test Two

Remove the regulator cover and with the generator operating at a medium speed hold the circuit breaker contacts closed.
a. Ammeter shows no charge—open circuit breaker shunt winding, incorrect setting of circuit breaker, or dirty contacts. Clean contacts and reset circuit breaker as in Par. I-33a. If the circuit breaker cannot be set, the shunt coil is open and the regulator should be removed for overhaul.
b. No generator output—clean the circuit breaker contacts and try the test again. If there is still no charge the series windings are open and the regulator should be removed for overhaul.

I-46. Test Three

Run the generator at idle speed and momentarily connect a jumper from the F terminal to the regulator base.
a. Voltage builds up—open field circuit or regulator out of adjustment. See test 4, Par. I-47.
b. Voltage does not build up—grounded series circuit. Remove regulator for overhaul.

I-47. Test Four

Operate at a medium speed with the jumper removed. Remove the regulator cover and hold the voltage regulator contacts closed.

a. Voltage builds up—voltage regulator contacts burned or dirty or incorrect regulator setting. Clean the contacts and adjust the regulator as in Par. I-33.

b. Voltage does not build up — clean contacts and repeat test. If the voltage still does not build up, see test 5, Par. I-48.

I-48. Test Five

Remove the regulator cover and hold the current regulator contacts closed.

a. Voltage builds up—current regulator contacts burned or dirty or incorrect regulator setting. Clean the contacts and adjust the regulator as in Par. I-33.

b. Voltage does not build up—clean the contacts and repeat the test. If the voltage still does not build up remove the regulator for an overhaul.

Fig. 169 illustrates the Model 4-63 starting motor, the internal construction of which is representative of all the motors used on the models discussed here. There are some differences in starting switch control and flywheel drive mechanism which are covered separately. Also, the 12-volt starting motor has no band cover, item 3.

I-50. Maintenance Procedure

A periodic inspection should be made of the starting circuit. While the interval between these checks will vary according to the type of service, it should, under normal conditions, be made every 500 hours of operation. At this check the following points should be inspected.

I-51. Wiring

Inspect the starting circuit to make sure that all connections are clean and tight. Check for worn or damaged insulation on the wires. Perform a voltage-loss test to make sure there is no loss of starting motor efficiency resulting from high resistance connections. Voltage loss from the battery terminal to the starting motor terminal should not exceed .30 volts for each 100 amperes. Voltage loss between the battery ground post and the starting motor frame should not exceed .10 volts for each 100 amperes. If the voltage loss is greater

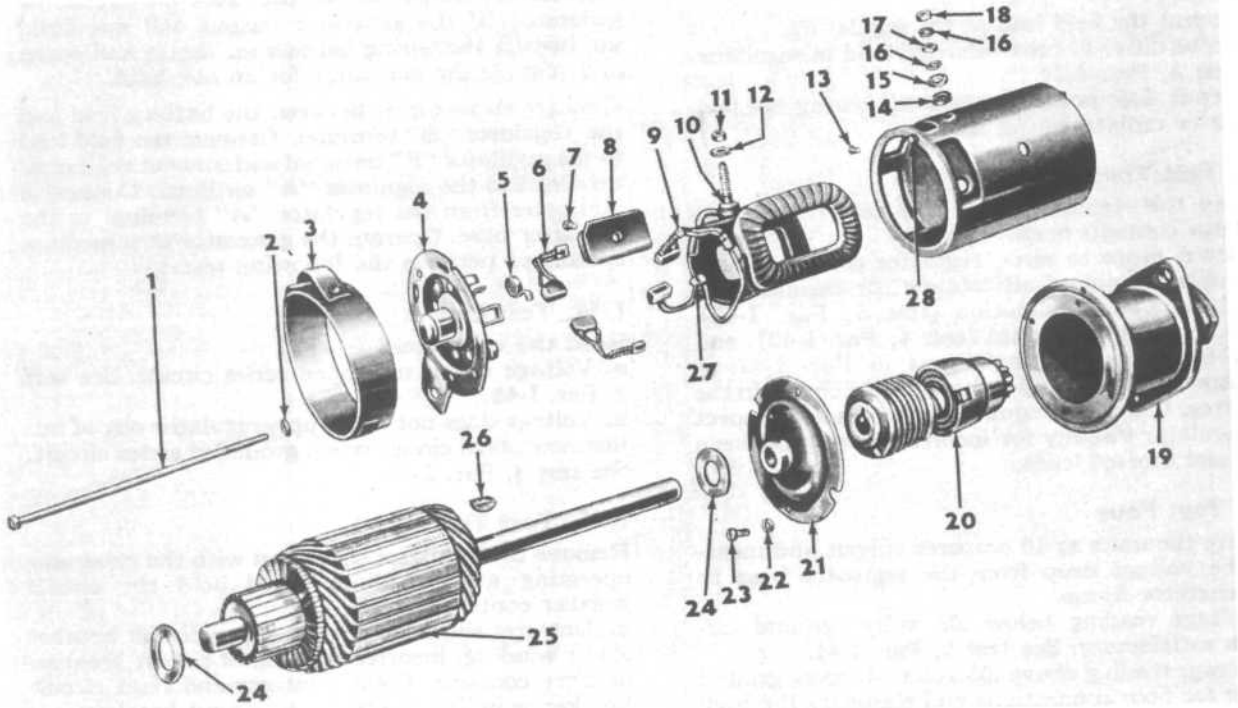


FIG. 169—TYPICAL STARTING MOTOR

1—Thru Bolt
2—Lockwasher
3—Band Cover
4—Commutator End Head
5—Brush Spring
6—Brush Set
7—Pole Shoe Screw
8—Pole Shoe
9—Field Coil Assembly
10—Terminal Stud
11—Insulator Bushing
12—Insulator Washer
13—Ground Screw
14—Insulator Washer
15—Plain Washer
16—Lockwasher
17—Terminal Stud Nut
18—Terminal Stud Nut
19—Pinion Housing
20—Bendix Drive
21—Bronze Bearing
22—Lockwasher
23—Screw
24—Thrust Washer
25—Armature
26—Woodruff Key
27—Equalizer
28—Dowel Pin

I-49. STARTING MOTOR

The starting motor is similar in construction to the generator, but the design of the parts is different due to it being necessary for the starting motor to handle a large amount of current for short intervals. Both motor and generator require a frame, field coils, armature and brushes.

than these limits, measure the voltage loss over each part of the circuit until the resistance causing the voltage loss is located and corrected.

I-52. Commutator

Sluggish starting motor operation may be caused by a dirty commutator or worn brushes. If the commutator is dirty or discolored, it can be cleaned on 6-volt starting motors with 00 sandpaper. Blow the sand out of the motor after cleaning. The commutator on 12-volt starting motors cannot be cleaned while the starting motor is mounted on the engine and it will be necessary to remove it and proceed as for an overhaul. Should the commutator in any starting motor be rough or worn, it should be removed for cleaning and reconditioning.

I-53. Brushes

The brushes should slide freely in their holders and make full contact on the commutator. Worn brushes should be replaced.

I-54. Overhaul Procedure

At periodic intervals the starting motor circuit should be thoroughly checked and the motor removed from the engine for cleaning and checking.

I-55. Disassembly

To remove the starting motor from the engine, disconnect the leads and cover the battery lead with a short piece of hose to prevent short circuiting. Remove the flange bolts holding the starting motor to the flywheel housing. Remove the starting motor from the vehicle.

Each part of the starting motor should be removed, cleaned, and inspected for evidence of wear or damage. The Bendix Drive should be cleaned and inspected for evidence of wear or a distorted spring. Bearings should be checked for proper clearance and fit. All insulation should be free of oil and in good condition. The armature, field coils, and brushes should be checked for good ground and lack of open circuits.

I-56. Brushes

The brushes should slide freely in their holders and make full contact on the commutator. Worn brushes should be replaced.

Check brush spring tension with a spring scale. Hook the scale under the brush spring near the brush and pull on a line parallel with the side of the brush. Take the reading just as the spring leaves the brush. It is important that the brush spring tension be kept within the limits specified at the end of this section. If the tension is too low, there will be a loss of efficiency from poor brush contact. Too great a tension will cause excessive brush and commutator wear. To change the tension, twist the spring at the holder with long-nosed pliers.

Worn brushes should be replaced.

Brushes that are soldered to the field coil should be unsoldered and the loop in the field coil lead should be opened. Insert the new brush pigtail to its full depth in the loop. The new brush lead should be tightly clinched in the terminal and then soldered to make a strong, low-resistance connection.

I-57. Commutator

Check the commutator for wear and discoloration. If the commutator needs cleaning, use 00 sandpaper and afterward make sure all the sand is removed. If the commutator is rough or worn, it should be turned down in a lathe until all roughness is gone. Remove tool marks by sanding with 00 sandpaper. Undercut the mica segments to a depth of $\frac{1}{32}$" [0,79 mm.] in an undercutting fixture. After undercutting, check the armature on a growler, Fig. 166. The procedure for this check is given in Par. I-58.

I-58. Armature

Visually inspect the armature for mechanical defects before checking for shorted or grounded coils. Use a set of test probes for testing armature circuits. To test the armature for grounds, touch one point of the test probes to a commutator segment and touch the other point to the core or shaft. Do not touch the points to the bearing surface or to the brush surface as the arc formed will burn the smooth finish. If the lamp lights, the coil connected to the commutator segment is grounded.

To test for shorted armature coils, a growler as shown in Fig. 166 is necessary. The armature is placed against the core and a steel strip is held on the armature. The growler is then energized and the armature rotated slowly by hand. If a shorted coil is present, the steel strip will become magnetized and will then vibrate.

I-59. Field Coils

Using test probes, check the field coils for both ground and open circuits. To test for ground, place one probe on the motor frame or pole piece and touch the other probe to the field coil terminals. If a ground is present, the lamp will light.

To test for open circuits, place the probes on the field coil terminal and on an insulated brush. If the light does not light, the coil is open circuited.

I-60. Brush Holder Inspection

Using test probes, touch the insulated brush holder with one probe and a convenient ground on the commutator end head with the other probe. If the lamp lights, it indicates a grounded brush holder.

I-61. Assembly of Starting Motor

When assembling absorbent bronze bearings, always use the proper arbor designed to give the proper bearing fit. Soak the bearing in oil before assembling in the bearing bore.

Brushes should be correctly installed and connected as outlined in Par. I-56 in order to be sure of proper starting motor efficiency.

Soak the bearings in oil and give the bearing seats a light coating of oil.

I-62. Bench Test

Check the starting motor for free-running voltage and current within specifications. To test, connect the starting motor to a battery, ammeter, and voltmeter. If the current is too high, check the bearing alignment and end play to make sure there is no binding or interference.

Use a spring scale and torque wrench and check the stall torque to see that the motor is producing its rated cranking power. The stall torque will be the product of the spring scale reading and the length of the arm in feet. If the torque is not up to specifications, check the seating of the brushes on the commutator and the internal connection of the starting motor for high resistance.

Check the Bendix Drive for correct operation. The Bendix Drive pinion should shift satisfactorily when the starting motor is operated under no-load condition.

I-63. Bendix Folo-Thru Drive

The Bendix Folo-Thru drive is designed to overcome premature demeshing of the drive pinion from the flywheel ring gear until a predetermined engine speed is reached. See Fig. 170.

No repairs or adjustments are possible on this drive and a complete new unit must be installed if trouble develops.

I-64. Lubrication of Folo-Thru Drive

A periodic cleaning and relubrication of the drive is advisable, the frequency of which will depend on the type of service to which the vehicle is subjected and the locale of operation.

Remove the starting motor from the engine and take off the outboard housing. The pinion and barrel assembly will be in the demeshed position on the screwshaft. *Do not* move it forward *until after* that portion of the armature shaft ahead of the pinion has been cleaned. If accidentally rotated to the outer end of the screwshaft it will lock in that position and cannot be forced back.

Do not disassemble the drive for any reason.

Do not dip or wash the drive in any cleaning solution.

Do not remove the drive from the armature shaft.

Remove excess oil, grease or foreign matter from the armature shaft by wiping it with a clean cloth.

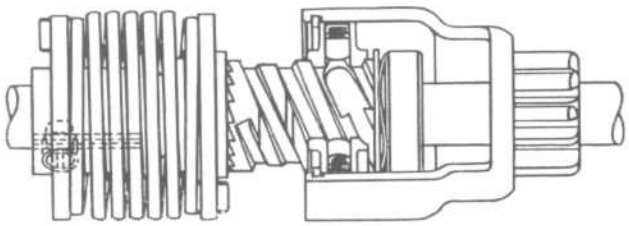


FIG. 170—BENDIX FOLO-THRU DRIVE

Dampen the cloth with kerosene if necessary. A light film of SAE 10 oil may then be applied to the shaft.

Now rotate the pinion and barrel assembly to the fully extended position, thereby exposing the screwshaft triple threads. Use a cloth dampened with kerosene to wipe them clean. *Do not use gasoline or any commercial cleaner.* If the dirt is thick and gummy, apply the kerosene with a small brush. Tilt the starting motor so that a small amount will run under the control nut. Relubricate with a thin film of SAE 10 oil. Use SAE 5 at extremely low temperatures.

Reassemble the starting motor to the engine with the drive in the extended position. Carefully mesh the pinion with the flywheel ring gear before tightening the starter motor mounting bolts. It may require a slight rotation of the pinion to index it into the ring gear. When the engine starts the drive pinion will automatically demesh from the ring gear and return to its normal position.

I-65. Starting Switch

Should a starting motor fail to deliver maximum power the fault may be due to voltage drop at the starting switch contacts due to corrosion or burning. Check the switch by comparing the voltage at the battery terminals and that at the starting switch terminals. The voltage drop should not exceed .05 volts per 100 amperes. When checking a solenoid type switch, the contacts should be closed electrically to simulate actual conditions of operation.

Should it be impossible to file the switch contact plates to obtain a clean full surface contact the switch should be replaced.

The switch is an electrically controlled starting switch with the control connected to the ignition switch. This starting switch is a solenoid-type which electrically closes the circuit between the battery and the starting motor. When the ignition key is turned to the extreme right, a contact is made which energizes the solenoid winding and closes the circuit. The solenoid is spring loaded and the circuit is opened when the ignition key is allowed to return to the "Ignition On" position. No repairs or adjustments can be made on this switch and if trouble develops in one it must be replaced by a new switch.

Note: On early production L6-226 models equipped with dual horns, interference may develop between the starter solenoid "hot" terminal and the lowest point of the dual horn assembly. The condition may be corrected by rotating the solenoid bracket 90° about its rear mounting bolt and attaching the front mounting bolt in its new top location. The battery and cables to the solenoid terminals should be disconnected while relocating the solenoid bracket.

I-66. Directional Signals

Complete instructions are included in each directional signal kit for installation on the various models as well as instructions on dual tail light installation on those models where dual tail lights must be installed before directional signal instal-

lation. Fig. 171 shows the wiring of a composite directional signal circuit. The most frequent causes of failure in the directional signal system are loose connections and burned-out bulbs. A flashing rate approximately twice the normal rate usually indicates a burned-out bulb in the circuit.

When trouble in the signal switch is suspected it is advisable to make the following test to definitely locate the trouble before going to the effort of removing the signal switch. If, for example, the right rear stop light and right front parking light are inoperative and switch failure is indicated, first put the control lever in neutral position. Then disconnect the wire to the right side circuit and touch it to or bridge it to the "L" terminal, thus by-passing the signal switch. If the right side circuit lights, the signal switch is inoperative and must be replaced.

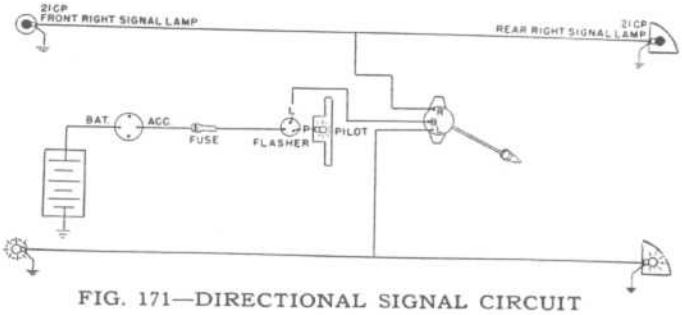


FIG. 171—DIRECTIONAL SIGNAL CIRCUIT

SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Battery Discharged:	
Short in Battery Cell	Replace Battery
Short in Wiring	Check Wiring Circuit
Generator Not Charging	Inspect Generator and Fan Belt
Loose or Dirty Terminals	Clean and Tighten
Excessive Use of Starter	Tune Engine
Excessive Use of Lights	Check Battery
Generator:	
Low Charging Rate—	
Dirty Commutator	Clean Commutator
Poor Brush Contact	Repair or Install New Brushes
Regulator Improperly Adjusted	Adjust
High Resistance in Charging Circuit	Clean and Tighten Terminals
Ground Strap Engine to Frame Broken	Replace
Loose or Dirty Terminals	Clean and Tighten
Too High Charging Rate—	
Regulator Improperly Adjusted	Adjust or Replace
Short in Armature	Replace
Starting Motor:	
Slow Starter Speed—	
Discharged Battery or Shorted Cell	Recharge or Repair
Ground Strap Engine to Frame	Clean Terminals and Tighten
Loose or Dirty Terminals	Clean and Tighten
Dirty Commutator	Clean with No. 00 Sandpaper
Poor Brush Contact	Repair or Install New Brushes
Worn Bearings	Replace
Burned Starter Switch Contacts	Replace Switch
Distributor:	
Hard Starting—	
Distributor Points Burned or Pitted	Clean Points or Replace (Adjust)
Breaker Arm Stuck on Pivot Pin	Clean and Lubricate
Breaker Arm Spring Weak	Replace
Points Improperly Adjusted	Adjust .020"
Spark Plug Points Improperly Set	Adjust .030"
Spark Plug Wire Terminals in Distributor Cap Corroded	Clean
Loose Terminals	Check Circuit
Loose or Dirty Terminals on Ground Strap—Engine to Frame	Clean and Tighten
Condenser Faulty	Replace
Improper Ignition Timing	Set Timing
Lights:	
Burn Dim—	
Loose or Dirty Terminals	Clean and Tighten
Leak in Wires	Check Entire Circuit for Broken Insulation
Poor Switch Contact	Install New Switch
Poor Ground Connection	Clean and Tighten
Aim Headlamp Beams	Use Aiming Chart
Horn Fails to Sound	
1. Broken or Loose Electrical Connection	1. Check Wiring and Connections at Horn Button and Battery—Clean and tighten.
2. Battery Low or Dead	2. Check Battery—Hydrometer should read 1.225.
3. Contact Points Burned or Broken Off	4. Replace Parts Necessary.
Horn Sounds Unsatisfactory Tone	
1. Poor Electrical Connection	1. Check Connections at Horn, Horn Button, Battery.
2. Battery Low	2. Check with Hydrometer, should read 1.225.
3. Loose Cover and Bracket Screws	3. Tighten Bracket Bolts at Horn.
4. Voltage at Horn too High or too Low	4. Check with Voltmeter.

ELECTRICAL SYSTEM SPECIFICATIONS

MODEL:	L6-226 Models 6 Volt	L6-226 Models 12 Volt	F4-134 Models 6 Volt	F4-134 Models 12 Volt
Battery:				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Auto-Lite
Model	1M-100R	11HS-50	1M-100R	11HS-50
Plates per Cell	15	9	15	9
Capacity	100 Ampere Hour	50 Ampere Hour	100 Ampere Hour	50 Ampere Hour
Volts	6	12	6	12
Length	8 23/32" [22,1 cm.]	10 15/64" [26,6 cm.]	8 23/32" [22,1 cm.]	10 15/64" [26,6 cm.
Width	7" [17,78 cm.]	6 25/32" [17,2 cm.]	7" [17,78 cm.]	6 25/32" [17,2 cm.]
Height	8 5/8" [21,9 cm.]	9 7/32" [23,4 cm.]	8 5/8" [21,9 cm.]	9 7/32" [23,4 cm.]
Specific Gravity:				
Fully Charged	1.260	1.260	1.260	1.260
Recharge at	1.225	1.225	1.225	1.225
Ground Terminal	Negative	Negative	Negative	Negative
Location	Under Hood-Right Side	Under Hood-Right Side	Under Hood-Right Side	Under Hood-Right Side
Starting Motor				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Auto-Lite
Model	MCH 6210	MDM 6006	MCH 6203	MDM 6005
Drive	Bendix Folo-Thru	Bendix Folo-Thru	Bendix Folo-Thru	Bendix Folo-Thru
No-Load Draw Max.	65 Amp.-5v-4300 rpm.	50 Amp.-10v-4400 rpm.	65 Amp.-5v-4300 rpm.	50 Amp.-10v-4400 rpm.
Stall Torque	6 ft. lbs. [0,829 kg-m.]	5 ft. lbs. [0,692 kg-m.]	6 ft. lbs. [0,829 kg-m.]	5 ft. lbs. [0,692 kg-m.]
	335 Amp.-2v	210 Amp.-4v	335 Amp.-2v	210 Amp.-4v
Volts	6	12	6	12
Armature End Play	.005" to .030" [0,127 a 0,762 mm.]	.005" to .030" [0,127 a 0,762 mm.]	.005" to .030" [0,127 a 0,762 mm.]	.005" to .030" [0,127 a 0,762 mm.]
Brushes	4	4	4	4
Brush Spring Tension	42 to 53 oz. [1,19 a 1,5 kg.]	31 to 47 oz. [0,9 a 1,3 kg.]	42 to 53 oz. [1,19 a 1,5 kg.]	31 to 47 oz. [0,9 a 1,3 kg.]
Cranking Speed	185 rpm.	185 rpm.	185 rpm.	185 rpm.
Bearings	3 Bronze	3 Bronze	3 Bronze	3 Bronze
Starting Switch:				
Make	Essex	Essex	Auto-Lite	Auto-Lite
Model	RBM-8800-1	RBM-8850-0	SW-4105	SW-4105
Distributor:				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Auto-Lite
Model	IAT-4206B	IAT-4206B	IAT-4204A	IAT-4204A
Type Advance	Centrifugal	Centrifugal	Centrifugal	Centrifugal
Firing Order	1-5-3-6-2-4	1-5-3-6-2-4	1-3-4-2	1-3-4-2
Breaker Point Gap	.020" [0,508 mm.]	.020" [0,508 mm.]	.020" [0,508 mm.]	.020" [0,508 mm.]
Breaker Arm Tension	17 to 20 oz. [0,482 a 0,567 kg.]	17 to 20 oz. [0,482 a 0,567 kg.]	17 to 20 oz. [0,482 a 0,567 kg.]	17 to 20 oz. [0,482 a 0,567 kg.]
Cam Angle	39°	39°	42°	42°
Max. Auto. Advance	9° @ 1675 rpm.	9° @ 1675 rpm.	11° @ 1700 rpm.	11° @ 1700 rpm.
Condenser Capacity	.21 to .25 mfd.	.21 to .25 mfd.	.21 to .25 mfd.	.21 to .25 mfd.
Timing	5° BTC	5° BTC	5° BTC	5° BTC
Timing Mark	Vibration Damper	Vibration Damper	Timing Gear Cover	Timing Gear Cover

ELECTRICAL SYSTEM SPECIFICATIONS — (Continued)

MODEL:	L6-226 Models 6 Volt	L6-226 Models 12 Volt	F4-134 Models 6 Volt	F4-134 Models 12 Volt
Generator:				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Auto-Lite
Model	GGW 4801 EN	GJC 7002-K	GGW 4801 D	GJC 7002-J
Volts	6 to 8	12 to 15	6 to 8	12 to 15
Ground Polarity	Negative	Negative	Negative	Negative
Controlled Output	45 Amps.	30 Amps.	45 Amps.	30 Amps.
Rotation-Drive End	Clockwise	Clockwise	Clockwise	Clockwise
Control	CV Regulator	CV Regulator	CV Regulator	CV Regulator
Armature End Play	.010" [0,254 mm.] Max.	.010" [0,254 mm.] Max.	.010" [0,254 mm.] Max.	.010" [0,254 mm.] Max.
Brushes	2	2	2	2
Brush Spring Tension	35 to 53 oz. [0,992 a 1,5 kg.]	18 to 36 oz. [0,5 a 1 kg.]	35 to 53 oz. [0,992 a 1,5 kg.]	18 to 36 oz. [0,5 a 1 kg.]
Bearing-Drive End	Ball	Ball	Ball	Ball
Bearing-Commutator End	Bronze	Bronze	Bronze	Bronze
Voltage Regulator:				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Auto-Lite
Model	VBE 6105A	VRX 6009B	VBE 6105A	VRX 6009B
Gauges and Indicators:				
Fuel	King Seeley or Stewart-Warner		King Seeley or Stewart-Warner	
Oil Pressure	King Seeley or Stewart-Warner		King Seeley or Stewart-Warner	
Temperature	King Seeley or Stewart-Warner		King Seeley or Stewart-Warner	
Ammeter	King Seeley or Stewart-Warner		King Seeley or Stewart-Warner	
Coil:				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Auto-Lite
Model	CR 6009	CAG 4002A	CR 6009	CAG 4002A
Draw-Engine Stopped	5 Amps. @ 6.3v	2.8 Amps. @ 12.5v	5 Amps. @ 6.3v	2.8 Amps. @ 12.5v
Draw-Engine Idling	2.5 Amps.	.....	2.5 Amps.	.....
Spark Plugs:				
Make	Auto-Lite A7 or Champion J-8		Auto-Lite A7 or Champion J-8	
Size	14 mm.		14 mm.	
Gap	.030" [0,762 mm.]		.030" [0,762 mm.]	
Lamp Bulb Trade No's.:				
Headlights	5040S	5400S	5040S	5400S
Parking Lights	63	67	63	67
Parking & Dir. Signal	1158	1176	1158	1176
Stop, Tail, & Dir. Signal	1158	1034	1158	1034
License (Utility Wagon)	63	67	63	67
Indicator Lamps:				
Headlamp Beam	51	53	51	53
Directional Signal	51	53	51	53
Charge	51	53	51	53
Oil Pressure	51	53	51	53
Instrument Lamp	55	57	55	57
Dome Lamp	87	93	87	93
Radio Dial Lamp	44	1891	44	1891
Flasher, Dir. Signal	P229D	524	P229D	524
Fuse Data				
Directional Signal	SFE 14	SFE 9	SFE 14	SFE 9
Overdrive (4x2 Mod.)	SFE 20	SFE 14	SFE 20	SFE 14
Heater	SFE 14	SFE 9	SFE 14	SFE 9
Radio	SFE 9	AGC 7½	SFE 9	AGC 7½
Horn:				
Type	Electric-Vibrator	Electric-Vibrator	Electric-Vibrator	Electric-Vibrator
Make	Auto-Lite	Sparks-Withington	Auto-Lite	Sparks-Withington
Model	HAB 4603	C-6870-2	HAB 4603	C-6870-2

SECTION J

CLUTCH

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J-1. GENERAL

The clutch for L6-226 Models is of either Auburn or Borg & Beck manufacture. The clutch for F4-134 Models is of either Auburn or Rockford manufacture. The Borg & Beck clutch is made with either nine or six springs; the Rockford clutch has six; and the Auburn clutch has three.

All clutches are single-plate and dry-disc type. Models L6-226 4WD and 4x4 are equipped with a 10″ [25,4 cm.] driven plate; Model L6-226 4x2 has a 9¼″ [23,5 cm.] driven plate; all F4-134 Models have an 8½″ [21,6 cm.] driven plate.

The driven plates of all models are built with spring center vibration neutralizers and have two flexible facings which provide smooth engagement of the engine power. The reconditioning and adjustment procedures which follow include all the above mentioned clutches. The clutch pedal adjustments are also given for each model. Specifications for all clutches are found at the end of this section.

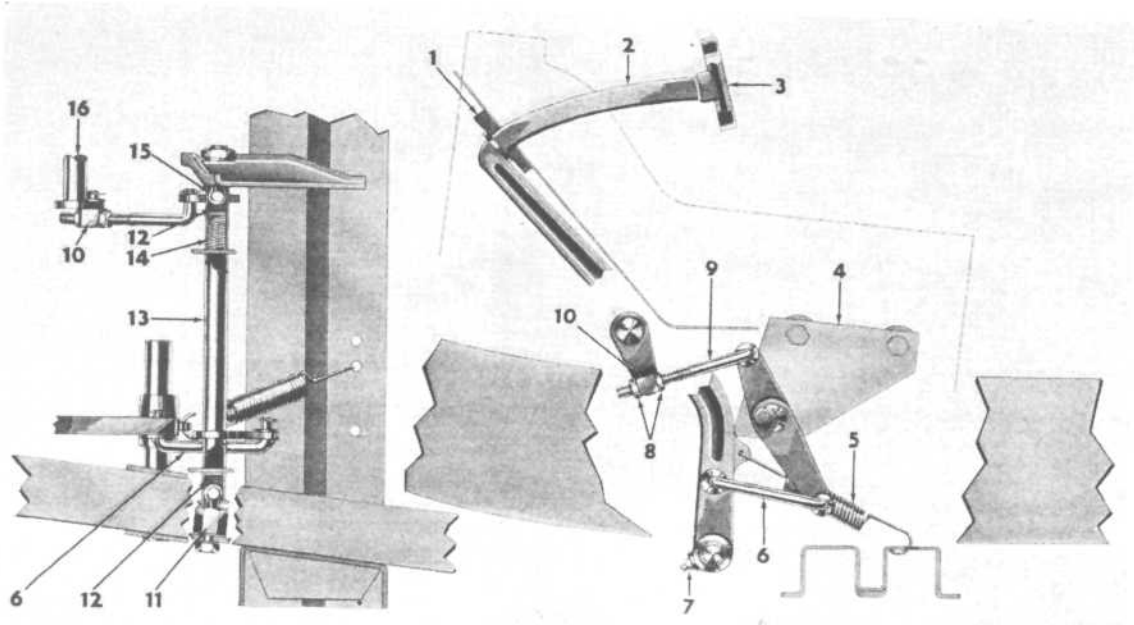


FIG. 172—CLUTCH CONTROL—L6-226 MODELS

1—Pedal Grommet
2—Clutch Pedal
3—Pedal Pad
4—Cross Shaft Support
5—Retracting Spring
6—Lower Control Link
7—Lubrication Fitting
8—Lock Nuts
9—Upper Adjusting Rod
10—Adjusting Trunnion
11—Ball Nut
12—Felt Pad
13—Cross Shaft
14—Spring
15—Clutch Control Ball Stud
16—Release Shaft

J-2. Clutch Pedal Adjustment

As the clutch facings wear the free pedal travel diminishes. When sufficient wear occurs to cause the pedal to rest against the toe board it is necessary to adjust the free travel.

Correct clearance on all models is 1″ (25.4 mm.). This clearance is essential to disengage the clutch release bearing and prevent unnecessary wear and possible clutch slippage. When adjusted as outlined above there is a safe clearance of approximately 1/16″ (1.59 mm.) between the clutch release bearings and the clutch fingers.

On L6-226 models, Fig. 172, to adjust the clutch pedal free travel, loosen the two lock nuts on the pedal adjusting rod, Fig. 173. Turn the nuts forward to increase or backward to decrease the free travel. After pedal free travel of 1″ (25.4 mm.) is established, tighten both lock nuts against the adjusting trunnion, being careful not to change the adjustment.

On all models as shown in Figs. 174 and 175, with the exception of the 6-226 models, the adjustment is made at the threaded connection between the clutch control lever and the clutch control tube lever. To increase the free travel, loosen the locknut No. 12, and screw adjusting nut No. 11 forward then tighten the locknut.

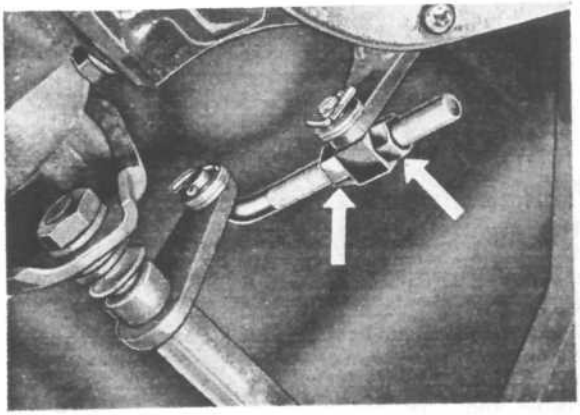


FIG. 173—CLUTCH ADJUSTMENT—L6-226 MODELS

J-3. Reconditioning

When it is necessary to recondition the clutch, follow the procedure outlined in the "Transmission" section for the removal of the transmission or transmission and transfer case from the vehicle. Note that labor will be saved on all F4-134 Models if the engine is removed from the chassis without the bell housing. Then remove the clutch from the flywheel.

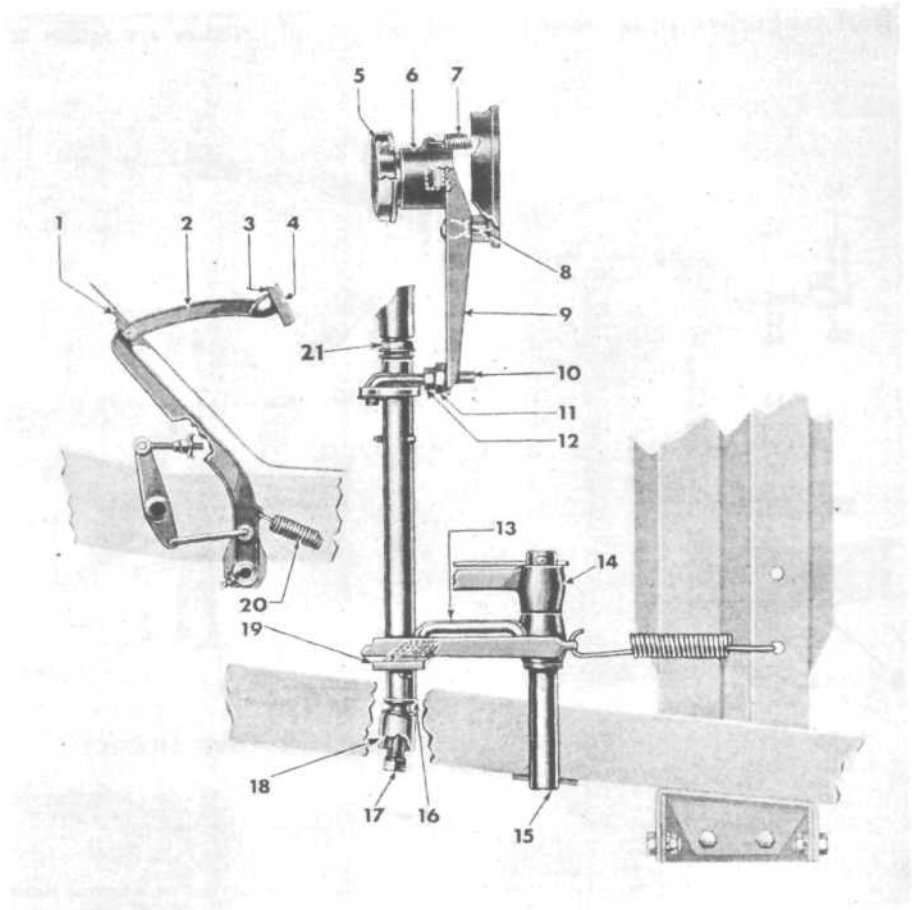


FIG. 174—CLUTCH CONTROL
Models F4-134 4WD and 4x4

1—Pedal Grommet
2—Clutch Pedal
3—Pedal Pad
4—Pedal Pad Cover
5—Clutch Release Bearing
6—Release Bearing Carrier
7—Release Bearing Carrier Spring
8—Clutch Lever Fulcrum
9—Clutch Control Lever
10—Control Rod
11—Control Rod Nut
12—Lock Nut
13—Clutch Control Lever Link
14—Brake Pedal
15—Pedal Shaft
16—Dust Seal
17—Ball Stud Bolt
18—Ball Stud
19—Control Cross Shaft and Lever
20—Retracting Spring
21—Ball Stud

On L6-226 Models equipped with the split bell housing, it is advisable to disconnect both front and rear propeller shafts, pull the transmission and transfer case to the rear sufficiently to clear the shaft from the clutch, remove the bottom pan from the bell housing and remove the clutch from the flywheel with the engine still in the vehicle.

Mark both the pressure plate and the flywheel so that the assembly may be installed in the same position after the repairs are completed. When removing the clutch from the flywheel, loosen the screws attaching the pressure plate to the flywheel in sequence, a little at a time, to prevent distortion of the clutch bracket.

Should an objectional vibration with early F4-134 Models occur upon deceleration or partial deceleration at speeds between 30 and 45 mph. [45-75 kph.], the vibration may be reduced or eliminated by replacing the clutch driven plate in the vehicle with clutch driven disc 919870.

J-4. Disassembly—Auburn Clutch

a. Place cover support plate (part of fixture) and clutch on Clutch Rebuilding and Adjusting Fixture C-585-C. Mark pressure plate and pressure plate cover with prick punch to assure alignment in the original position when assembling.

b. Place fixture compression plate on centering screw so that it rests evenly on all three pressure plate levers (Fig. 176).

c. Install and tighten nut against compression washer to relieve pressure at the heel of levers.

d. Remove pressure plate lever clip, adjusting screw, lock nut and flat washer from heel of each lever.

e. Carefully back off fixture compression nut all the way until pressure plate springs are no longer compressed. Remove fixture compression plate.

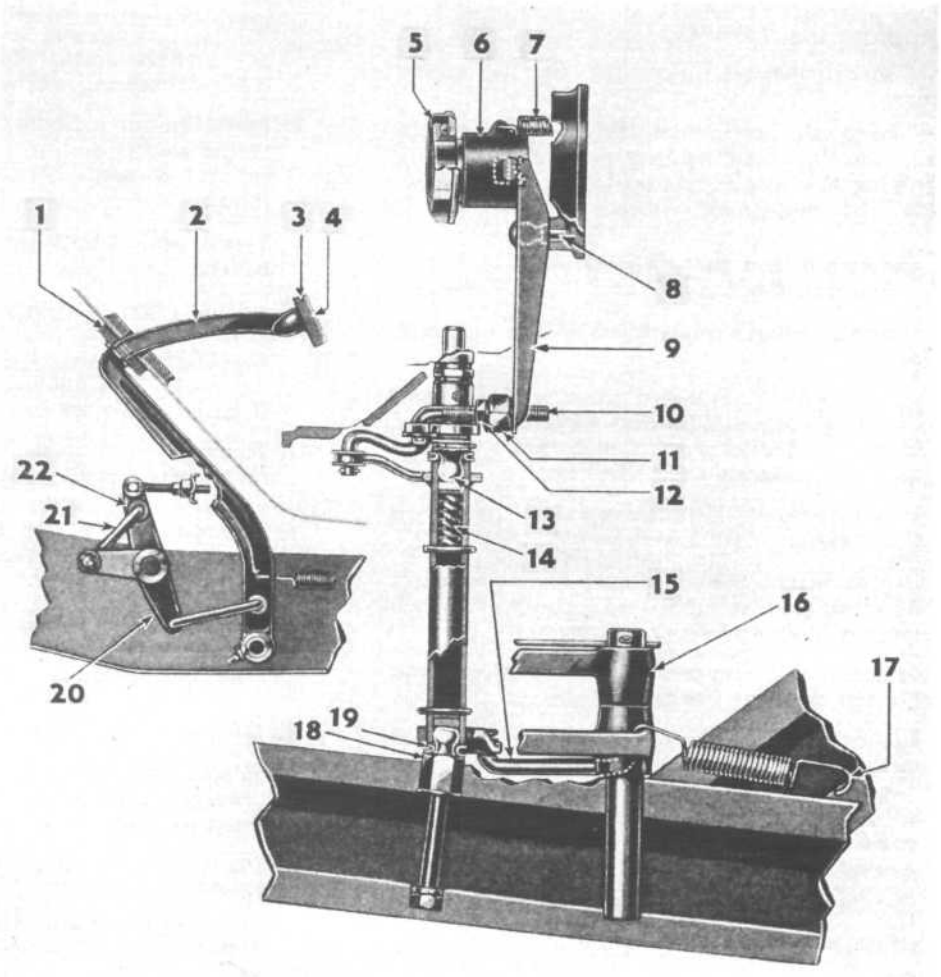
f. Remove pressure plate springs and lift pressure plate cover from pressure plate.

J-5. Inspection—Auburn Clutch

After clutch is disassembled, inspect each part for wear and replace if necessary. Check pressure plate for warpage and for scored surface. Check each

FIG. 175—CLUTCH CONTROL
Model F4-134 4x2

1. Pedal Grommet
2. Clutch Pedal
3. Pedal Pad
4. Pedal Pad Cover
5. Release Bearing
6. Bearing Carrier
7. Carrier Retracting Spring
8. Release Lever Fulcrum
9. Control Lever
10. Upper Control Rod
11. Control Rod Adjusting Nut
12. Control Rod Lock Nut
13. Control Tube Ball Stud
14. Control Tube Spring
15. Lower Control Rod
16. Brake Pedal
17. Pedal Retracting Spring
18. Frame End Ball Stud
19. Dust Seal
20. Outer Control Tube and Lever
21. Inner Clutch Control Rod
22. Inner Control Tube and Lever



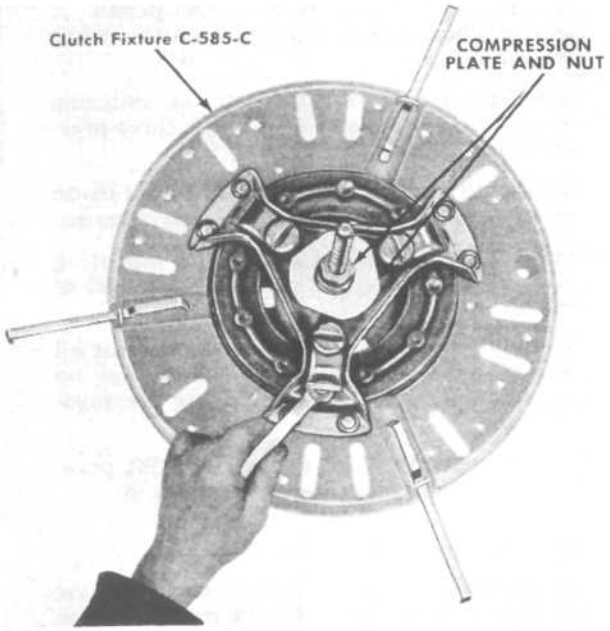


FIG. 176—DISASSEMBLING AUBURN CLUTCH

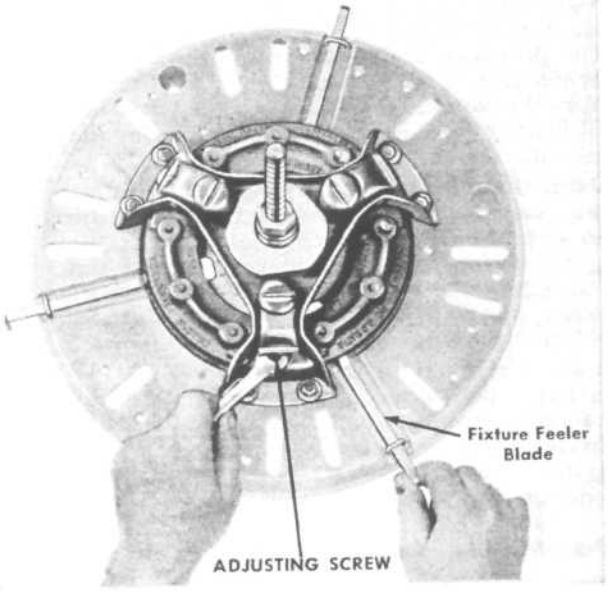


FIG. 177—ADJUSTING LEVERS ON AUBURN CLUTCH

pressure plate spring using a spring testing fixture and a torque indicating wrench.

See "Clutch Specifications" for correct spring pressure.

When using the recommended spring checking fixture, the "pounds" pressure is obtained by multiplying the torque wrench reading (in "foot-pounds") by two.

J-6. Assembly and Adjustment—Auburn Clutch

Proper assembly and adjustment of the clutch is as follows:

a. Place pressure plate and pressure plate cover on Clutch Rebuilding and Adjusting Fixture C-585-C. Make sure punch marks made during disassembly are lined up.

b. Install pressure plate springs under levers on the pressure plate cover.

c. Press down on the toe of each lever and insert a fixture support block under the heel of each lever to hold springs in place.

d. Install fixture compression plate and nut and tighten down as far as possible.

e. Remove support blocks from under levers and install clutch adjusting screws, washers, locknuts and pressure plate lever clips. Tighten adjusting screws into pressure plate as far as possible.

NOTE: Apply Lubriplate sparingly to all contact and pivot surfaces of levers.

f. Back off and remove fixture nut and compression plate.

g. Lift clutch off fixture, remove cover support plate and place clutch back on fixture.

h. Install fixture thickness spacers C-585-17 on fixture centering screw.

i. Install compression plate, self-aligning washer, thrust washer and nut. Tighten nut to its full extent to properly position pressure plate levers.

j. Install and tighten bolts holding cover plate to fixture.

k. Adjust pressure plate levers by turning lever adjusting screws, Fig. 177, until each of the three fixture feeler blades have the same slight drag or "feel" when pushed in and out. Tighten lock nuts.

l. Remove clutch from fixture. The assembly is now ready for installation.

J-7. Clutch Repair—Rockford Clutch

Overhaul of the six spring Rockford clutch is accomplished on the same Clutch Rebuilding and Adjusting Fixture C-585-C used for the three spring Auburn clutch repair. Procedures for disassembly, inspection and assembly of the clutch follow:

J-8. Disassembly—Rockford Clutch

The six spring clutch pressure plate, pressure plate cover, springs and levers can be completely disassembled for inspection or repairs as follows:

a. Place clutch on Clutch Rebuilding and Adjusting Fixture C-585-C. Mark pressure plate and pressure plate cover with prick punch to assure alignment in the original position when assembling.

b. Place compression spider and nut on fixture centering screw and tighten nut to relieve clutch spring pressure.

c. Remove retainer ring from the outer pin on each lever. Drive out the outer pins only. Fig. 178.

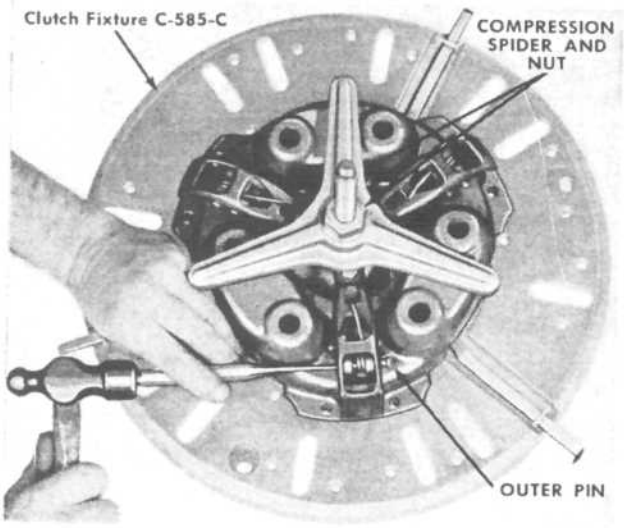


FIG. 178—DISASSEMBLING ROCKFORD CLUTCH

d. Carefully back off compression spider and nut all the way until pressure plate springs are no longer compressed. Remove spider and nut.

e. Lift off pressure plate cover and levers from pressure plate.

J-9. Inspection—Rockford Clutch

After the clutch is disassembled, inspect each part for wear and replace if necessary. Check pressure plate for warpage and for scored surface. Check each pressure plate spring using a spring testing fixture. See the Specifications at the end of this section for correct spring pressure.

When using the recommended spring checking fixture, the "pounds" pressure is obtained by multiplying the torque wrench reading (in "foot-pounds") by two.

J-10. Assembly and Adjustment—Rockford Clutch

Proper assembly and adjustment of the clutch is as follows:

a. Place pressure plate on Clutch Rebuilding and Adjusting Fixture C-585-C and place springs in position on pressure plate.

b. Assemble levers to pressure cover plate and place in position on pressure plate and springs. Make sure prick punch marks made during disassembly are aligned.

c. Install compression spider and nut to fixture and tighten down to compress clutch springs.

d. Install and tighten bolts to hold pressure plate cover against fixture. Remove compression spider and nut.

e. Install outer pins and retainer rings to each lever.

NOTE: Apply Lubriplate SPARINGLY to all contact and pivot surfaces of levers.

f. Place fixture thickness spacers C-585-16 on fixture centering screw, then install the fixture compression plate and nut. Tighten nut until compression plate contacts No. 16 spacer.

g. Adjust the three lever adjusting screws until a .002" feeler blade has a slight drag between the compression plate and each adjusting screw. Fig. 179.

h. Remove compression plate and nut, remove bolts holding pressure plate cover to fixture and remove pressure plate assembly.

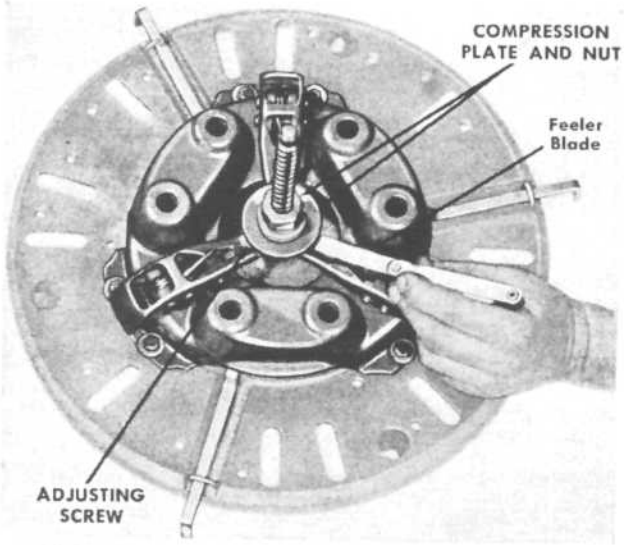


FIG. 179—ADJUSTING LEVERS ON ROCKFORD CLUTCH

J-11. Clutch Installation—Auburn and Rockford

a. Inspect Pilot Bushing in Flywheel

Inspect the transmission drive pinion shaft pilot bushing which is pressed into the center of the flywheel. If the bushing is worn or damaged, it should be removed, using Pilot Bushing Remover KF-5. Screw the tapered end of the tool into the damaged bushing, allowing the tool to cut its own threads until a solid grip is obtained. Insert the puller screw and rotate it until bushing is forced out of flywheel. Fig. 180.

To install a new bushing, slide the bushing onto the end of Pilot Bushing Installing and Burnishing Tool KF-6 and insert the bushing into flywheel. A soft hammer can be used against the tool to help drive the bushing in place. When the tool is re-

moved (by tightening the cap and pressure nut as shown in Fig. 181), the bushing will be burnished to correct size. Apply a small amount of lubricant to the bushing bore.

b. Inspect Clutch Disc

Before the clutch disc is installed, it should be carefully inspected for warpage. If grease or oil is evident on the friction facings, the facings should be replaced and the cause of oil accumulation corrected. Excessively worn facings should also be replaced with factory recommended parts.

c. Inspect Clutch Release Bearing and Sleeve

The clutch release bearing and sleeve are attached to the front facing of the transmission case by a spring. Check the bearing and sleeve for evidence of grease leaks from within the bearing or for wear and looseness. Replace parts if necessary.

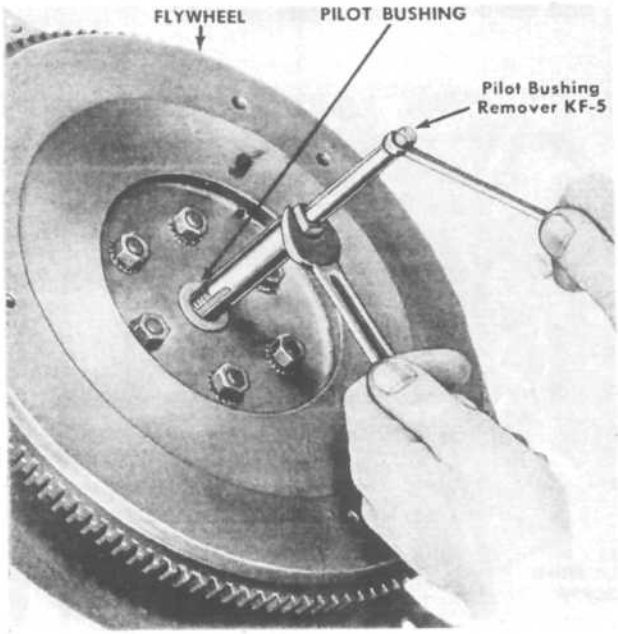


FIG. 180—REMOVING PILOT BUSHING FROM FLYWHEEL

d. Reassembly

To assemble the clutch to the flywheel, first put a small amount of light cup grease in the flywheel clutch shaft bushing, install the driven plate, with short end of hub toward the flywheel, then place the pressure plate assembly in position. With clutch plate aligning arbor, No. C-360 or a spare clutch shaft, align the driven plate splines leaving the arbor in position while tightening the pressure plate screws evenly.

Next, assemble the bell housing to the engine or reinstall the engine. Make sure that the clutch release bearing carrier return spring is hooked in place. For the balance of the assembly reverse the operations that were used in disassembly, referring to the instructions given in the "Transmission" section. Finally adjust the clutch control rod so there is 1" (25.4 mm.) free pedal travel.



FIG. 181—INSTALLING PILOT BUSHING TO FLYWHEEL

J-12. Borg & Beck Clutch

This clutch, as used in Willys vehicles has either nine or six springs. Procedures for disassembly, inspection, assembly and adjustment of both the nine and six spring clutches follow:

J-13. Disassembly—Borg & Beck Clutch

Install the clutch on the C-585-C fixture. Mark the cover and pressure plate with a prick punch to assure alignment in the original position when assembling.

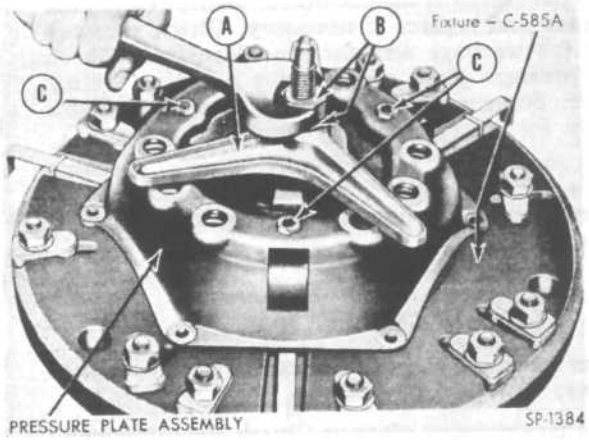


FIG. 182—DISASSEMBLING SIX SPRING CLUTCH

a. Install the three-legged spider (A, Fig. 182) so that it rests directly against the top of the clutch pressure plate cover.

b. Install the plain washer and nut on the fixture (B, Fig. 182), and tighten down the nut to relieve the spring load on the pressure plate eyebolt nuts.

c. Remove the pressure plate lever eyebolt nuts (C, Fig. 182).

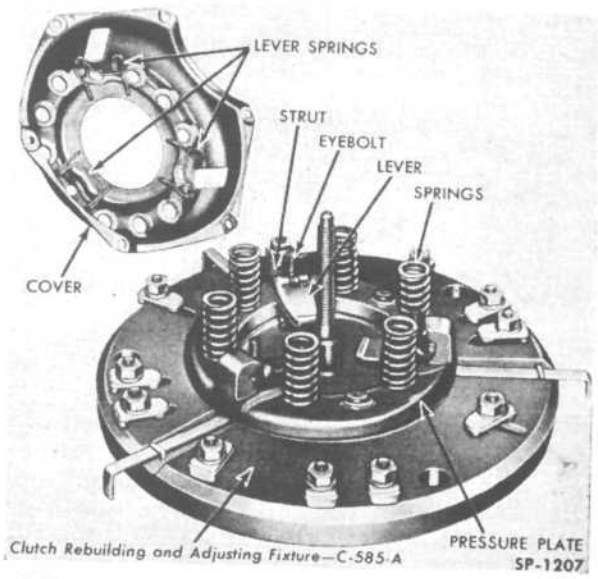


FIG. 183—SIX SPRING CLUTCH COVER PLATE REMOVED

d. Release and remove the fixture nut and washer. Lift off the pressure plate cover exposing the springs, levers and pressure plate for inspection or replacement (Fig. 183).

e. Remove the pressure plate struts, levers, lever pins and the eyebolts from the pressure plate.

f. Remove the pressure plate lever springs from the cover.

J-14. Inspection—Borg & Beck Clutch

Determine if the pressure plate is scored or warped —if so it should be replaced. Check the clutch pressure plate springs, using a spring testing fixture.

See Page 138 for the correct spring pressure. When using the recommended spring checking fixture, the "pounds" pressure is obtained by multiplying the torque wrench reading (in "foot-pounds") by two.

J-15. Assembly and Adjustment—Borg & Beck Clutch

Proper assembly and adjustment of the clutch is as follows:

a. Assemble the clutch pressure plate on the C-585-C fixture.

b. Assemble the eyebolts, lever pins, pressure plate levers and struts on the pressure plate (Fig. 184). Install the nine or six pressure plate springs on the pressure plate.

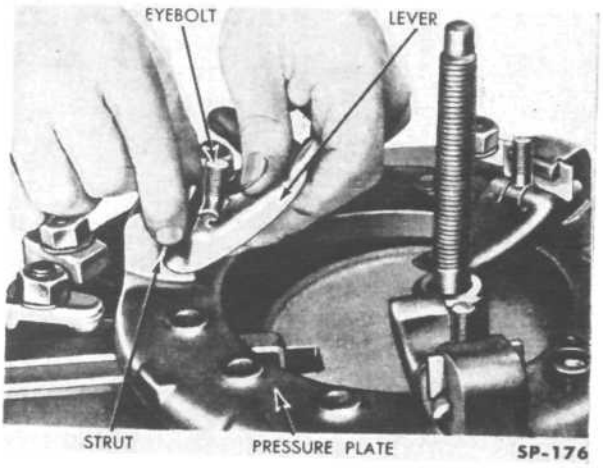


FIG. 184—ASSEMBLING LEVERS ON CLUTCH PRESSURE PLATE

NOTE: If working on a six spring pressure plate do not install adjacent to each other, install them as shown in Fig. 183. Apply Lubriplate to all contact and pivot surfaces of the eyebolts, lever pins and levers.

c. Install the three lever springs in the cover. Set the cover in place on the pressure plate, aligning the prick punch marks on the cover and plate to assure proper balance.

d. Position the pressure plate and cover on the C-585-C fixture so that the pressure plate levers are directly over the feeler blades of the fixture (A, Fig. 185). Install the three-legged spider, washer, and nut on the fixture centering screw and tighten down until the cover is seated on the fixture base and the three eyebolts protrude above the cover.

e. Install the three nuts on the eyebolts.

f. Install the fixture clamps to the clutch cover and tighten down to hold the cover securely to the fixture. Release and remove the nut, washer and spider.

g. Install the thickness spacer C-585-20 (B, Fig. 185), compression plate (C), self-aligning washer (D), plain washer (E), and the nut on the centering screw of the fixture.

h. Tighten the compression nut its full extent to properly position the pressure plate levers.

i. Adjust the pressure plate levers (G, Fig. 185) by turning the eyebolt nuts down until each of the three feelers (A) has the same slight drag or "feel" when pushed in and out. When the proper adjustment is made, stake the bolt and nut (H, I, and J, Fig. 185) and remove the clutch from the fixture. The clutch assembly is now ready for installation.

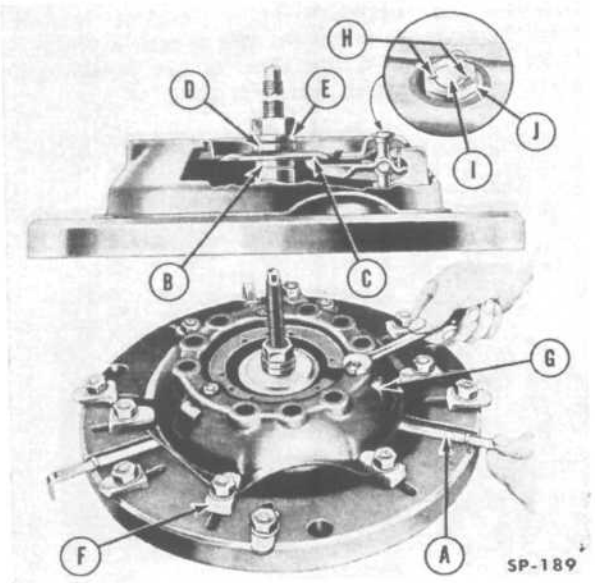


FIG. 185—ADJUSTING PRESSURE PLATE LEVERS

J-16. Clutch Disc

The clutch discs for the nine or six spring clutches are designed for operation with their respective clutches. However, the disc assemblies may be interchanged. Difference in general appearance of the discs may be noted in the method of housing the six torque dampening springs and in the hub design.

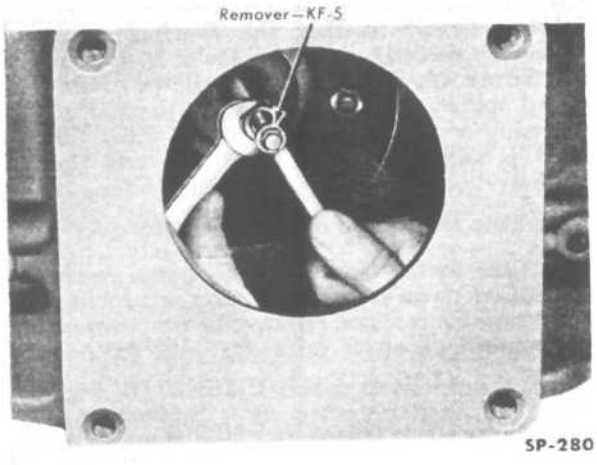


FIG. 186–REMOVING CRANKSHAFT PILOT BUSHING

After removal of the clutch assembly, the disc should be inspected. The presence of grease or oil on the friction facing will cause the clutch to chatter and grab during engagement and possibly slip at higher speeds. If this condition is evident, the facings or disc assembly should be replaced and the cause of oil accumulation corrected. Excessively worn facings should be replaced. Only factory recommended facings and disc assemblies should be used for replacement. The clutch disc must be installed with the long end of the hub toward the transmission.

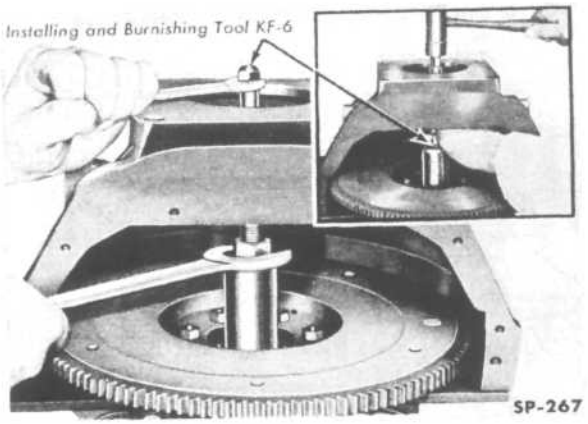


FIG. 187—INSTALLING AND BURNISHING CRANKSHAFT PILOT BUSHING

J-17. Crankshaft Pilot Bushing

All L6-226 Models

Inspect the pilot bushing; if it is worn or damaged it must be replaced. Remove the old bushing, using a KF-5 Clutch Shaft Pilot Bushing Remover (Fig. 186). Install the new bushing on the KF-6 Installing and Burnishing Tool and drive it into place in the crankshaft with a soft mallet. The bushing will contract slightly, holding the tool in place. The rings of the tool will burnish the bushing to a smooth finish as the nut and cup of the tool are turned out and removed (Fig. 187). Apply a small amount of lubricant to the bushing bore.

J-18. Installation

Install the clutch to the flywheel as described in Par. J-11d.

J-19. TROUBLE SHOOTING

J-20. Clutch Control Adjusting Rod Breaking

Models L6-226 4WD and 4x4

Under conditions of unusual operation, repeated breaking of the clutch control adjusting rod may occur. This condition may be corrected as follows:

a. Remove and discard the clutch control adjusting rod assembly.

b. Using a hand brake adjusting rod 642316, extend the $\frac{3}{8}$″ [9,525 mm.] thread all the way to the yoke end.

c. Remove the jam nuts and adjusting link guide from a clutch control adjusting link 212764 and install them on the hand brake adjusting rod modified in step b.

d. Install the converted adjusting link on the vehicle using two $\frac{3}{8}$″ x $1\frac{1}{4}$″ [9,525-31,75 mm.] clevis pins and two $\frac{3}{32}$″ x $\frac{3}{4}$″ [2,38-19 mm.] cotter pins. Lubricate the clevis pins before assembling. Position the link with the yoke end pointing upward.

e. Adjust clutch pedal free play.

SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Slipping:	
Improper Pedal Adjustment	Adjust Pedal Free Travel
Weak Pressure Springs	Replace
Lining Oil Soaked	Install New Driven Plate
Worn Linings or Torn Loose from Plate	Install New Driven Plate
Burned Clutch	Replace
Grabbing or Chattering:	
Gummy or Worn Linings	Install New Driven Plate
Loose Engine Mountings	Tighten
Scored or Broken Pressure Plate	Install New Pressure Plate
Improper Clutch Finger Adjustment	Readjust
Clutch Plate Crimp or Cushion Flattened Out	Replace Driven Plate
Dragging:	
Too Much Pedal Play	Adjust
Improper Finger Adjustment	Readjust
Pressure Plate Binds in Bracket	Adjust
Warped Pressure or Driven Plate	Replace
Torn or Loose Clutch Facing	Replace
Rattling:	
Broken or Weak Return Springs in Driven Plate	Replace
Worn Throw-Out Bearing	Replace
Fingers Improperly Adjusted	Readjust
Worn Driven Plate Hub of Transmission Main Gear Shaft	Replace
Pilot Bushing in Flywheel Worn	Replace

CLUTCH SPECIFICATIONS

MODEL:	L6-226 4WD L6-226 4x4	L6-226 4x2	All F4-134 Models
Pressure Plate:	Auburn or Borg & Beck Single Dry Plate	Auburn or Borg & Beck Single Dry Plate	Auburn or Rockford Single Dry Plate
Type			
Number of Springs:			
Auburn	3	3	3
Borg & Beck	6 or 9	6 or 9	.....
Rockford	.....	.....	6
Spring Pressure:			
3 springs	220 to 230 lbs. at 1 9/16" [91,6 a 104,3 kg.-39,6 mm.]	239 to 264 lbs. at 1 13/16" [108,4 a 119,7 kg.-46 mm.]	245 to 265 lbs. at 1 9/16" [111 a 120 kg.-39,7 mm.]
6 springs	160 lbs. at 1 5/16" [72,5 kg.-33,3 mm.]	239 to 251 lbs. at 1 1/2" [108,4 a 113,8 kg.-38,1 mm.]	190 to 210 lbs. at 1.156" [86,1 a 95,2 kg.-29,3 mm.]
9 springs	155 to 165 lbs. at 1 1/2" [70,3 a 74,8 kg.-38,1 mm.]	155 to 165 lbs. at 1 1/2" [70,3 a 74,8 kg.-38,1 mm.]	.....
Driven Plate:			
Make	Borg & Beck	Borg & Beck	Borg & Beck
Facings	Moulded	Moulded	Moulded
Diameter	10" [25,4 cm.]	9 1/4" [23,4 cm.]	8 1/2" [21,6 cm.]
Thickness	.125" [3,17 mm.]	.125" [3,17 mm.]	.132" to .138" [3,43 mm.]
Torque Capacity	202 lb-ft. [27,9 kg-m.]	182 lb-ft. [25,1 kg-m.]	140 lb-ft. [19,4 kg-m.]
Clutch Release Bearing	Prelubricated Sealed Ball Bearing	Prelubricated Sealed Ball Bearing	Prelubricated Sealed Ball Bearing
Clutch Shaft Bushing:			
Location	In Flywheel	In Flywheel	In Flywheel
Material	Bronze Graphite	Bronze Graphite	Bronze Graphite
Size	.631" I.D. [16,02 mm.]	.631" I.D. [16,02 mm.]	.628" I.D. [15,9 mm.]
Clutch Pedal Adjustment	1" [2,54 cm.]	1" [2,54 cm.]	1" [2,54 cm.]

TRANSMISSION AND OVERDRIVE

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K-1. GENERAL

All vehicles covered in this manual are equipped with three-speed synchromesh-type transmissions with synchronized second- and high-speed gears. Separate repair procedures for transmissions for 4-wheel-drive vehicles and for 2-wheel-drive vehicles are included in this section of the manual. All 4-wheel-drive vehicles are also equipped with a transfer case attached to the rear of the transmission. See Section L of this manual for repair procedures for the transfer case. Some 2-wheel-drive vehicles are equipped with an overdrive (optional equipment) attached to the rear of the transmission. Overdrive repair procedures are given at the end of this section of the manual beginning with Par. K-14.

All 4-wheel-drive vehicles are equipped with a cane-type shift mounted on top of the transmission. All 2-wheel-drive vehicles are equipped with a remote control shift mounted on the steering wheel column. For adjustment and repair procedures for the remote control, see Par. K-7.

The transmission is attached to the rear face of the flywheel bell housing and is supported on a rubber insulator at the frame center cross member which forms the rear engine support.

K-2. Transmission Removal
All 4-Wheel-Drive Models

The following transmission removal sequence applies in general to all 4-wheel-drive vehicles covered by this manual. Minor differences between models will not affect the procedure.

a. Drain the transmission and transfer case. Replace the drain plugs.

b. Remove the transmission access cover from the floor pan.

c. Remove the shift lever and shift housing assembly from the transmission. Remove the gasket.

d. Remove the set screw from the transfer case shift lever pivot pin (Fig. 207, No. 21). Remove the pivot pin, shift levers, and shift lever springs.

e. If vehicle is equipped with power take-off, remove the shift lever plate screws and lift out the lever.

f. Disconnect the front and rear propeller shafts from the transfer case, following the procedure outlined in Section M of this manual.

Should the vehicle be equipped with a power take-off, disconnect the transfer case end of the power-take-off drive shaft.

g. Disconnect the speedometer cable at the transfer case.

h. Disconnect the front and rear hand brake cables at the hand brake lever mounted on the frame cross member.

i. Place jacks under the transmission and engine, protecting the engine oil pan with a block of wood.

j. Remove nuts holding rear mounting to frame cross member.

k. Remove transfer case snubbing rubber bolt nut at cross member.

l. Remove bolts holding frame center cross member to frame side rail and remove cross member.

m. Remove bolts holding transmission to flywheel bell housing.

n. Force transmission to right to disengage clutch control lever tube ball joint.

o. Lower jacks under engine and transmission; slide transmission and transfer case assemblies toward rear of vehicle until the clutch shaft clears the bell housing.

p. Lower jack under transmission. Remove transmission and transfer case as an assembly from under the vehicle.

q. For the separation of the transmission and transfer case, refer to Par. K-3.

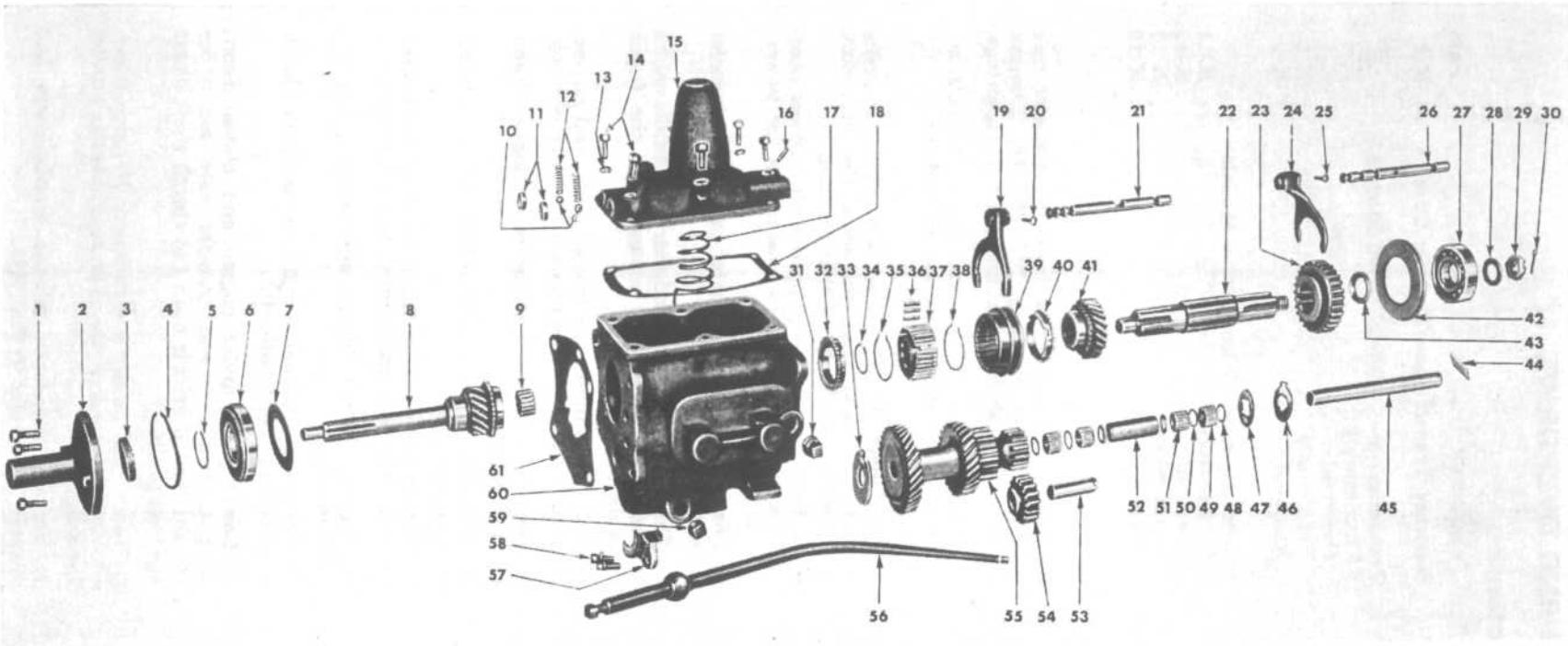


FIG. 188—TRANSMISSION—4-WHEEL DRIVE MODELS

1—Bearing Retainer Bolt
2—Bearing Retainer
3—Bearing Retainer Oil Seal
4—Bearing Snap Ring
5—Main Drive Gear Snap Ring
6—Main Drive Gear Bearing
7—Front Bearing Washer
8—Main Drive Gear
9—Pilot Roller Bearing
10—Poppet Ball
11—Shift Rail Cap
12—Poppet Spring
13—Lockwasher
14—Shift Housing Bolt
15—Shift Housing
16—Interlock Plunger
17—Shift Lever Spring
18—Shift Housing Gasket
19—High and Intermediate Shift Fork
20—Shift Fork Pin
21—High and Intermediate Shift Rail
22—Mainshaft
23—Sliding Gear
24—Low and Reverse Shift Fork
25—Shift Fork Pin
26—Low and Reverse Shift Rail
27—Rear Bearing
28—Mainshaft Washer
29—Mainshaft Nut
30—Cotter Pin
31—Filler Plug
32—Blocking Ring
33—Front Countershaft Thrust Washer
34—Clutch Hub Snap Ring
35—Synchronizer Spring
36—Synchronizer Plate
37—Clutch Hub
38—Synchronizer Spring
39—Clutch Sleeve
40—Blocking Ring
41—Second Speed Gear
42—Rear Bearing Adapter
43—Bearing Spacer
44—Lock Plate
45—Countershaft
46—Rear Countershaft Thrust Washer
47—Rear Countershaft Thrust Washer
48—Countershaft Bearing Washer
49—Countershaft Bearing Rollers
50—Countershaft Bearing Washer
51—Countershaft Bearing Rollers
52—Countershaft Bearing Spacer
53—Reverse Gear Shaft
54—Reverse Idler Gear
55—Countershaft Gear Set
56—Shift Lever
57—Oil Collector
58—Oil Collector Screw
59—Drain Plug
60—Transmission Case
61—Bearing Retainer Gasket

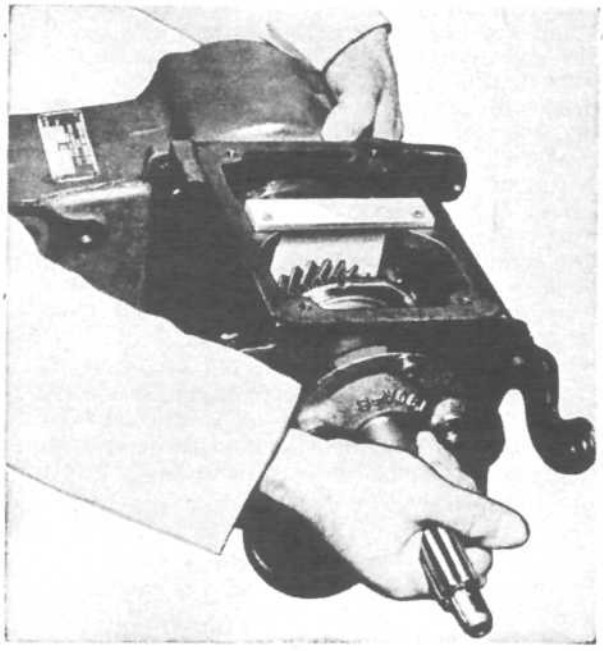


FIG. 189—MAINSHAFT RETAINING PLATE W-194

K-3. Separating Transmission and Transfer Case

a. Remove the six screws and lockwashers attaching the transfer case rear cover (Fig. 207, No. 5) and remove the cover. Or, should the vehicle be equipped with a power take-off, remove the power take-off shift unit which replaces the cover.

b. Remove cotter pin, nut, and washer which hold the transfer case main drive gear on the rear end of the transmission mainshaft. If possible at this point, remove the main drive gear. If not possible, see Par. d and e below.

c. Remove the transmission-to-transfer-case screws.

d. Separate the transfer case from the transmission. When separating the two units, use care that the transmission mainshaft bearing, which bears in both housings, remains in the transmission housing. To separate the two units if the transfer case main drive gear was not removed in Par. b above, follow the procedure in Par. e below.

e. Install transmission mainshaft retaining plate, tool W-194, as shown in Fig. 188 to prevent the mainshaft from pulling out of the transmission case. Should this tool be unavailable, loop a piece of wire around the mainshaft directly back of the mainshaft second-speed gear. Install the transmission shift housing right and left front attaching screws part way into the transmission case. Twist the wire and attach each end to one of the screws. Draw the wire tightly. With the mainshaft securely in place, support the transfer case and, with a rawhide mallet or brass drift and hammer, tap lightly on the end of the mainshaft to loosen the gear and separate the two units.

K-4. Transmission Disassembly

All 4-Wheel-Drive Models

Note: Numbers in parentheses refer to items shown in Fig. 188.

a. Drain the lubricant and clean the outside of the case with cleaning solvent.

b. Remove the shift housing and gasket from the top of the transmission.

c. If the transfer case is attached, separate it from the transmission as outlined in Par. K-3.

d. Remove the three screws and washers attaching the front main drive gear bearing retainer (2) to the transmission. Remove the retainer and gasket (61).

e. Remove the two socket-head screws from the front end of the transmission case. These screws support the oil collector (57) inside the case.

f. Tap lightly on the front end of the countershaft to loosen the lock plate (44). Remove the lock plate from slots cut in the rear ends of the countershaft and reverse idler shaft.

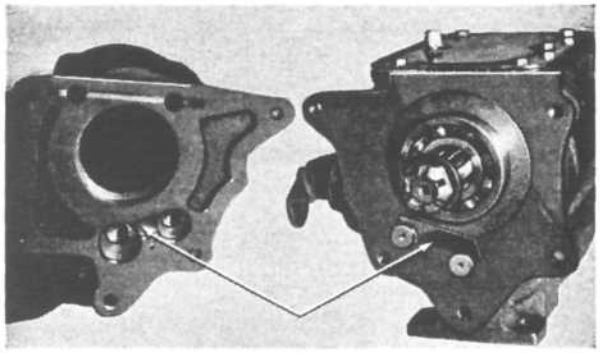


FIG. 190 — SHAFT LOCK PLATE

g. Using special tool No. W-166 (Fig. 191) or a brass drift, drive the countershaft (45) toward the rear of the case and remove it. The countershaft gear set (55) will drop to the bottom of the transmission case. If the special tool is used, the needle bearings (49 and 51) will remain in the countershaft gear hub and the gears and bearings may later be removed as an assembly.

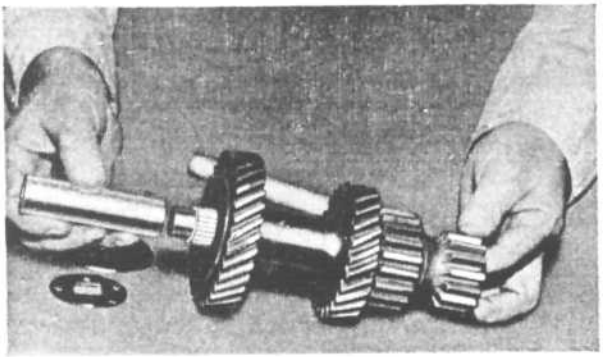


FIG. 191—COUNTERSHAFT GEAR BEARING ARBOR

h. Remove the mainshaft rear bearing adapter (42).

i. Remove the mainshaft from the case. The mainshaft assembly with the gears still in place may be removed through the rear bearing adapter opening.

j. Drive the main drive gear (8) into the case enough to remove the oil collector. Remove the oil collector.

k. Remove the main drive gear.

l. Remove the countershaft gear set and the three thrust washers. Remove the washers, needle bearings, and spacer from the assembly.

m. Remove the reverse idler shaft and gear by driving the shaft into the case using a brass drift.

K-5. Transmission Overhaul

a. Wash the transmission case thoroughly inside and outside with cleaning solvent.

b. Check bearing and shaft bores. Inspect the case for cracks. Check the front and rear faces and dress off any burrs with a fine mill file. If cracks are found or the bores are not true, replace the case.

c. Clean and inspect all gears for cracks, chipped or cracked teeth, or excessive wear of the teeth.

d. Inspect all bushings and bearings for wear or damage.

e. Check first and reverse sliding gear for freedom of movement on the mainshaft.

f. Check the clutch sleeve to see that it slides freely on the hub.

g. Check the condition of the bearing retainer oil seal.

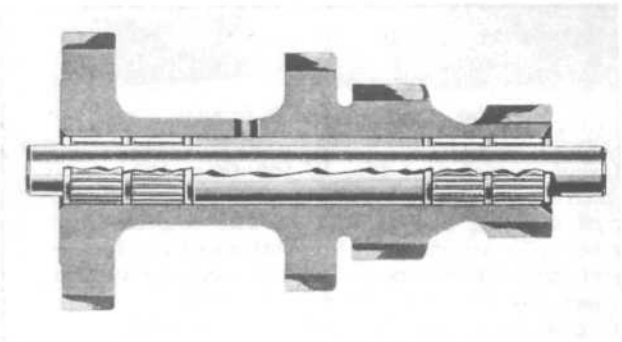


FIG. 192 — COUNTERSHAFT GEAR BEARINGS

K-6. Transmission Reassembly

All 4-Wheel-Drive Models

Note: Numbers in parentheses refer to items shown in Fig. 188.

Assemble the unit in the reverse order of disassembly, noting the following points.

a. On early production F4-134 4x4 Models, the countershaft gear assemblies included only four washers. No washers were installed at the ends of the spacer. On later production F4-134 4x4 vehicles and all other 4-wheel-drive vehicles, a shorter spacer and the two additional washers shown in Fig. 192 were used. When a transmission of the earlier type is disassembled, change to the shorter spacer and add the two washers upon reassembly.

b. Assemble the spacer (52), six washers (48 & 50), and four countershaft needle bearings (49 & 51) in the countershaft gear hub, using special tool (W-193 for F4-134 models and W-166 for L6-226 models) with loading sleeve as shown in Fig. 191 & 192. Place the spacer inside the hub and insert the special tool in the spacer. Place a washer at each end of the spacer and load a set of bearing rollers at each end. Then add a washer, a set of bearing rollers, and finally another washer at each end to complete the assembly. Place the countershaft gear assembly in the case but do not install the countershaft until the mainshaft and main drive gear are installed.

c. The countershaft gear set, when assembled in the case, should have .012″ to .018″ [0,305 a 0,457 mm.] end play. This clearance is obtained by selective thickness of the rear steel thrust washer (46) which is available in .0555″ and .0625″ [1,410 a 1,587 mm.] thickness.

d. To assemble the countershaft gear set in the case, first install the large bronze thrust washer (33) at the front of the case with the lip of the washer entered in the slot of the case. Use heavy grease to hold this washer in position. Next, install the steel thrust washer (46) at the rear of the case. Start the countershaft into the case just enough to hold this washer in place. Be sure the thrust washers are correctly positioned. Then position the bronze-faced washer (47) against the rear end of the gear and place the gear in its running position. Tap the countershaft through the countershaft gear set and the case, forcing out the special tool.

e. When assembling the mainshaft gears, the low and reverse sliding gear is installed with the shift shoe groove toward the front of the transmission.

f. The sequence of assembly of the synchronizer unit is shown in Fig. 193. First install the two springs in the high and intermediate clutch hub (37) with the spring tension opposed. Place the right lipped end of one spring in a slot of the hub and

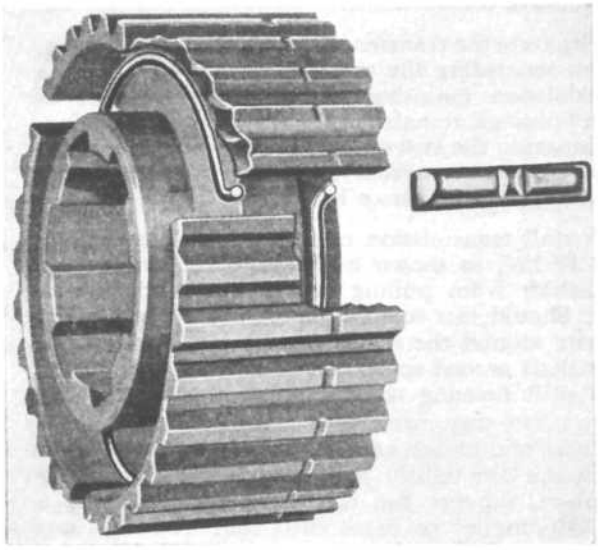


FIG. 193—SYNCHRONIZER SPRINGS

place the spring in the hub. Turn the hub around and make exactly the same installation with the other spring, starting with the same slot. Install the three synchronizer shifting plates (36) in the three slots in the hub with the smooth side of the plates out. Hold the plates in position and slip the second and direct speed clutch sleeve (39) over the hub with the long beveled edge toward the long part of the clutch hub. Install the two blocking rings (40) one on each side of the hub. Install the completed assembly on the mainshaft with the beveled edge of the clutch sleeve toward the front end of the shaft.

g. When installing the mainshaft, use care that the needle bearing rollers (9) in the main drive gear (8) are correctly positioned. Use heavy grease to hold them in position for assembly.

h. Attach the transfer case to the transmission before the unit is installed in the vehicle. When doing this, use care that the countershaft and reverse idler shaft lock plate shown in Fig. 190 is correctly positioned in the recess in the transfer case housing. Three 1⅛" long [29 mm.] screws and two 1" long [25 mm.] screws are used to attach the transfer case housing to the transmission housing. Install the 1" long screws in the lower left and lower right mounting holes.

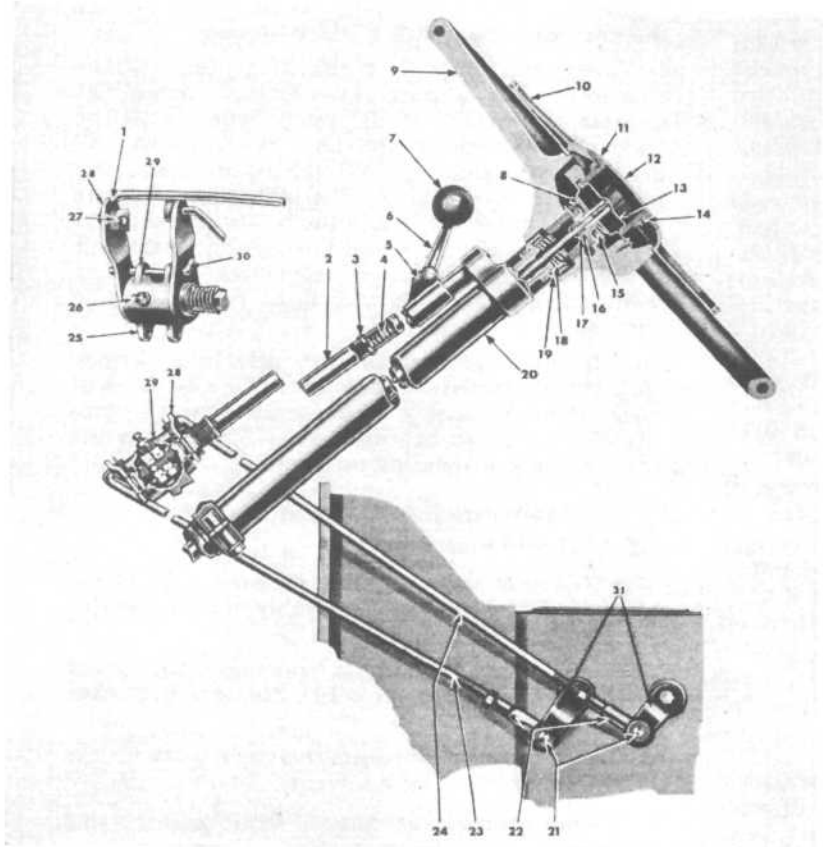
K-7. Transmission Remote Control Adjustment

All 2-Wheel-Drive Models

a. If the shift is not smooth and positive, first disconnect the transmission shift rods from the remote control levers. Check and correct any binding of the remote control shaft on steering column. Check operation of remote control levers and clutches as outlined in paragraph K-9, and correct as necessary.

b. Reconnect the transmission shift rods to the remote control lever. Shift to neutral position. Disconnect shift rods from shift levers at transmission by removing clevis pins (Fig. 194, No. 21). Insert a short piece of snug fitting ¼" [6,35 mm.] rod (No. 30) through the gearshift levers and housing as shown in the inset drawing. This places the clutch and shift lever assemblies in neutral position. Adjust each shift rod yoke (22) so a clevis pin (21) may be freely inserted through clevis and shift lever. Secure the clevis pins. Remove the ¼" rod. Road test vehicle.

c. If difficulty is still experienced with the shift from first to second gear, or if transmission hangs in first gear while attempting to shift to second gear, shorten the low and reverse shift rod one turn at a time (usually three full turns are required) until an improvement is obtained.



1—Low and Reverse Lever and Clutch
2—Shaft Assembly
3—Screw
4—Cross Shift Bias Spring
5—Lever Fulcrum Pin
6—Shift Lever
7—Control Lever Ball
8—Horn Button Ground Spring
9—Steering Wheel
10—Horn Ring
11—Horn Button
12—Horn Button Emblem
13—Horn Button Contact Cup
14—Horn Button Snap Ring
15—Steering Wheel Nut
16—Horn Button Spring
17—Horn Button Spring Cup
18—Steering Column Bearing Spring
19—Steering Column Bearing Assembly
20—Steering Column Bearing and Bracket
21—Clevis Pin
22—Adjusting Yoke
23—Control Rod—Second and High
24—Control Rod—Low and Reverse
25—Cross Shift Bracket Assembly
26—Lubricating Fitting
27—Shift Rod Anti-Rattle Spring
28—Gear Shift Lever
29—Housing
30—Rod
31—Control Lever

FIG. 194—TRANSMISSION REMOTE CONTROL

d. If normal shifting cannot be obtained with the above adjustments, inspection of the transmission will be required, especially the transmission shifting mechanism, as outlined in paragraph K-12h.

K-8. Removal of Remote Control

a. Remove the shift rods (Fig. 194, No. 23 & 24) from the transmission and from the clutch levers (28).

b. Remove gearshift lever fulcrum pin (5) and the shift lever (6).

c. Remove plates on the floor panel at the steering column.

d. Remove the damper which secures the shaft to the instrument panel brace.

e. Remove the two screws holding remote control housing (29) to the steering column and lift the housing from the positioning pin.

f. Remove the assembly down through the floor panel.

g. Remove the lower clutch and shift lever (1) from the housing by turning counterclockwise.

h. Remove the housing from the upper clutch and shift lever in the same manner.

i. Wash all parts in a cleaning solution.

K-9. Reassembly of Remote Control

a. Check clearance of shift dog which engages in slot of clutches, and if clearance is greater than .009″ [0,2286 mm.], replace the worn parts.

b. Assemble upper clutch and lever assembly (28) into the housing (29) making sure the alignment hole in the housing faces toward the engine. Turn the upper lever assembly in as far as it will go, and then back off approximately one turn until the hole in the lever aligns with the hole in the housing.

c. Assemble the lower clutch and lever assembly (1) into the housing until faces of clutches contact, then back off, not more than half a turn, until the alignment hole in the lever is in line with the hole in the housing. If the holes cannot be aligned in a half turn or less, it will be necessary to grind off the face of the lower clutch square with the axis, grinding not to exceed .015″ [0,397 mm.]. Backing off not more than half a turn from face-to-face contact gives the proper clearance of .015″ to .031″ [0,397 a 0,794 mm.] between the two clutches.

d. Assemble the unit to the steering post. Reinstall and adjust the remote control rods (23 & 24).

e. After assembly, if the shift dog catches on the edge of the slot in the clutch when moving the lever up and down, disconnect the shift rod (23) at the transmission end and either lengthen or shorten it slightly.

K-10. Transmission Removal

All 2-Wheel-Drive Models

The following sequence of removal covers the transmission and overdrive. To remove a standard transmission without overdrive, follow the same procedure, disregarding operations listed for the overdrive.

a. Disconnect the remote control shift rods (Fig. 194, No. 23 & 24) from the control levers (31).

b. Disconnect the two wires from the solenoid (Fig. 199, No. 54). Tag the wires and terminals for reassembly.

c. Disconnect the two wires from the overdrive rail switch (Fig. 199, No. 38) if the vehicle is equipped with this switch. Tag the wires and terminals for reassembly.

d. Disconnect the propeller shaft front universal joint at the transmission or overdrive as outlined in section M of this manual.

e. Disconnect the speedometer cable at the transmission or overdrive. Have available an ordinary cork of the correct size to close the cable attaching opening to prevent leakage of lubricant.

f. Disconnect the overdrive control cable and conduit.

g. Remove the rubber mounted saddle support at the rear end of the overdrive. Use care not to lose the spacers.

h. Remove the overdrive governor assembly.

i. Place a jack under the flywheel bell housing and raise the jack sufficiently to be tight under the housing.

j. Remove the frame cross member with the rubber insulators attached.

k. Place a jack under the engine to support the engine when the transmission is removed. Protect the engine oil pan with a block of wood.

l. Thread out the screws attaching the transmission to the bell housing as far as possible and yet support the weight of the transmission. Pull the transmission back to the bolt heads which will provide approximately ¾″ [1,905 mm.] opening between the two housings. This will relieve pressure on the clutch release fork in the bell housing. Insert a long screw driver through the opening in the side of the bell housing and pry the clutch release fork from engagement with the clutch release bearing carrier.

m. Remove the transmission attaching screws. Pull the transmission back until the clutch shaft clears the bell housing. Remove the assembly with the clutch release bearing carrier mounted in the main drive gear bearing retainer.

K-11. Transmission Disassembly

All 2-Wheel-Drive Models

The following sequence covers disassembly of the transmission only. For disassembly of the overdrive see Par. K-21.

a. Remove the four screws from the transmission case cover (Fig. 195, No. 10). Remove the cover and gasket.

b. Drain the lubricant from the housing. Wash the assembly with cleaning solvent.

c. Remove the screws from the front main bearing retainer (2) and remove retainer.

d. Shift the transmission into low gear.

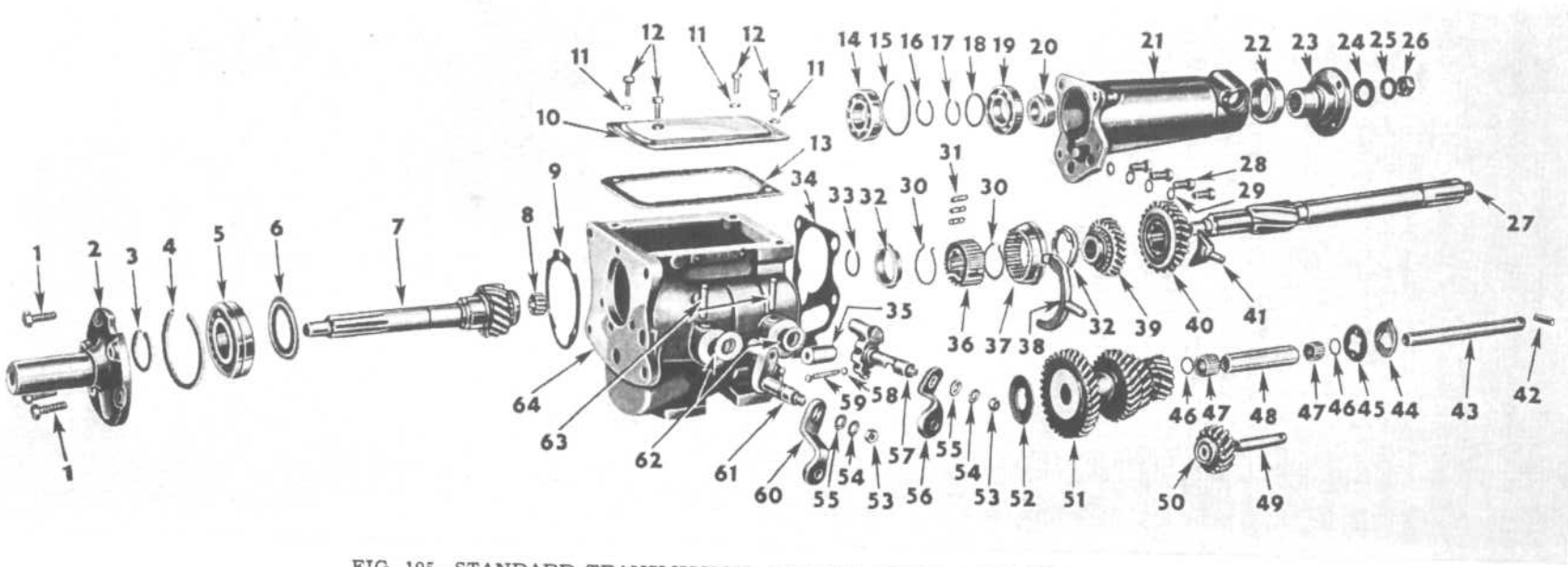


FIG. 195—STANDARD TRANSMISSION—2-WHEEL DRIVE—WITHOUT OVERDRIVE

1—Main Bearing Retainer Bolt
2—Main Bearing Retainer
3—Main Drive Gear Snap Ring
4—Bearing Snap Ring
5—Main Drive Gear Bearing
6—Oil Baffle
7—Main Drive Gear
8—Pilot Bearing Rollers
9—Bearing Retainer Gasket
10—Case Cover
11—Case Cover Bolt Gasket
12—Case Cover Bolt
13—Case Cover Gasket
14—Rear Main Shaft Bearing
15—Rear Bearing Snap Ring
16—Mainshaft Snap Ring
17—Rear Bearing Snap Ring
18—Rear Bearing Washer
19—Rear Mainshaft Bearing
20—Speedometer Drive Gear
21—Rear Bearing Retainer
22—Mainshaft Oil Seal
23—Coupling Flange
24—Mainshaft Washer
25—Mainshaft Nut Lockwasher
26—Mainshaft Nut
27—Mainshaft
28—Rear Bearing Retainer Bolt
29—Retainer Bolt Lockwasher
30—Synchronizer Spring
31—Synchronizer Shifting Plate
32—Blocking Ring
33—Clutch Hub Snap Ring
34—Rear Bearing Retainer Gasket
35—Interlock Sleeve
36—Clutch Hub
37—Clutch Sleeve
38—High and Intermediate Shift Fork
39—Second Speed Gear
40—Low and Reverse Gear
41—Low and Reverse Shift Fork
42—Idler and Countershaft Lock Plate
43—Countershaft
44—Thrust Washer
45—Thrust Washer
46—Countershaft Bearing Shift Spacer
47—Countershaft Bearing Rollers
48—Countershaft Bearing Long Spacer
49—Reverse Idler Gear Shaft
50—Reverse Idler Gear
51—Countershaft Gear
52—Thrust Washer
53—Control Lever to Shaft Nut
54—Lever to Shaft Lockwasher
55—Lever to Shaft Washer
56—Low and Reverse Control Lever
57—Low and Reverse Shift Lever
58—Poppet Ball
59—Poppet Spring
60—High and Intermediate Control Lever
61—High and Intermediate Shift Lever
62—Shift Shaft Oil Seal
63—Shift Lever Shaft Pin
64—Transmission Case

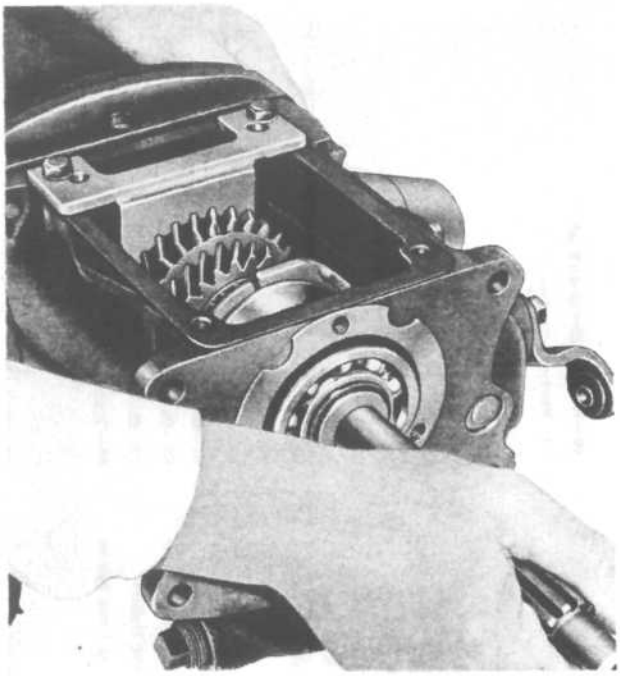


FIG. 196—MAINSHAFT RETAINING PLATE

e. Install transmission mainshaft retaining plate, tool W-194, Fig. 196, to prevent the mainshaft from pulling out of the transmission case. Should this tool be unavailable, loop a piece of wire around the mainshaft directly back of the low-speed sliding gear (40). Install the transmission cover right- and left-front attaching screws in the transmission case. Twist the wire and attach one end to each of the two screws. Draw the wire tightly.

f. Remove nut (26) which attaches the companion flange to the mainshaft. Remove washer (24) and lockwasher (25). Hold the companion flange with special tool C-3281, Fig. 247. Remove the companion flange with puller tool W-172.

g. Remove the screws attaching the rear bearing retainer (21) to the transmission case. Remove the retainer and gasket.

h. Remove oil seal (22) speedometer drive gear (20) and rear shaft bearing (19) from the bearing retainer.

i. Remove tool W-194 or the wire installed in Par. e above.

j. Slide the mainshaft to the rear until the rear bearing (14) is clear of the case. The mainshaft may then be shifted to the side of the case sufficiently for removal of the shifting forks (38 & 41).

k. Remove the lock plate (42) from the ends of the idler shaft and countershaft.

l. Using special tool (W-193 for Model F4-134 or W-166 for Model L6-226) or a brass drift, drive out the countershaft (43) toward the rear. The countershaft gear set will drop to the bottom of the transmission case. If the special tool is used, the needle bearings (47) will remain in the countershaft gear hub, and the gears and bearings may later be removed as an assembly.

m. Remove the main drive gear (7) with bearing through the front of the case. Note that this gear cannot be removed when the countershaft gears are in position. Take care, when removing this gear, not to misplace the thirteen needle bearing rollers (8) in the gear end of the shaft.

n. Remove the mainshaft snap ring (16) the mainshaft bearing snap ring (15) and the mainshaft bearing (14) which is grooved, from the mainshaft.

o. Remove the snap ring (33) from the mainshaft. Then remove the clutch hub and synchronizer assembly through the top of the case.

p. Remove the mainshaft (27) low and reverse sliding gear (40) and second-speed gear (39) as one unit through the top of the case.

q. Remove the countershaft gear set (51) through the top of the case. Take care not to misplace the bearing rollers (47) at each end of the spacer, the two rear thrust washers (44 & 45), the front thrust washer (52), or the short spacers or washers (46).

r. Using a soft drift, drive the reverse idler shaft (49) out the rear of the case. Remove the reverse idler gear.

K-12. Transmission Overhaul

All 2-wheel-drive Models

a. Wash the transmission case thoroughly inside and outside with cleaning solvent.

b. Check bearing and shaft bores. Inspect the case for cracks. Check the front and rear faces and dress off any burrs with a fine mill file. If cracks are found or the bores are not true, replace the case.

c. Clean and inspect all gears for cracks, chipped or cracked teeth, or excessive wear of the teeth.

d. Inspect all bushings and bearings for wear or damage.

e. Check first and reverse sliding gear for freedom of movement on the mainshaft.

f. Check the clutch sleeve to see that it slides freely on the hub.

g. Check the condition of the bearing retainer oil seal.

h. With the transmission case empty, the interlock sleeve and poppet assembly should be carefully checked. Should this assembly be too long, it will be impossible to shift gears and if it is too short, it will fail to function as an interlock to prevent shifting into two gears at one time. Use a feeler gauge to check the clearance, which must be from .001″ to .007″ [.025 to .178 mm.]. Make this measurement between the end of the interlock sleeve and the notched surface of the second-and-high shift lever when it is in second gear and the other shift lever is in neutral. To obtain correct clearance, interlock sleeves are available for selective fits. The different lengths can be identified by a letter etched at the end.

1.287″ [326,9 cm.] — etched C
1.291″ [327,9 cm.] — etched B
1.295″ [328,9 cm.] — etched A
1.299″ [329,9 cm.] — no mark
1.303″ [331,0 cm.] — etched D

Should an interlock sleeve need replacing, proceed as follows:

First drive out the taper retaining pins (63) from the bottom of the shift lever bosses. Remove the nuts (51) and washers (52 & 55) from the control levers and remove levers. Push the shift levers into the case to remove them and then remove the sleeve, poppet ball, and spring. Check the oil seals carefully for oil leakage and replace if necessary.

i. If it is evident that a minimum clearance of .001″ to .007″ cannot be obtained between the end of the interlock sleeve and shift levers, even though the longest sleeve has been installed, remove the original interlock pin from the shift lever poppet spring. Replace the original interlock pin with a transfer case intermediate gear needle bearing roller, Part No. 809294, which has been ground to a length of .780″ [19,8 mm.]. The installation of this modified roller should ensure positive engagement of the ball at each end of the interlock sleeve in the respective detents of the shifting levers as the transmission is shifted through the shift pattern. Assemble the transmission to where shift action can be checked. If it is apparent that the improvised pin is too long and is causing a bind when shifting is attempted, reduce its length a little at a time from the .780″ dimension until a smooth shift action with a positive ball and detent engagement is obtained. Install this improvised pin only when the longest interlock sleeve does not provide the desired minimum clearance.

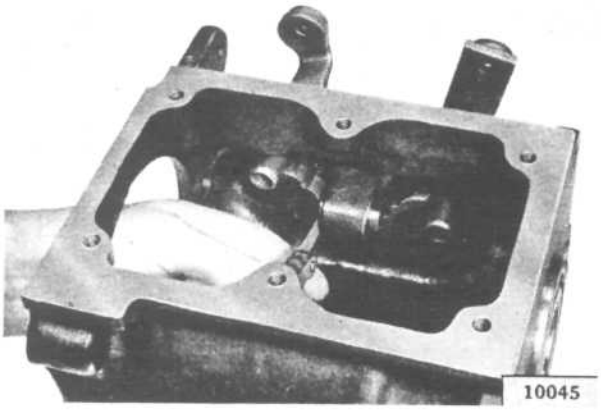


FIG. 197—INTERLOCK SLEEVE CLEARANCE

Reassemble in reverse order. When assembling the interlock sleeve be sure that the shift lever poppet spring works freely inside the interlock and that the interlock pin, or the modified roller substituted for the pin, is not omitted from inside the spring. If the notched surfaces of the shifting levers are dirty or rough they should be thoroughly cleaned and smoothed. If notched surfaces are scored or damaged, the lever or levers should be replaced.

Note: Each time an interlock sleeve or shift lever is replaced, check the clearance between the interlock sleeve and the shift lever.

K-13. Transmission Reassembly

All 2-Wheel-Drive Models

Assemble the unit in reverse order of disassembly noting the following points:

a. On early production F4-134 4x2 Models, the countershaft gear assemblies included only four washers. No washers were installed at the ends of the spacer. On later production F4-134 4x2 vehicles and all other 2-wheel-drive vehicles, a shorter spacer and the two additional washers shown in Fig. 192 were used. When a transmission of the earlier type is disassembled, change to the shorter spacer and add the two washers upon reassembly.

b. Use a special tool (W-193 for Model F4-134 or W-166 for Model L6-226) when reassembling the countershaft gear set. See Fig. 191. Place the tool through the gear set. Insert the spacer (48), positioning it at the center of the gear set. Place a set of rollers at each end of the spacer, followed by a spacing washer at each end. Use a small amount of grease to hold the spacing washers in position. Before installing the mainshaft, place the assembled countershaft gear set in the bottom of the case with the larger gear toward the front of the case.

c. The sequence of assembly of the synchronizer is shown in Fig. 193. First install the two springs (30) in the high and intermediate clutch hub (36). These springs must be installed with the spring tension opposed. Place the right-lipped end of one spring in a slot of the hub and place the spring in the hub. Turn the hub around and make exactly the same installation with the other spring, starting with the same slot. Install the three synchronizer shifting plates (31) in the three slots in the hub with the smooth sides of the plates out. Holding the plates in position, slip the second and direct speed clutch sleeve (37) over the hub. Install the two blocking rings (32), one on each side of the hub.

d. When installing the mainshaft, use care that the needle bearing rollers (8) in the main drive gear are correctly positioned. Use heavy grease to hold them in position for assembly.

e. For ease in installing the countershaft, turn the transmission case over to allow the gears to mesh. Start the countershaft (43) through the rear of the case with the lock plate slot toward the rear and the slot in alignment with the slot in the idler gear shaft. Place the two rear thrust washers (44 & 45) over the end of the shaft and align the countershaft gears with the shaft. Press the shaft through the gears. Place the front thrust washer in position with the tongue of the washer in the slot in the case. Press the shaft into the front of the case, forcing out the special tool.

K-14. OVERDRIVE

Optional equipment on all 2-Wheel-Drive Models

The overdrive unit, attached to the rear of the transmission, is essentially a fourth forward gear ratio. The shift into "fourth gear" is electrically operated at the discretion of the operator. Operation in overdrive gives an approximate 30% reduc-

tion in engine speed, relative to normal engine speed with the transmission in high gear without overdrive, for any given vehicle speed above approximately 30 mph [48 kph.].

The overdrive unit contains a built-in freewheeling mechanism. This mechanism automatically disengages the engine from the transmission when the accelerator is not depressed and vehicle speed is below 21 to 25 mph [33,6 a 40,0 kph.]. This permits the engine to "idle" while the vehicle continues to move under its own momentum. It is not necessary to use the clutch to shift gears when the freewheeling mechanism is in operation at these low speeds.

The overdrive control button is located at the left end of the instrument panel. Pulling the control button OUT locks the overdrive unit to the transmission, resulting in normal operation without overdrive. Pushing the button IN frees the overdrive unit from the transmission, allowing the overdrive to function as a "fourth gear."

K-15. Operating The Overdrive Controls

a. Push IN the overdrive control button to place the overdrive in operation. This can be done at any vehicle speed. With the control button in this position, the overdrive automatically shifts into "fourth gear," at speeds above 30 mph [48 kph.] when the accelerator is released momentarily.

b. Pull OUT the overdrive control button when overdrive operation is not desired. This may be done either while the accelerator pedal is pressed to the floor board or when the vehicle is stopped.

c. For passing or quick acceleration when in overdrive, press the accelerator pedal firmly to the floor board. This action will operate the kickdown switch. Release the accelerator pedal to return to overdrive.

d. Because of the freewheeling feature in overdrive, the control button should be pulled OUT when driving in mountainous country, on icy or slick surfaces, when descending steep hills, or when the vehicle is to be pushed to start the engine.

K-16. Overdrive Rail Switch

A rail switch, Fig. 202, No. 27, was installed on the overdrive unit of all F4-134 2-wheel-drive vehicles up to and including vehicle serial numbers 54747-10084 and 54847-10096. The rail switch was eliminated on all F4-134 vehicles with serial numbers higher than those given above.

K-17. Operation With Overdrive Disengaged

Pulling OUT the overdrive control button rotates the control lever (Fig. 202, No. 25) which in turn moves the shift rail and fork assembly (21) to the rear. The movement of the fork moves the stationary gear (54) into engagement with the pinion cage (51), thereby locking the transmission mainshaft to the overdrive mainshaft. The two shafts then rotate as a unit in a one-to-one ratio. On units equipped with rail switches (see Par. K-16), movement of the shift rail to the rear also engages the plunger of the rail switch, thereby opening the electrical circuit of the overdrive.

K-18. Operation With Overdrive Engaged

a. When the overdrive control button is pushed IN, the control lever moves the shift rail and fork assembly forward. Forward movement of the fork disengages the stationary gear from the pinion cage, freeing the transmission mainshaft from the overdrive mainshaft. On vehicles equipped with a rail switch, forward movement of the shift rail also operates the switch, thereby closing the electrical circuit. The overdrive is now ready to function automatically, within the limits controlled by the governor.

b. At the time outlined in Par. a above, power is transmitted from the transmission mainshaft to the overdrive mainshaft through the freewheel cam (Fig. 202, No. 45). While the engine is being accelerated, the cam transmits power from the transmission mainshaft to the overdrive mainshaft. However, when the engine decelerates, the cam no longer transmits power, the engine "idles," and the vehicle goes forward under its own momentum. This is freewheeling.

c. When the vehicle reaches a speed of approximately 30 mph, the overdrive governor (28) closes its contacts, energizing the solenoid (19). When energized, the solenoid attempts to push the stationary gear panel (18) into engagement with the stationary gear plate (61) and balk ring (60). See Fig. 205.

d. The final step in overdrive engagement occurs when the operator lifts his foot momentarily from the accelerator. This momentary deceleration causes a slight torque reversal, moving the balk ring out of the way of the gear pawl, allowing the pawl to engage the sun gear plate, as shown in Fig. 205.

e. The pawl prevents rotation of the sun gear, causing the planet gears to rotate around the sun gear. In so doing, the planet gears drive the overdrive mainshaft through the gear teeth on the inside diameter of the ring gear (52) and on the mainshaft assembly, over-running the freewheeling cam. Rotation of the planet gears around the sun gear drives the overdrive mainshaft at a ratio of one revolution for every seven-tenths of a revolution of the transmission mainshaft, resulting in 30% reduction in engine speed.

f. Upon deceleration of the vehicle, when the vehicle speed is reduced to the range of 21 to 25 mph. [33,6 a 40,0 kph.], the overdrive governor opens the electrical circuit, de-energizing the solenoid. The solenoid plunger, which is spring loaded, withdraws the pawl from engagement with the gear plate. The sun gear turns with the planet gears which continue deceleration while the engine speed drops to idle. Freewheeling is again in effect.

K-19. Kickdown Switch Operation

a. To provide additional power for passing on the highway, when in overdrive, a kickdown switch is provided. The operation of this switch changes the speed relation between the transmission mainshaft and overdrive mainshaft back to one-to-one ratio. To operate the switch, the operator depresses the accelerator pedal as far as possible.

b. Operation of the kickdown switch, through electrical controls, de-energizes the solenoid and momentarily interrupts the ignition circuit. The solenoid plunger urges the pawl from the gear plate. However, the driving torque reaction holds the pawl in place until the torque is momentarily relieved. The momentary interruption of the ignition circuit provides the relief of the torque necessary to release the pawl. When the pawl is released, the drive is through the freewheeling rollers.

a. The governor is a centrifugal switch which closes to complete circuit A at a governor speed of 840 rpm. (approximately 29 mph [46,7 kph.] vehicle speed). The switch opens at a governor speed of 680 rpm (approximately 24 mph [38 kph.] vehicle speed), which opens circuit A.

b. Some vehicles are equipped with a rail switch (see Par. K-16). When the overdrive control button is pushed IN, the switch is closed to com-

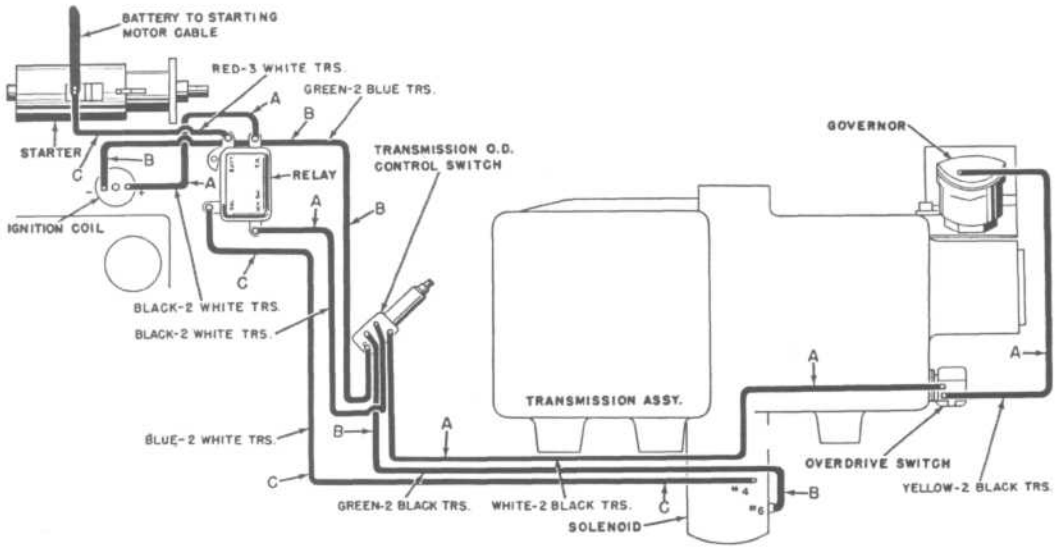


FIG. 198—COLOR-CODED WIRING DIAGRAM—OVERDRIVE

c. When the kickdown switch is released by the operator lifting his foot momentarily from the accelerator, the overdrive automatically re-engages.

d. The kickdown switch must be correctly positioned in relation to the accelerator pedal. Adjustment is made by two nuts, one on each side of the toe board. Adjust the switch to provide .005″ [0,127 mm.] clearance between the underside of the accelerator pedal and the plunger of the switch when the carburetor throttle is wide open.

K-20. Overdrive Electrical Controls

There are no adjustments provided for the sealed electrical units. Replace any defective unit.

Three separate electrical circuits automatically control the overdrive. They are identified by letters A, B, and C on the overdrive wiring diagram, Fig. 198. Wire coverings are color-coded differently for each circuit to assist in tracing the individual circuits. Circuit A energizes the governor and controls the relay. Circuit B serves to momentarily short out the ignition circuit in conjunction with the kickdown switch. Circuit C energizes the solenoid.

plete circuit A. When the control button is pulled OUT, the switch is opened, opening circuit A. On vehicles not equipped with a rail switch, circuit A is routed directly to the governor.

c. When circuit A is completed by the governor reaching cut-in speed, the relay closes. This energizes circuit C and a heavy current momentarily passes through the solenoid. The circuit is protected against this current by a 20-ampere fuse mounted on the relay. Should this fuse burn out, the overdrive will not function.

d. The kickdown switch (Transmission O.D. Control Switch in Fig. 198) is mechanically operated by the accelerator pedal. See Par. K-19. Operation of the kickdown switch opens circuit A, in turn opening the relay and circuit C and de-energizing the solenoid. Operation of the switch also momentarily provides a direct ground for the ignition coil primary circuit through circuit B. Grounding the primary circuit causes the engine to miss about three consecutive firings, thereby relieving the torque and allowing disengagement of the solenoid pawl from the sun gear.

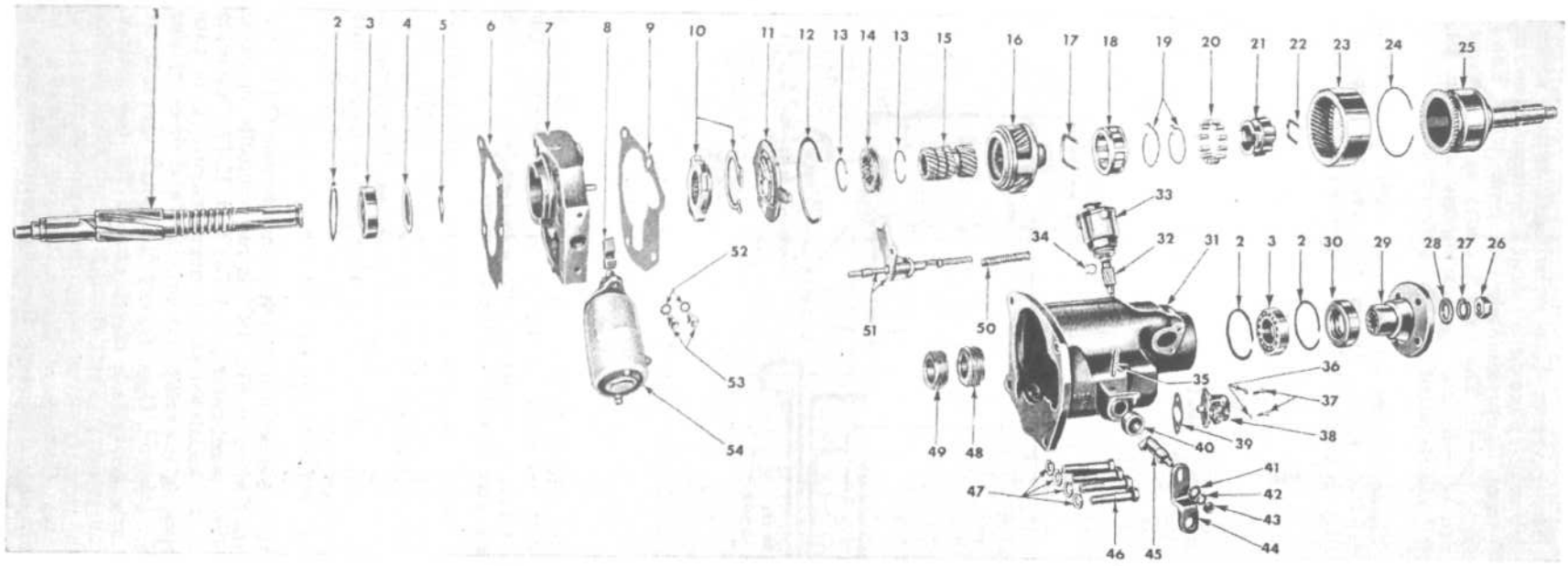


FIG. 199—TRANSMISSION OVERDRIVE—EXPLODED VIEW

1—Transmission Mainshaft
2—Mainshaft Bearing Snap Ring
3—Mainshaft Bearing
4—Mainshaft Oil Baffle
5—Mainshaft Snap Ring
6—Adapter to Transmission Gasket
7—Overdrive Housing Adapter
8—Sun Gear Pawl
9—Housing to Adapter Gasket
10—Balk Ring and Gear Plate
11—Overdrive Cover Plate
12—Cover Plate Snap Ring
13—Sun Gear Snap Ring
14—Sun Gear Shifting Collar
15—Sun Gear
16—Planetary Gear Cage
17—Roller Retainer Clip
18—Freewheel Roller Retainer
19—Roller Retainer Spring
20—Freewheel Roller
21—Freewheel Cam
22—Cam Retainer Clip
23—Overdrive Ring Gear
24—Ring Gear Snap Ring
25—Mainshaft
26—Mainshaft Nut
27—Mainshaft Lockwasher
28—Mainshaft Washer
29—Coupling Flange
30—Mainshaft Oil Seal
31—Housing
32—Governor Driven Gear
33—Governor
34—Driven Gear Retaining Ring
35—Control Shaft Pin
36—Rail Switch Lockwasher
37—Rail Switch Screw
38—Rail Switch
39—Rail Switch Gasket
40—Control Shaft Oil Seal
41—Control Lever Washer
42—Control Lever Lockwasher
43—Control Lever Nut
44—Control Lever
45—Control Shaft
46—Housing to Transmission Bolt
47—Housing to Transmission Lockwasher
48—Speedometer Drive Gear
49—Governor Drive Gear
50—Shift Retractor Spring
51—Shift Rail and Fork
52—Solenoid Lockwasher
53—Solenoid Bolt
54—Solenoid

K-21. Overdrive Disassembly

a. Drain oil from both transmission and overdrive housings.

b. Remove two cap screws holding solenoid (Fig. 199, No. 53) to left side of overdrive housing adapter (7). Turn solenoid a quarter turn to right and pull out to disengage solenoid plunger from sun gear pawl. Remove solenoid.

c. Remove two cap screws holding overdrive rail switch (38) and remove switch and gasket. See Par. K-16.

d. Unscrew governor from right side of overdrive housing.

e. Remove cap screw holding speedometer driven gear assembly to left rear of overdrive housing and remove the gear.

f. Remove four cap screws holding transmission cover to housing. Remove the cover and gasket. Shift the transmission into low gear. Place transmission mainshaft retaining plate (Tool W-194, Fig. 196) to the rear of the low and reverse speed sliding gear. Attach the plate to the transmission with two transmission cover cap screws. If this tool is not available, loop a piece of wire around the mainshaft just back of the low speed sliding gear. Fasten the ends of the wire to two front transmission cover screws to hold the mainshaft in position.

g. Remove nut (26) which attaches the companion flange to the overdrive mainshaft. Hold companion flange with special Tool No. C-3281, as shown in Fig. 253.

h. Remove the companion flange with special puller (Tool No. W-172) as shown in Fig. 208.

i. Drive the overdrive control shaft taper pin (35) from the overdrive housing, driving it up from the bottom.

j. Pull out on the overdrive control shaft (45) to disengage control shaft from the shaft rail. The overdrive housing cannot be removed from the transmission until the shaft is free of the rail.

k. Remove the four cap screws (46) which hold the overdrive housing and housing adapter to the transmission. Pull the overdrive housing to the rear, and at the same time, push forward on the overdrive mainshaft to prevent the mainshaft from coming off with the housing. Remove the overdrive housing and gasket.

l. Remove the speedometer drive gear (48) and the governor gear (49) from the mainshaft. These gears can be removed by inserting a brass rod through the rear of the housing and tapping them loose. Remove them through the front of the housing.

m. Remove the overdrive mainshaft (25) and ring gear (23) as an assembly by pulling to the rear and rocking back and forth. Hold one hand under the freewheeling unit to catch the twelve rollers (20) which will drop out as the mainshaft is removed. To remove the ring gear from the mainshaft, loosen the gear by removing the snap ring.

n. Remove the cam retainer clip (22) from the freewheeling cam and transmission mainshaft. Remove the freewheeling cam (21) and overdrive pinion cage (16) as an assembly by pulling to the rear.

o. Remove the roller retaining clip (17) holding the freewheeling cam to pinion cage and separate the two assemblies. No further disassembly of the pinion cage should be attempted.

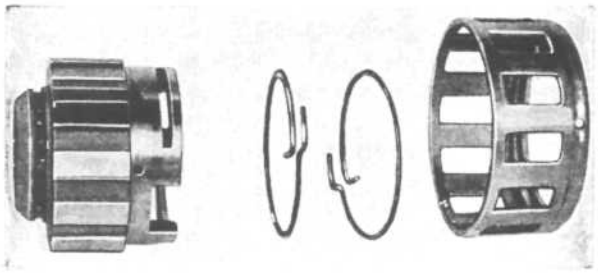


FIG. 200--FREEWHEELING CAM RETAINER

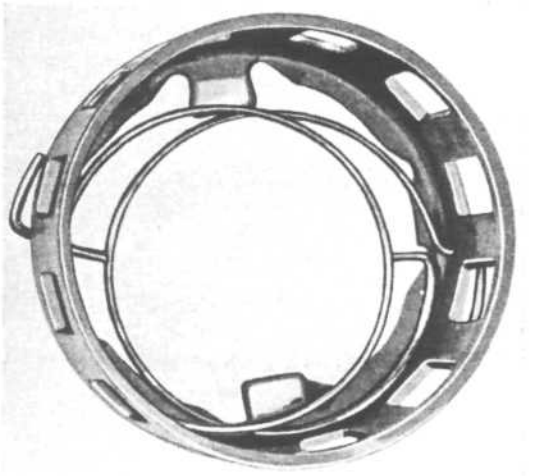


FIG. 201—FREEWHEELING CAM RETAINER WITH SPRINGS ASSEMBLED

p. Examine the freewheeling cam and retainer assembly thoroughly before disassembly. See Fig. 200 and 201. The roller retainer springs (19) place a tension on cam (21), holding the cam in a counterclockwise position when viewing the cam from the rear. Also, the high part of the ramps of the cam are under the roller openings of the retainer, forcing the rollers outward. The hooked ends of the two retainer springs extend to the right (still view from the rear) of the holes in the roller retainer. One of the two holes in the retainer is closer to the forward end of the retainer than the other hole; also, one of the two holes in the cam is closer to the forward end of the cam than the other hole. This keeps the two springs from overlapping each other. The spring that is hooked into the forward hole in the retainer is also hooked into the forward hole of the cam. When disassembling the unit, hold the assembly in the left hand. With the right hand, pull the cam to the rear, stretching the springs until the ends of the springs in the cam

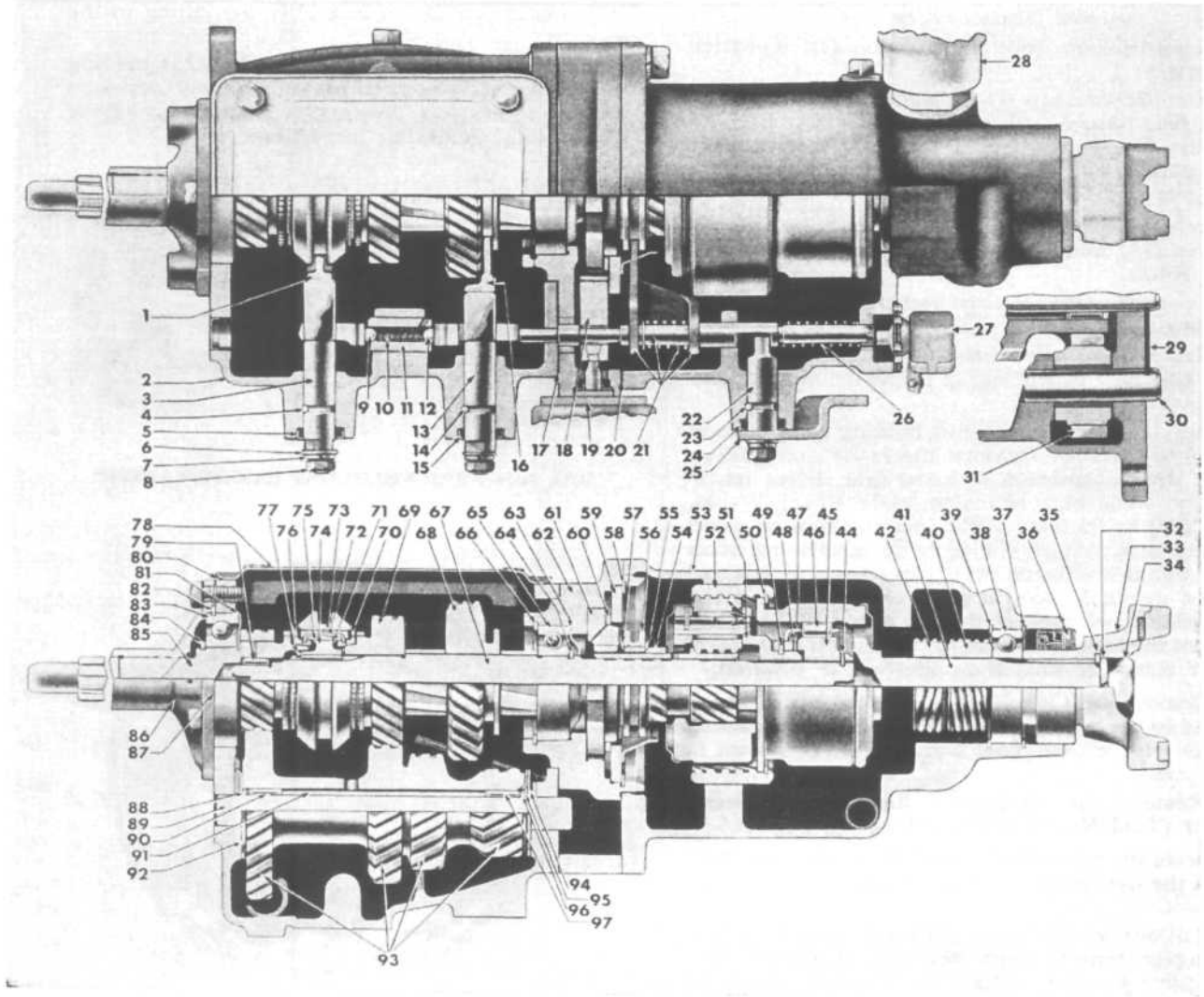


FIG. 202—TRANSMISSION AND OVERDRIVE

1—High and Intermediate Shift Fork
2—Transmission Case
3—Transmission Shift Lever Assembly—High and Intermediate
4—Shift Shaft Tapered Pin
5—Shift Shaft Oil Seal
6—Control Lever Washer
7—Control Lever Lockwasher
8—Control Lever Nut
9—Shift Lever Poppet Ball
10—Shift Lever Poppet Spring
11—Shift Lever Interlock Sleeve
12—Shift Lever Poppet Ball
13—Transmission Shift Lever Assembly—Low and Reverse
14—Shift Shaft Tapered Pin
15—Shift Shaft Oil Seal
16—Low and Reverse Shift Fork
17—Transmission Case Gasket (Adapter to Transmission)
18—Overdrive Sun Gear Pawl
19—Overdrive Solenoid
20—Overdrive Housing Gasket (Overdrive Housing to Adapter)
21—Overdrive Shift Rail and Fork Assembly
22—Overdrive Control Shaft
23—Overdrive Control Shaft Tapered Pin
24—Overdrive Control Shaft Oil Seal
25—Overdrive Control Lever
26—Overdrive Retractor Spring
27—Overdrive Rail Switch
28—Overdrive Governor
29—Reverse Idler and Countershaft Lock Plate
30—Reverse Idler Gear Shaft
31—Reverse Idler Gear Assembly
32—Overdrive Mainshaft Nut Lockwasher
33—Transmission End (Rear) Yoke
34—Overdrive Mainshaft Nut
35—Overdrive Mainshaft Nut Washer
36—Overdrive Mainshaft Oil Seal
37—Mainshaft Bearing Snap Ring
38—Mainshaft Bearing
39—Mainshaft Bearing Snap Ring
40—Speedometer Drive Gear
41—Overdrive Mainshaft Assembly
42—Governor Drive Gear
44—Overdrive Freewheel Cam Retainer Clip
45—Overdrive Freewheel Cam
46—Overdrive Freewheel Roller
47—Overdrive Freewheel Roller Retainer
48—Overdrive Freewheel Roller Retainer Springs
49—Overdrive Freewheel Roller Retainer Clip
50—Overdrive Ring Gear Snap Ring
51—Overdrive Planetary Gear Cage Assembly
52—Overdrive Ring Gear
53—Overdrive Housing
54—Overdrive Sun Gear
55—Overdrive Sun Gear Shift Collar Snap Ring
56—Overdrive Sun Gear Shifting Collar
57—Overdrive Sun Gear Shift Collar Snap Ring
58—Overdrive Cover Plate Snap Ring
59—Overdrive Cover Plate and Trough Assembly
60—Overdrive Sun Gear Balk Ring
61—Overdrive Sun Gear Plate
62—Transmission Overdrive Adapter Housing
63—Transmission Mainshaft Oil Baffle
64—Transmission Mainshaft Bearing
65—Mainshaft Bearing
66—Mainshaft Bearing Snap Ring
67—Transmission Mainshaft
68—Sliding Gear Low and Reverse
69—Mainshaft Second Speed Gear Assembly
70—Synchronizer Blocking Ring
71—Synchronizer Spring
72—Synchronizer Shifting Plate
73—Intermediate and High Clutch Sleeve
74—Intermediate and High Clutch Hub
75—Synchronizer Spring
76—Synchronizer Blocking Ring
77—Transmission Intermediate and High Clutch Hub Snap Ring
78—Transmission Case Cover
79—Mainshaft Pilot Bearing Rollers
80—Transmission Case Cover Gasket
81—Main Drive Gear Baffle
82—Main Drive Gear Bearing Snap Ring
83—Main Drive Gear Bearing
84—Main Drive Gear Snap Ring
85—Transmission Main Drive Gear
86—Main Drive Gear Bearing Retainer
87—Main Drive Gear Bearing Retainer Gasket
88—Countershaft Bearing Spacer—Short
89—Countershaft
90—Countershaft Bearing Roller
91—Countershaft Bearing Spacer, Long
92—Countershaft Thrust Washer, Front (Bronze)
93—Countershaft Gears
94—Countershaft Thrust Washer, Rear (Steel)
95—Countershaft Thrust Washer, Rear (Bronze)
96—Countershaft Bearing Spacer, Short
97—Countershaft Bearing Roller

clear the retainer. Hold the unit in this position with the index finger of the left hand. Unhook the springs from the cam with a small screw driver or needle-nose pliers. Remove the cam and springs.

q. Remove the shift rail and fork (51) and the sun gear (15) by pulling both to the rear.

r. Remove the snap ring (12) from the housing adapter.

s. Remove the cover plate (11) bulk ring and gear plate (10) and stationary gear pawl (Fig. 202, No. 18). The balk ring is a slip fit on the gear plate and can be removed by pulling the ring from the plate hub.

t. Remove the snap ring (2) which holds the housing adapter to the transmission mainshaft bearing. Starting at the left side of the adapter where the snap ring boss is cut away, use a screw driver to work the ring free. See Fig. 203. Pull the adapter to the rear, separating it from the mainshaft bearing by tapping lightly on the rear of the mainshaft with a rawhide hammer.

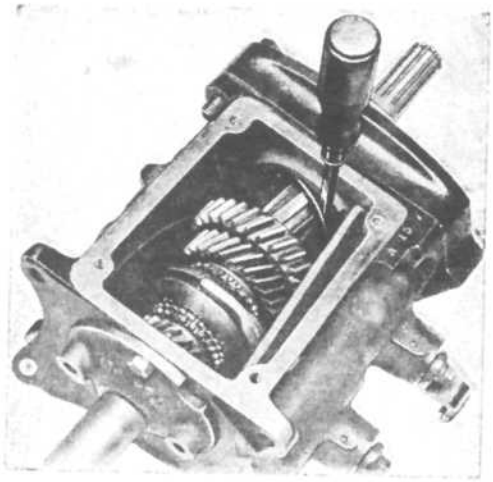


FIG. 203—REAR BEARING SNAP RING

u. Remove oil baffle (4) and gasket (6).

v. Remove the overdrive shift rail retractor spring (50) from the overdrive housing.

w. Remove nut (43) from the overdrive control shaft. Remove the control lever (44). Remove the control shaft (45) through the inside of the overdrive housing.

x. Remove the oil seal (30) from the rear of the overdrive housing.

y. Remove the snap ring (2) from the rear of the overdrive housing. Use a brass drift to tap the bearing out the rear of the housing.

K-22. Overdrive Reassembly

To reassemble the overdrive, reverse the procedure outlined in Par. K-21. The following points of assembly require special attention.

a. The sun gear balk ring, Fig. 204, must have from 3½ to 5½ lbs. [1,58 a 2,49 kg.] running friction (measured on a 1⅝" [16,8 mm.] radius) when mounted on the sun gear plate hub. Replace any parts necessary to obtain this friction. This friction acts as a brake to allow the solenoid panel to engage without gear noise. In the absence of friction a "clunking" noise will occur when the overdrive engages. Eventually the sun gear slot edges may become burred and prevent engagement of the pawl.

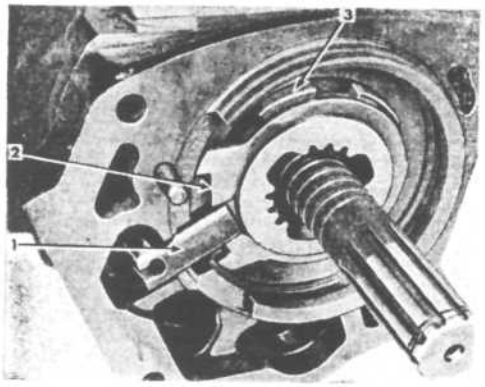


FIG. 204—SOLENOID BALK RING

b. Install the balk ring as shown in Fig. 204. Place the wider flat edge of the ring (Fig. 204, No. 2) toward the top of the transmission which places the inner beveled edge toward the gear plate (3).

c. Install the sun gear pawl (Fig. 204, No. 1) with its grooved edge toward the top of the transmission.

d. Note that the ball end of the solenoid plunger has two flat sides. These flat sides are 35° from the vertical line of the solenoid, making it necessary to turn the solenoid one-quarter turn to engage the plunger with the sun gear pawl. After installing the solenoid, test the engagement of the plunger in the pawl by pulling straight out. If correctly engaged, the pawl will hold the solenoid. Unless the solenoid is correctly installed, the transmission will not shift back to conventional drive when the kickdown switch is pressed. The vent in the solenoid cap should be installed down with the terminals to the rear of the overdrive unit.

e. Use care when assembling the freewheeling cam and retainer assembly. See Fig. 200 and 201 and Par. K-21p. To reassemble, hook the two springs into the retainer, making sure the hooked end points to the right (Fig. 201). Place the retainer on the bench with the open end (rear) up. Make sure the springs are not crossed. Take hold of the free end of the rear spring and stretch it up clear of the retainer, hook the end of the spring into the rear hole in the cam, and let the cam down into the

retainer. Turn the assembly over with the front end up. Work the installed spring over the hub of the cam. Hook the free end of the second spring into its hole in the cam. Obtain clearance to do this by holding the cam down (so it does not pilot into the retainer) and to the side of the retainer opposite the hole. After the spring is hooked, work it down over the cam hub.

f. Use heavy grease to hold the freewheeling rollers in position in the retainer. Place a rubber band around the rollers (Fig. 205) with sufficient tension to drop the rollers into the grooves of the cam. Hold them in position when the retainer is turned to the left. The rollers must be in the grooves and compressed to the smallest possible diameter before the ring gear and mainshaft will pass over the rollers. Leave the rubber band around the rollers and install the ring gear and mainshaft. Oil will dissolve the rubber band.

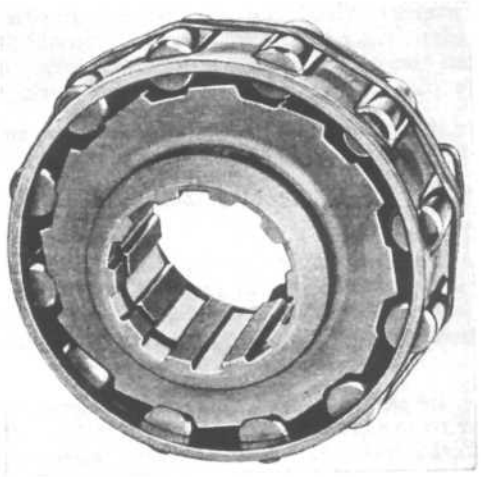


FIG. 205—FREEWHEELING ROLLERS

SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Lock in Two Gears	Adjust Remote Control, Replace Poppet or Shift Levers
Slips Out of High Gear	
Transmission Misaligned with Bell Housing	Align Transmission Case to Bell Housing and Bell Housing to Engine
End Play in Main Drive Gear	Tighten Front Retainer
Damaged Pilot Bearing or Front Bearing	Replace
Slips Out of Second	
Worn Gear	Replace
Weak Poppet Spring	Replace
Noise in Low Gear	
Gear Teeth Worn	Replace Gears
Shifting Shoe Bent	Replace Shoe
Lack of Lubrication	Drain and Refill
Grease Leak into Bell Housing	
Gasket Broken Front Bearing Retainer	Replace
Transmission Main Drive Gear Oil Seal	Replace
No overdrive operation	Fuse blown in relay to solenoid circuit (Circuit "C" Fig. 198). Replace fuse.
	Open circuit in relay control circuit (Circuit "A" Fig. 198). Turn on ignition switch and be sure circuit is "hot" to governor terminal. If not check entire circuit "A" including wires, relay, kickdown switch and rail switch for open circuit.
Will not shift into overdrive automatically	Faulty governor which will not make contact. Replace. Faulty relay or solenoid. Replace. Overdrive pawl stuck or binding in adapter plate housing. Free up.
Relay clicks at idle speeds or as soon as ignition is turned on. Vehicle in overdrive from standing start. Impossible to shift into reverse. Impossible to pull out of overdrive control plunger. Impossible to tow or push car.	Short or ground in relay control circuit (Circuit "A" Fig. 198). Check wiring, relay, kickdown switch, rail switch, and governor for short or ground. Faulty governor. Replace. Faulty relay or solenoid. Replace.
Transmission will not return to conventional drive when accelerator is pressed to floor board.	Improperly adjusted or faulty kickdown switch. Adjust or replace. Faulty solenoid. Replace. Short or broken wire in circuit "B", Fig. 198. Repair. Stationary gear pawl binding or seized in adapter housing. Free up.
Heavy "thud" heard in transmission when accelerator is pushed to floor board (kickdown switch operated).	Overdrive solenoid plunger not engaged in stationary gear pawl due to improper assembly.
"Clunking" noise in transmission when overdrive engages.	Insufficient friction between balk ring and stationary gear plate hub. Replace balk ring.
Overdrive will not engage or disengage at proper speed.	Improperly operating governor. Replace.

TRANSMISSION SPECIFICATIONS

MODEL:	L6-226 4WD and 4x4	L6-226 4x2
Transmission:		
Make	Warner	Warner
Model	T-90-J	T-86
Type	Synchronous Mesh	Synchronous Mesh
Mounting	Unit Power Plant	Unit Power Plant
Shift Lever Location	Floor	Steering Post
Speeds	3 Forward, 1 Reverse	3 Forward, 1 Reverse
Ratios: — Low	2.798:1	2.571:1
— Second	1.551:1	1.550:1
— High	1.000:1	1.000:1
— Reverse	3.798:1	3.489:1
Overdrive:		
Make	.....	Warner
Model (Trans. with O.D.)	.....	T86E-R10B
Type	.....	Planetary
Cut-in Speed — Min.	.....	24 mph. [38,4 kph.]
Ratio	.....	0.7:1
Bearings:		
Clutch Shaft (Crankshaft)	I.D. .631" [16,02 mm.] Bushing	I.D. .631" [16,02 mm.] Bushing
Clutch Release	Ball	Ball
Clutch Shaft Rear (Front Trans.)	Ball	Ball
Mainshaft Front	Roller	Roller
Mainshaft Rear	Ball	Ball
Overdrive Mainshaft Rear	.....	Ball
Countershaft Gear	Roller	Roller
Reverse Idler Gear	Bushing	Bushing

MODEL:	F4-134 4WD and 4x4	F4-134 4x2
Transmission:		
Make	Warner	Warner
Model	T-90	T-96
Type	Synchronous Mesh	Synchronous Mesh
Mounting	Unit Power Plant	Unit Power Plant
Shift Lever Location	Floor	Steering Post
Speeds	3 Forward, 1 Reverse	3 Forward, 1 Reverse
Ratios: — Low	2.798:1	2.605:1
— Second	1.551:1	1.630:1
— High	1.000:1	1.000:1
— Reverse	3.798:1	3.536:1
Overdrive:		
Make	.....	Warner
Model (Trans. with O.D.)	.....	T96-R10B
Type	.....	Planetary
Cut-in Speed — Min.	.....	26 mph. [41,6 kph.]
Ratio	.....	0.7:1
Bearings:		
Clutch Shaft (Flywheel)	I.D. .628" [15,95 mm.] Bushing	I.D. .628" [15,95 mm.] Bushing
Clutch Release	Ball	Ball
Clutch Shaft Rear (Front Trans.)	Ball	Ball
Mainshaft Front	Roller	Roller
Mainshaft Rear	Ball	Ball
Overdrive Mainshaft Rear	.....	Ball
Countershaft Gear	Roller	Roller
Reverse Idler Gear	Bushing	Bushing

TRANSFER CASE

Contents

SUBJECT	PAR.
Front Bearing Cap	L-4
Rear Bearing Cap	L-5
Transfer Case — Disassembly	L-3
— Installation	L-7
— Overhaul	L-6
— Removal	L-2

L-1. GENERAL

The transfer case used in all 4-wheel-drive vehicles is shown in Figs. 206 and 207.

The transfer case is essentially a two speed transmission located at the rear of the standard transmission which provides a low and direct gear also a means of connecting the power to the front axle. The shifting mechanism is located on the transfer case.

On hard surface and level roads, disengage the front axle drive placing transfer case left shift lever in forward position. The right hand lever controls the gear ratio; low and high. Low gear can only be engaged when the left hand lever is in the engaged (rear) position for front drive.

L-2. Removal of Transfer Case

The transfer case may be removed from the vehicle without removing the transmission. Proceed as follows:

a. Drain transmission and transfer case and replace drain plugs.

b. Disconnect the hand brake return spring, front control cable and equalizer adjusting rod from the hand brake lever.

c. Disconnect front and rear propeller shafts at the transfer case. See Section M.

d. Disconnect speedometer cable at transfer case.

e. Remove floor board inspection plate.

f. Remove transfer case shift lever pivot pin screw.

1—Output Clutch Shaft
2—Output Clutch Shaft Bearing
3—Output Clutch Shaft Bearing Snap Ring
4—Output Shaft Bearing Cup
5—Output Shaft Bearing Cone and Roller
6—Output Shaft Gear
7—Output Shaft Sliding Gear
8—Oil Filler Plug
9—Speedometer Drive Gear
10—Output Shaft
11—Output Shaft Oil Seal
12—Speedometer Driven Pinion
13—Output Shaft Bearing Shims
14—Intermediate Shaft
15—Intermediate Gear Thrust Washer
16—Intermediate Gear
17—Main Shaft Gear
18—Intermediate Shaft Bearings
19—Output Shaft Clutch Gear
20—Output Clutch Shaft Pilot Bushing
21—Companion Flange Front

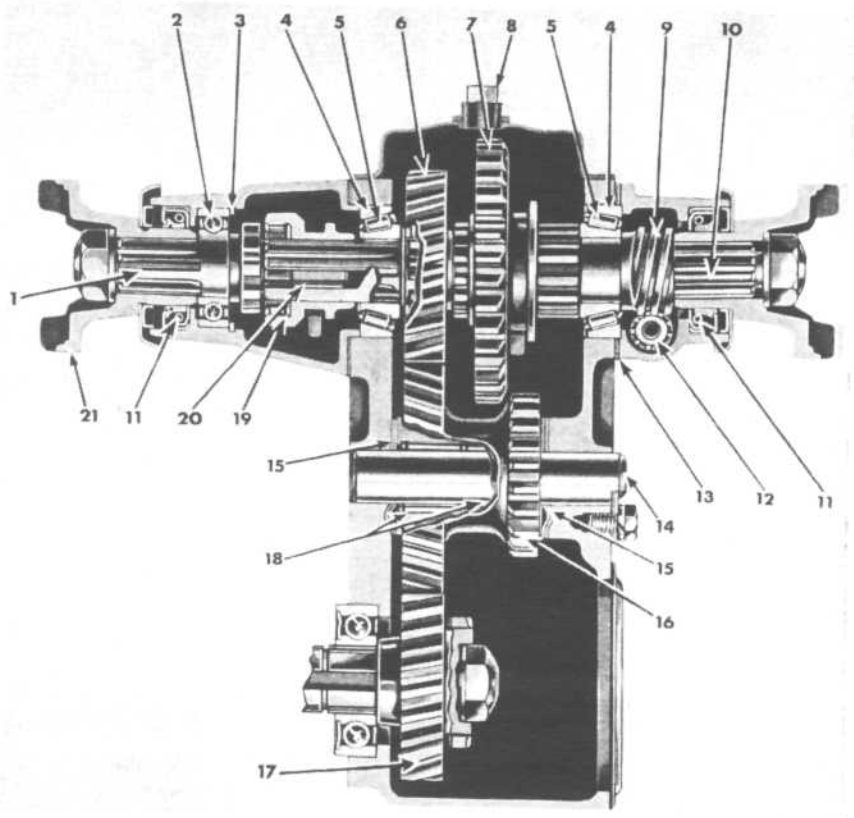


FIG. 206—TRANSFER CASE

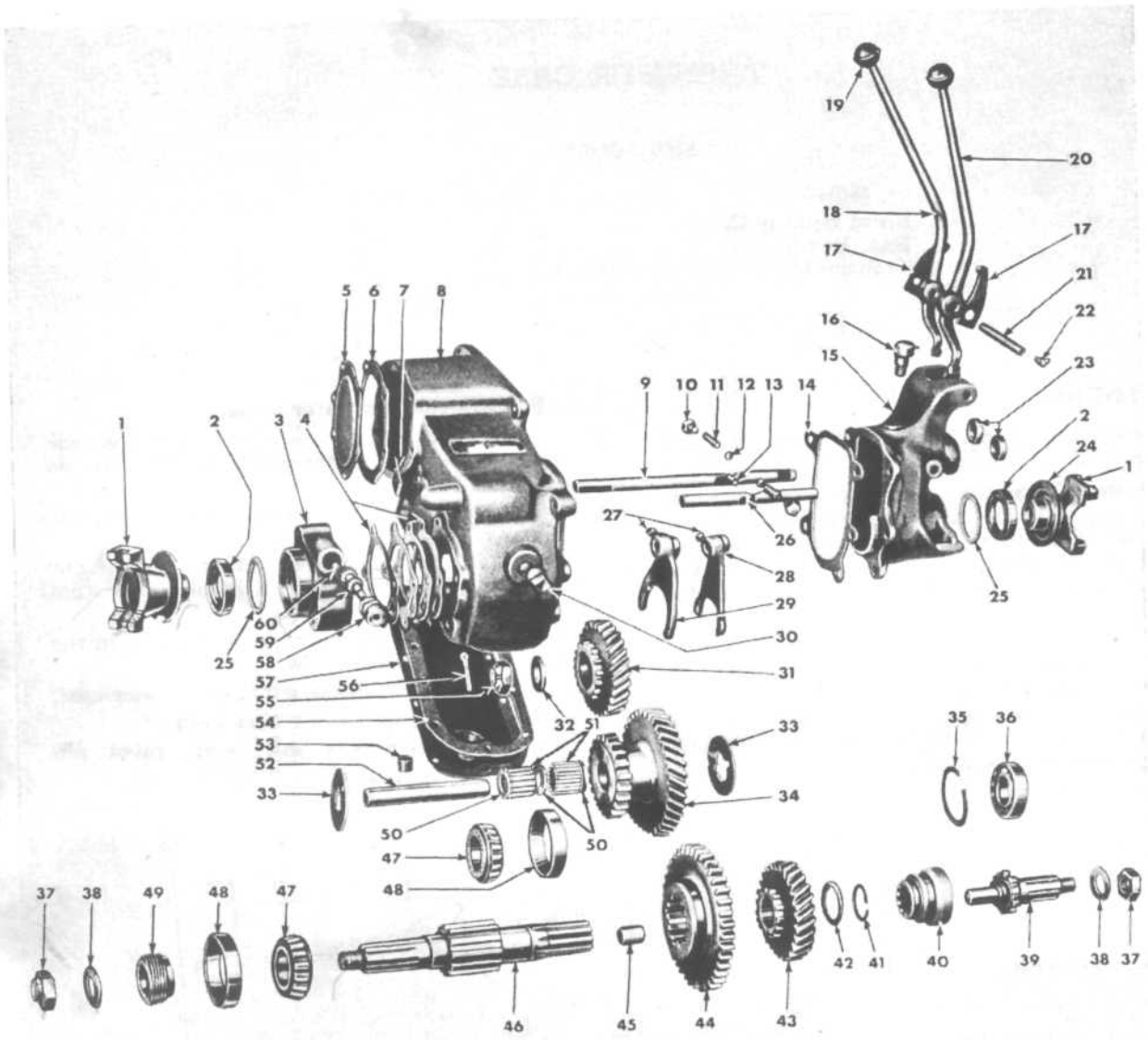


FIG. 207—TRANSFER CASE—4-WHEEL-DRIVE VEHICLES

1. Output Shaft Yoke End
2. Output Shaft Oil Seal
3. Rear Bearing Cap
4. Rear Bearing Adjusting Shims
5. Rear Cover
6. Rear Cover Gasket
7. Lock Plate
8. Transfer Case Housing
9. Underdrive and Direct Shift Rod
10. Poppet Plug
11. Poppet Spring
12. Poppet Ball
13. Shift Rod Interlock
14. Front Bearing Cap Gasket
15. Front Bearing Cap
16. Breather
17. Shift Lever Spring
18. Under Drive Shift Lever
19. Shift Lever Ball
20. Front Wheel Drive Shift Lever
21. Shift Lever Pivot Pin
22. Hydraulic Fitting
23. Oil Seal
24. Dust Shield
25. Oil Seal Gasket
26. Front Wheel Drive Shift Rod
27. Set Screw
28. Front Wheel Drive Shift Fork
29. Underdrive Shift Fork
30. Filler Pipe
31. Main Drive Gear
32. Main Shaft Washer
33. Thrust Washer
34. Intermediate Gear
35. Snap Ring
36. Clutch Shaft Bearing
37. Output Yoke Nut
38. Output Yoke Washer
39. Output Clutch Shaft
40. Clutch Gear
41. Output Shaft Snap Ring
42. Thrust Washer
43. Output Shaft Gear
44. Output Shaft Sliding Gear
45. Output Shaft Pilot Bushing
46. Output Shaft
47. Output Shaft Bearing Cone and Rollers
48. Output Shaft Bearing Cup
49. Speedometer Drive Gear
50. Intermediate Gear Bearing Spacers
51. Intermediate Gear Bearing
52. Intermediate Shaft
53. Drain Plug
54. Bottom Cover Gasket
55. Output Shaft Nut
56. Cotter Pin
57. Bottom Cover
58. Speedometer Gear Sleeve
59. Speedometer Driven Gear
60. Speedometer Driven Gear Bushing

g. Remove transfer case shift lever pivot pin and remove levers. If vehicle is equipped with power take-off remove shift lever plate screws and lift out lever.

h. Remove cover plate on rear face of transfer case. Remove cotter key, nut and washer from transmission mainshaft.

i. If possible, at this point remove the transfer case main drive gear from the transmission mainshaft. If not possible, see step 1 below.

j. Remove transfer case mounting bracket bolt and nut.

k. Remove transmission-to-transfer case bolts.

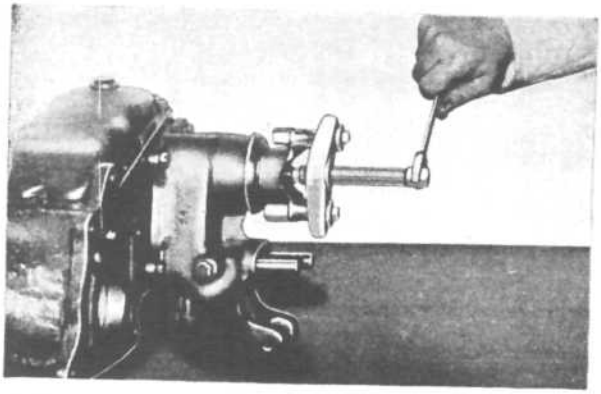


FIG. 208—UNIVERSAL JOINT FLANGE PULLER

l. Remove transfer case. If the transfer case main drive gear has not been removed in step i above, proceed as follows: Brace the end of the transmission mainshaft so that it cannot move in the transmission, pull the transfer case to the rear to loosen the gear and remove the gear. When separating the two housings, use care that the transmission mainshaft bearing, which bears in both housings, remains in the transmission case.

L-3. Transfer Case Disassembly

To remove the gears and bearings from the transfer case on the bench, the following procedure is recommended:

a. Remove the propeller shaft flange nut, No. 37, and washer and remove the flange with puller, Tool No. W-172 as shown in Fig. 208.

b. Remove lower cover screws and lock washers and remove the cover, No. 57, Fig. 207.

c. Remove lock plate screw, lock washer and lock plate, No. 7.

d. Use a brass punch to drive out intermediate shaft, No. 52, to the rear of the case. Do not lose the thrust washers which are assembled at each end of the gear shaft.

e. Remove intermediate gear, No. 34, with thrust washers, No. 33, and needle bearings, No. 51, through the bottom of the case.

f. Remove poppet plugs, No. 10, springs, No. 11, and balls, No. 12, on both sides of output bearing cap, No. 15. Shift front wheel drive to engaged position (shaft forward).

g. Remove screws holding front output bearing cap and remove the cap as an assembly. This will include the universal joint end yoke, clutch shaft, bearing, clutch gear, fork and shift rod. Use care not to lose the interlock, No. 13, which floats between the shift rods.

h. Remove the screws holding the rear output bearing cap, No. 3, and remove the cap as an assembly with the speedometer gear.

i. Use a rawhide hammer to drive against the front end of the main shaft to start the rear bearing from the case. Use Tool No. W-139



FIG. 209—BEARING CONE REMOVING WEDGE

as shown in Fig. 209, to wedge the front bearing from its seat on the shaft. Loosen snap ring, No. 42, and slide it forward on the shaft. Place Tool No. W-141 against the rear bearing as shown in Fig. 210, and drive the shaft on through the case to remove the rear bearing. As the shaft is removed the gears will remain in the case and can be removed from the bottom, also the snap ring and thrust washer.

j. Remove set screw in sliding gear shift fork, No. 28. This will allow the shift rod to be removed.

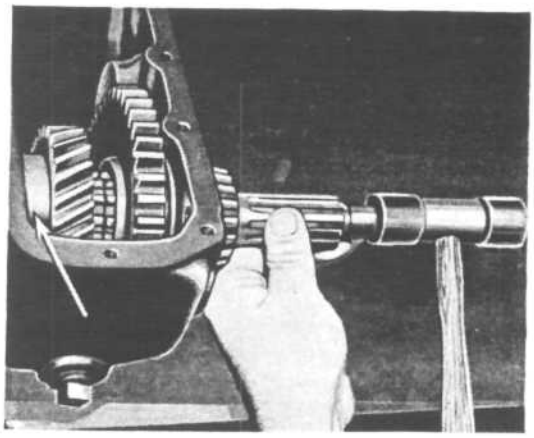


FIG. 210—BEARING CUP REMOVING RING

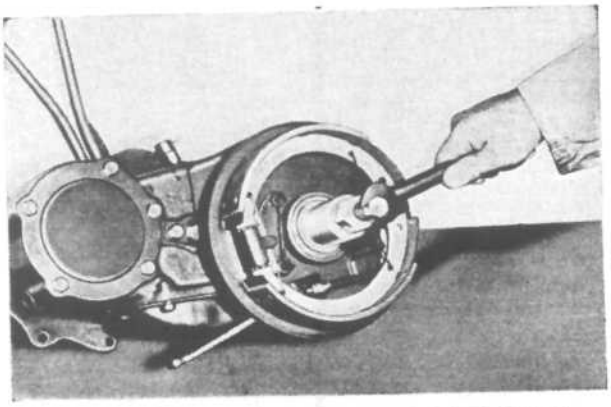


FIG. 211—OUTPUT SHAFT OIL SEAL PULLER

L-4. Dismantling Front Bearing Cap

a. Remove cotter pin, nut and washer which attach the universal joint yoke.

b. Remove the universal joint yoke with puller Tool No. W-172 as shown in Fig. 208.

c. Remove oil seal, No. 2, with Tool No. W-165 as shown in Fig. 211.

d. Remove set screw from shift fork, No. 29, and the shifting rod.

e. Clutch gear, No. 40, and fork, No. 28, can now be removed together.

f. Remove output clutch shaft, No. 39, carefully pressing it through the bearing.

g. Remove bearing retaining snap ring.

h. Remove the bearing assembly.

i. Remove the transfer case shift rod oil seal with Tool No. W-176 as shown in Fig. 212.

Note that the front cap is a separate assembly which may be removed for service should difficulty be experienced in this section of the transfer case.

L-5. Dismantling of Rear Cap Assembly

When dismantling the transfer case assembly the rear bearing cap is disassembled with the exception of the removal of the oil seal. This cap is, however, a separate assembly which may be removed for service. Follow the sequence below for removal.

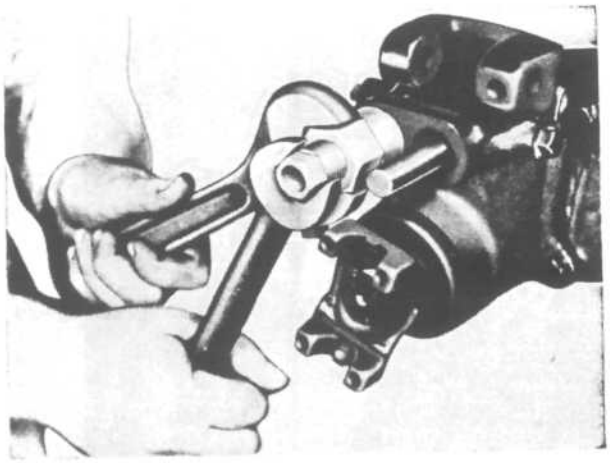


FIG. 212—SHIFT ROD OIL SEAL PULLER

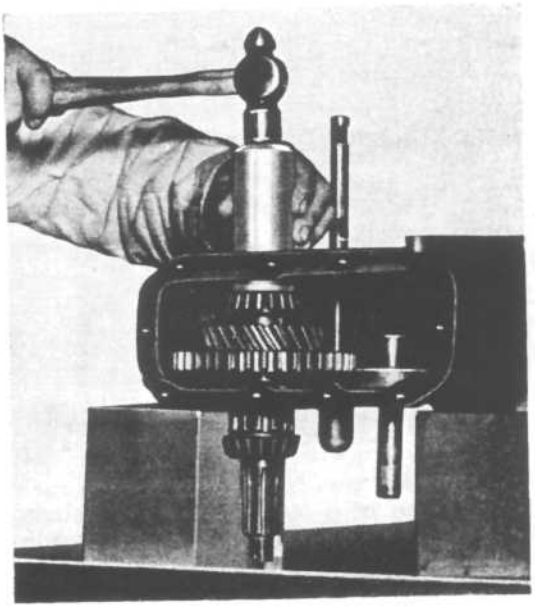


FIG. 213—BEARING CONE DRIVER

a. Remove the cotter pin, nut and washer which retain the universal joint companion flange.

b. Remove the universal joint companion flange.

c. Remove the oil seal with Tool No. W-165 as shown in Fig. 211.

d. Remove the speedometer driven pinion.

e. Remove the cap screw attaching the cap and remove the cap. Guard against losing or damaging the bearing adjusting shims placed between the cap and the transfer case housing.

f. Remove the speedometer driving gear.

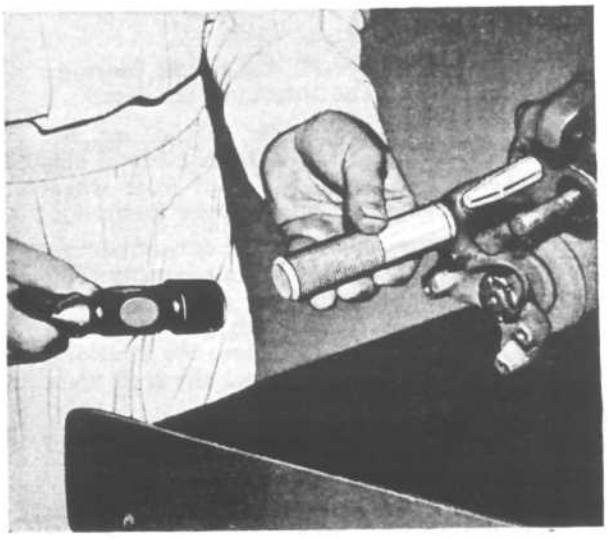


FIG. 214—SHIFT ROD OIL SEAL INSTALLER

L-6. Transfer Case Overhaul

Reassembly of the transfer case is a reversal of the foregoing routine of disassembly.

Use special bearing driver, Tool No. W-134, Fig. 213, for installation of the output shaft tapered cone and rollers. When installing the shift rail oil seals in the front bearing cap, it is necessary to protect the seals as they will be damaged when passing over the shift rail notches. Protect them with the

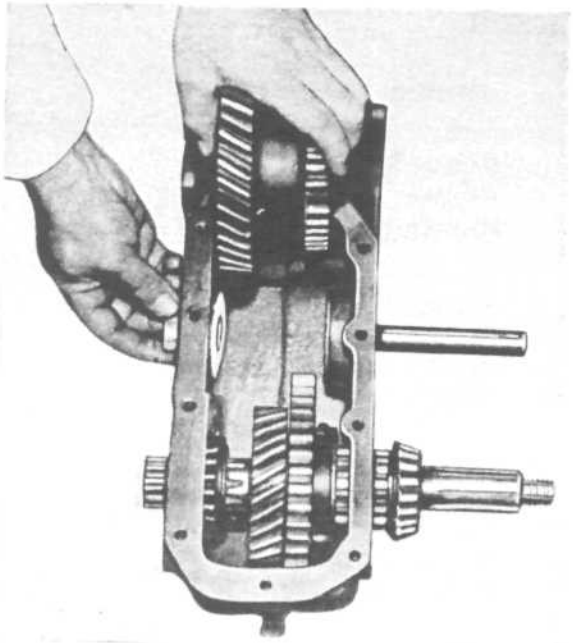


FIG. 215—THRUST WASHER PILOT

thimble, Fig. 214, and install them with driver, Tool No. W-130, Fig. 214. When installing the intermediate gears, support the thrust washer with pilot pin, Tool W-192, Fig. 215. This tool correctly locates the thrust washer before the gear assembly is positioned.

The output shaft gear snap ring may best be installed with Tool No. W-131, output shaft snap ring installing thimble and drive, Fig. 216. Should it be

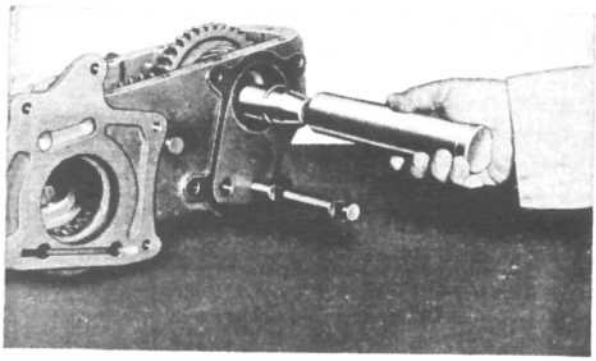


FIG. 216—OUTPUT SHAFT SNAP RING INSTALLER

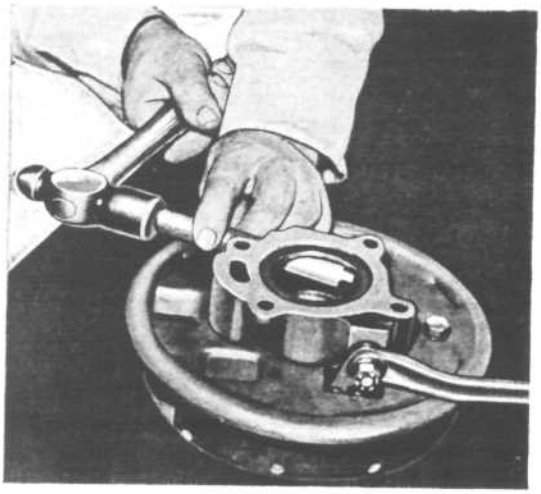


FIG. 217—SPEEDOMETER PINION BUSHING DRIVER

necessary to replace the speedometer driven pinion bushing, installation may best be made with bushing installer Tool No. W-133, Fig. 217.

When the rear bearing cap assembly is installed, check the end movement of the main shaft which determines the adjustment of the tapered roller bearings. For correct bearing adjustment the shaft should have .004″ – .008″ (.102 – .203 mm.) end play. Adjustment is made by selective shim installation between the cap and the case. Shims .003″, .010″ and .031″ (.076, .254, .787 mm.) in thickness are available for this adjustment. Do not install the rear cap oil seal until the bearings are correctly adjusted. Both the front and rear oil seals may be installed with oil seal driver Tool No. W-143, as shown in Fig. 218. When installing the end yokes on the output shafts, inspect for the presence of felt seals in each oil seal guard. (The oil seal guard is a part of each yoke assembly.) Felt seals should be installed in the oil seal guards if they are not present.

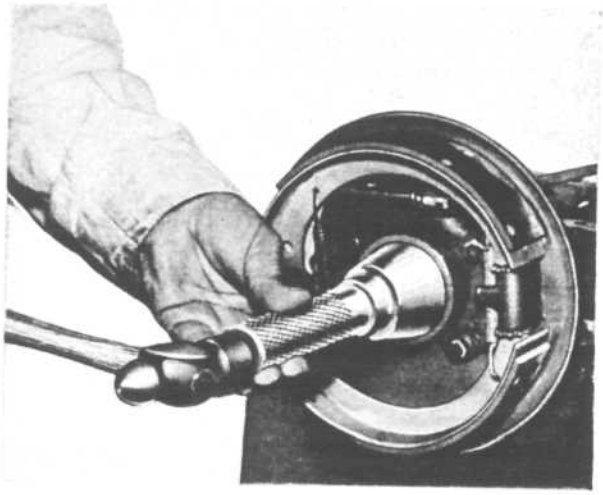


FIG. 218—OUTPUT SHAFT OIL SEAL DRIVER

L-7. Transfer Case Installation

The installation of the transfer case in the vehicle is covered in Section K.

Lubricate the pilot bearing in the flywheel and also lubricate the transmission and transfer case as outlined in the "Lubrication" section. Be sure that the clutch pedal has 1" [25.4 mm.] free travel as outlined in the "Clutch" section.

NOTE: On Model F4-134 4x4 there is a possibility of the engine striking the floor pan or dash when pulling at low engine speeds or on deceleration in low gear. This condition can be corrected, if objectionable, by installation of the transfer case snubber as used on Model F4-134 4WD.

SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Slips Out of Gear (High-Low)	
Shifting Lock Spring Weak	Replace Spring
Bearing Broken or Worn	Replace
Shifting Fork Bent	Replace
Slips Out Front Wheel Drive	
Shifting Lock Spring Weak	Replace
Bearing Worn or Broken	Replace
End Play in Shaft	Adjust
Shifting Fork Bent	Replace
Hard Shifting	
Lack of Lubricant	Drain and Refill
Shift Lever Stuck on Shaft	Remove, Clean and Lubricate
Shifting Lock Ball Scored	Replace Ball
Shifting Fork Bent	Replace Fork
Low Tire Pressure	Inflate
Grease Leak at Front or Rear Drive	
Grease Leak at Covers	Install New Gaskets
Grease Leak between Trans. and Transfer Cases	Install New Gaskets
Grease Leak at Output Shaft	Install New Oil Seal

TRANSFER CASE SPECIFICATIONS

Transfer Case:	
Make	Spicer
Model	18
Mounting	Unit with Transmission
Shift Lever	On Floor
Ratio	High 1:1 Low 2.46:1
Transfer Case Bearings:	
Transmission Mainshaft	Ball
Idler Gear	2 Roller
Output Shaft	2 Tapered Roller
Front Axle Clutch Shaft:	
Front Bearing	Ball
Rear Pilot in Output Shaft	Bronze Bush. I.D. .627" [15.93 mm.]
Speedometer Drive:	
Drive Gear Teeth	4
Driven Pinion Teeth	15

PROPELLER SHAFTS AND UNIVERSAL JOINTS

Contents

SUBJECT	PAR.
Propeller Shafts	M-1
Universal Joints	
Ball and Trunnion Type	M-2
Needle Bearing and Trunnion Type	M-3
Snap Ring Type — Assembly	M-5
— Disassembly	M-4
U-Bolt Type — Assembly	M-7
— Disassembly	M-6

M-1. GENERAL

The drive from the transmission to the rear axle on 2-wheel-drive vehicles and from the transfer case to the front and rear axles on 4-wheel-drive vehicles is through tubular propeller shafts, each shaft equipped with a universal joint at each end.

All vehicles except early production F4-134 4x2 vehicles have cardan cross (needle bearing) universal joints. Early production F4-134 4x2 vehicles were equipped with ball-and-trunnion universal joints.

M-2. Ball and Trunnion Universal Joint

Sequence of disassembly and assembly of this joint is shown in Fig. 220. First remove the body grease cover, No. 1, by bending back the tongues crimped over the housing flange and remove the compensating spring, No. 3. Push the housing back toward the center of the propeller shaft to expose the centering buttons, the trunnion pin, the balls and the needle bearings. When the centering buttons are removed guard against losing the spring washers which are assembled underneath. When replacing the trunnion pin, use a tool as shown in Fig. 223.

This type joint should be lubricated approximately each 20,000 miles (32,000 km.) of service by disassembling and repacking. Guard against installing too much grease or the action of the trunnions will damage the leather or rubber dust cover and also prevent proper movement of the propeller shaft against the compensating springs which are provided to control the end float of the shaft caused by the vehicle spring action. Do not pack each joint more than one-half full of lubricant.

M-3. Needle Bearing and Trunnion Universal Joint

Each shaft is equipped with a splined slip joint at one end to allow for variations in length caused by vehicle spring action. Some slip joints are marked with arrows at the spline and sleeve yoke, Fig. 224. When installing, align the arrows in the same plane. If unmarked with arrows, align the yokes at the front and rear of the shaft in the same parallel plane. This is necessary to avoid vibration.

All the universal joints of this type used are similar in construction except that some are of the "U"-bolt type and others of the "Snap Ring"-type. This difference is in the attachment of the joints only and is obvious.

These universal joints have needle bearings and are so designed that correct assembly is a very simple matter. No hand fitting or special tools are required, however, installation of the needle bearings is much easier if Tool No. W-148, Fig. 225, is used.

The journal trunnion and needle bearing assemblies are the only parts subject to wear and when it becomes necessary to replace these parts, the propeller shaft must be removed from the vehicle.

M-4. Dismantling of Snap Ring Type

The snap ring type joint is illustrated in Fig. 222. To remove the snap rings, pinch the ends together with a pair of pliers. If the rings do not readily snap out of the groove, tap the end of the bearing lightly which will relieve pressure against the rings. After removing the snap rings, press on the end of one bearing until the opposite bearing is pushed from the yoke arm. Turn the joint over and press the first bearing back out of that arm by pressing on the exposed end of the journal shaft. If Tool No. W-148 is not available use a soft ground drift with a flat face about $\frac{1}{32}$" (.794 mm.) smaller in diameter than the hole in the yoke arm and drive it out, otherwise there is danger of damaging the bearing.

Repeat this operation for the other two bearings, then lift out journal assembly by sliding it to one side.

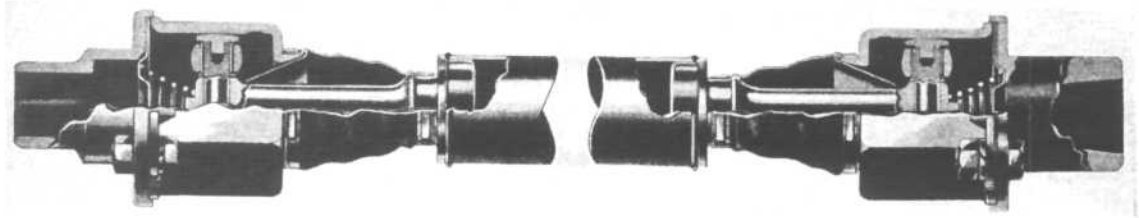


FIG. 219 — PROPELLER SHAFT AND UNIVERSAL JOINTS—BALL AND TRUNNION TYPE

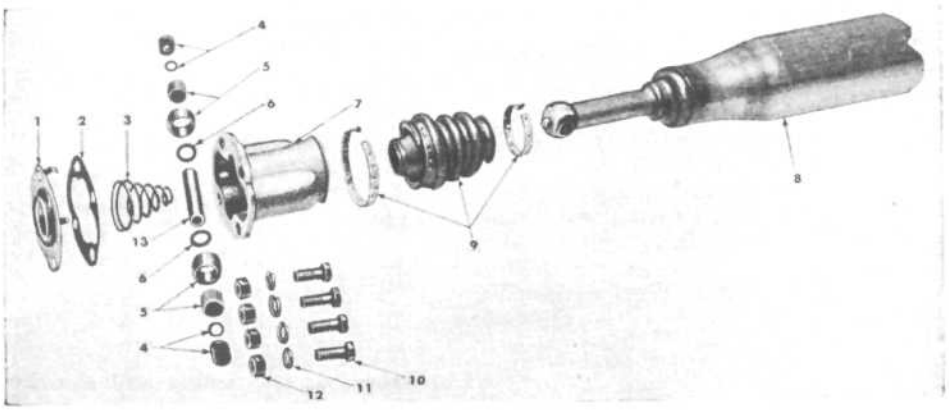


FIG. 220—PROPELLER SHAFT AND UNIVERSAL JOINT—BALL AND TRUNNION TYPE

1. Grease Cover
2. Universal Body Gasket
3. Compensating Spring
4. Spring and Button
5. Ball and Roller
6. Thrust Washer
7. Universal Joint Body
8. Propeller Shaft Tube
9. Dust Cover
10. Flange Bolt
11. Lockwasher
12. Nut
13. Trunnion Pin

M-5. Reassembling of Snap Ring Type

Reassembly is merely a reversal of the dismantling operation.

Wash all parts in cleaning solution and replace new parts for any that show wear. Make sure that the grease channel in each journal trunnion is open. It is advisable to install new gaskets, No. 4, Fig. 222, on the journal assembly. Fill the bearing races about one-third full of lubricant and install the rollers. If Special Tool No. W-148 is not available hold the bearings in a vertical position to prevent needles from dropping out when assembling the joint. When assembled, if joint appears to bind, tap the arms lightly with a hammer which will relieve any pressure on the bearings at the end of the journal.

M-6. Dismantling of "U"-Bolt Type

Removal of the attaching "U"-bolt releases one set of bearing races. Slide the propeller shaft into the yoke flange to remove them using care not to lose the rollers.

After the removal of the one set of bearing races, release the other set by removing the snap rings in the sleeve yoke by pinching the ends together with a pair of pliers. Should the rings fail to snap

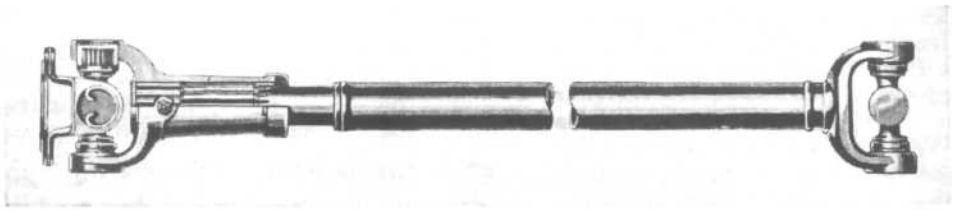


FIG. 221 — PROPELLER SHAFT AND UNIVERSAL JOINTS—NEEDLE BEARING TYPE

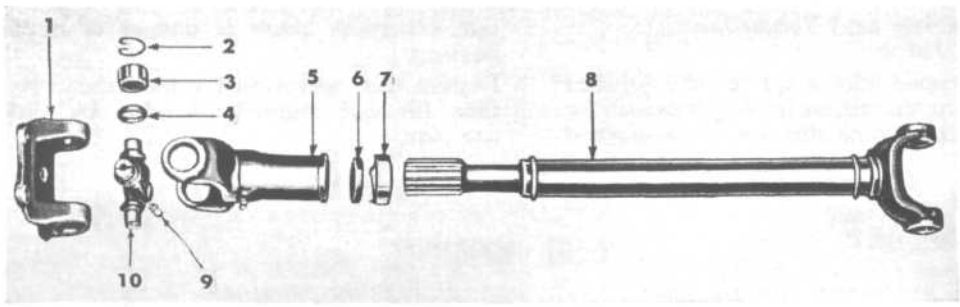


FIG. 222—PROPELLER SHAFT AND UNIVERSAL JOINTS—NEEDLE BEARING TYPE

1. Universal Joint Flange Yoke
2. Universal Joint Bearing Snap Ring
3. Universal Joint Bearing Race
4. Trunnion Gasket
5. Universal Joint Sleeve Yoke Assem.
6. Cork Washer
7. Dust Cap
8. Propeller Shaft Tube Assembly
9. Hydraulic Fitting
10. Universal Joint Journal Assembly

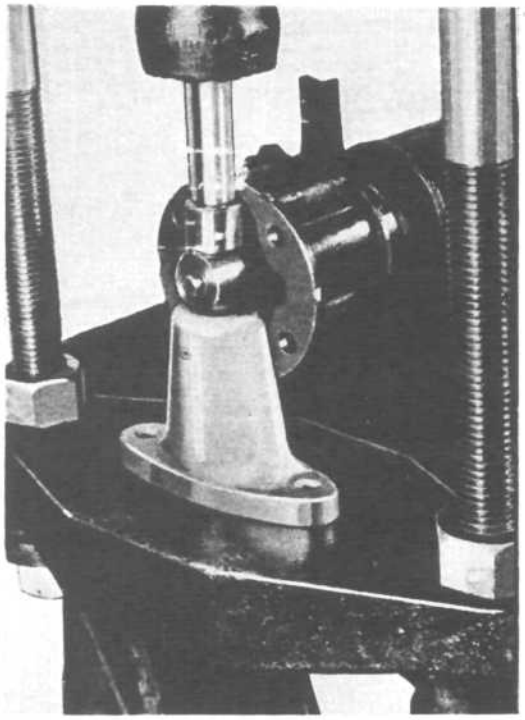


FIG. 223—UNIVERSAL JOINT PIN REMOVER AND REPLACER

readily from the groove, tap the end of the bearing lightly, which will relieve the pressure against them. Press on the end of one bearing, until the opposite bearing is pushed out of the yoke arm. Turn the universal joint over and press the first bearing out by pressing on the exposed end of the journal assembly. Should Tool No. W-148 be unavailable use a soft ground drift with a flat face about 1/32" (.794 mm.) smaller in diameter than the hole in the yoke arm and drive out the bearing. Lift the journal out by sliding to one side. Clean all parts and check for wear.

M-7. Reassembling of "U"-Bolt Type

Reassembling is merely a reversal of dismantling operation.

Make sure that the grease channel in each journal trunnion is open. It is advisable to install new gaskets, No. 4, Fig. 222, on the journal assembly. Fill the bearing races about one-third full of lubricant and install the rollers. The bearing races must be held in a vertical position to prevent the needles from dropping out when installing in the joint.

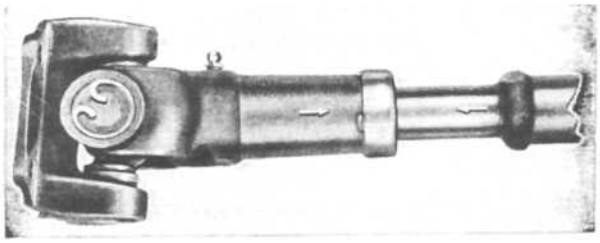


FIG. 224—ARROW MARKINGS

When assembled, if joint appears to bind, tap the arms lightly with a hammer which will relieve any pressure on the bearings at the end of the journal.

When assembling the bearings into the end yoke arm, the use of Tool No. W-148 over the extreme ends of the bearing races will draw the bearings into correct position and greatly facilitate seating them against the bearing shoulders in the end yoke. When installing the assembly in the vehicle be sure that the arrows on the propeller shaft and yoke sleeve are in alignment. Tighten the "U"-bolts equally. "U"-bolt torque wrench reading is 15–18 ft. lbs. (2.07 – 2.49 kg.-m.)

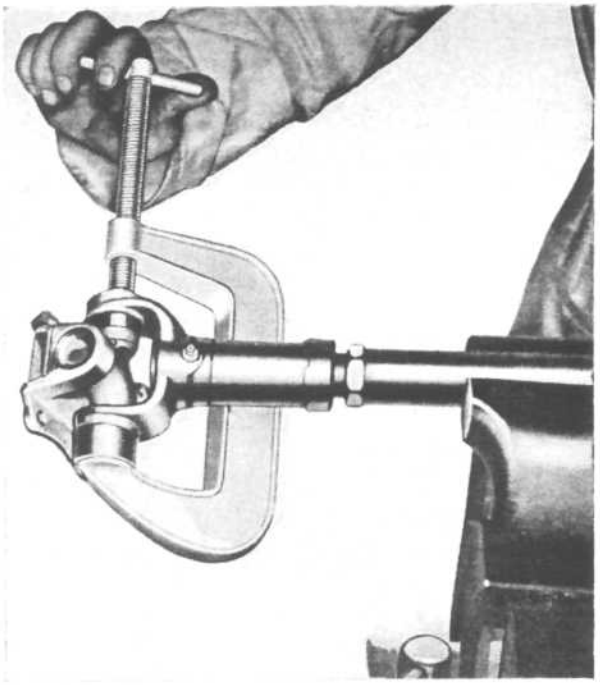


FIG. 225—UNIVERSAL JOINT BEARING CLAMP

SPECIFICATIONS

PROPELLER SHAFTS AND UNIVERSAL JOINTS

MODEL:	L6-226 4WD F4-134 4WD	L6-226 4x4 F4-134 4x4
Propeller Shaft:		
Make	Spicer	Spicer
Tube Diameter — Front	1¼" [3,17 cm.]	1¼" [3,17 cm.]
Tube Diameter — Rear	3" [7,62 cm.]	2" [5,08 cm.]
*Length — Front	22 1/16" [56,03 cm.]	22 1/16" [56,03 cm.]
*Length — Rear	54 23/32" [139,14 cm.]	41 5/8" [105,72 cm.]
MODEL:	L6-226 4x2	F4-134 4x2
Propeller Shaft:		
Make	Spicer	Spicer
Tube Diameter	2" [5,08 cm.]	2" [5,08 cm.]
*Length	35 25/32" [90,88 cm.]	40 9/16" [103,3 cm.]

Universal Joints	All Current Models**
Make	Spicer
Type	Snap Ring**
Bearings	Needle Rollers**

*Collapsed length. Measure between universal joint centers.
**See Par. M-1.

FRONT AXLE

Contents

SUBJECT	PAR.	SUBJECT	PAR.
4-Wheel-Drive Axles		Turning Angle	N-14
Differential Overhaul	N-11	Universal Joints	N-4
Overhaul and Adjustment	N-3	Elliot Type Axles	N-2
Steering Knuckle Oil Seal	N-10	Planar Type Suspension	N-13
Steering Knuckle Pivot Pins	N-7		

N-1. GENERAL

The front axle used on Model L6-226 4x2 and late production Model F4-134 4x2 is of the reverse Elliot type. The steering knuckles are mounted on pivot pins which pass through openings at each end of the I-beam and are locked securely in position by a tapered pin and nut. The knuckles ride on ball thrust bearings for ease of steering.

Early production F4-134 4x2 vehicles were equipped with Planer-type independent front suspension.

The reverse Elliot type steering knuckles are supported at the bottom by a "Dow" type transverse spring with the second leaf double wrapped at the spring eye for safety, and, at the top by brackets pivoted at the frame. Pivot pins are securely locked in the steering knuckles with tapered pins and the vehicle load is carried on ball bearings for ease of steering.

All 4-wheel drive models employ a live driving unit with hypoid type driving gears and spherical steering knuckles mounted on pivot pins which ride on tapered roller bearings for ease of steering. The drive is of the full floating type through axle shafts built integrally with universal joints which revolve in the steering knuckles.

On 4-wheel-drive models, the steering knuckle tie rod arm is integral with the steering knuckle. On Elliot-type axles, the arm is held securely in a tapered socket with heavy nut and cotter pin. On vehicles with Planar-type suspension, the arm is bolted to the knuckle.

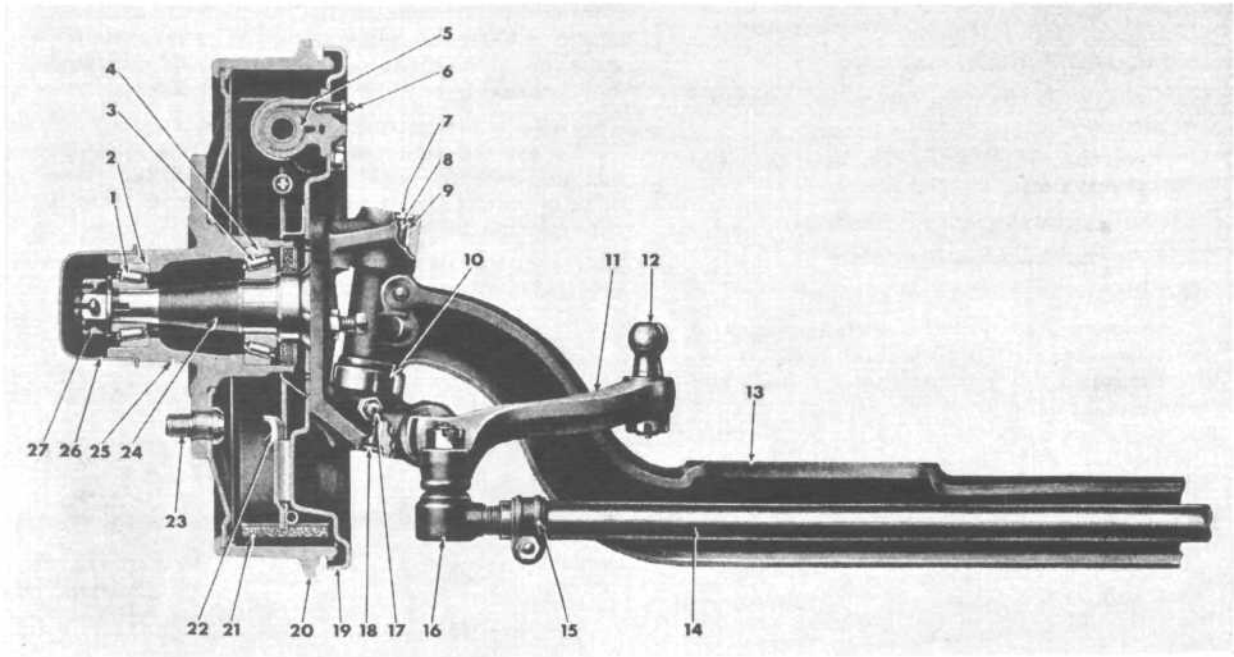


FIG. 226—FRONT AXLE—2-WHEEL-DRIVE MODELS

1. Front Wheel Bearing Cone and Rollers—Outer
2. Front Wheel Bearing Race—Outer
3. Front Wheel Bearing Cone and Rollers—Inner
4. Front Wheel Bearing Race—Inner
5. Wheel Brake Cylinder
6. Wheel Brake Cylinder Bleeder Screw
7. Pivot Bolt Expansion Plug—Upper
8. Pivot Bolt
9. Steering Knuckle Bushing
10. Pivot Bolt Thrust Bearing
11. Steering Knuckle Arm
12. Steering Arm Ball
13. Front Axle "I" Beam
14. Steering Tie Rod
15. Steering Tie Rod Clamp
16. Steering Tie Rod Socket Assembly
17. Hydraulic Lubricator
18. Pivot Bolt Expansion Plug—Lower
19. Brake Backing Plate Assembly
20. Brake Drum
21. Brake Shoe Assembly
22. Brake Shoe Retainer Plate
23. Wheel Hub Bolt
24. Steering Knuckle Assembly
25. Front Wheel Hub
26. Hub Cap
27. Front Axle Spindle Nut

The knuckles are connected by a tie rod which is mounted on ball and socket connections. The tie rods are adjustable to secure correct toe-in of the front wheels. A steering connecting rod connects the left knuckle arm with the steering gear arm.

On vehicles with Planar-type suspension, an extension of the tie rod, which is built in two parts, is connected directly to the steering gear arm.

Camber and caster of the front wheels is preset. Camber cannot be altered but caster can be adjusted by installing caster shims between the axle pad and the springs. For information on the steering geometry, see Section P.

Note: Whenever an axle is inspected, see if the ring gear lock straps, Fig. 208 No. 40, are present. These straps should be installed on those axles without them.

Note: Possibility of front differential gear failures is greatly reduced if the clearance between the differential side gears and differential case is correctly set. For procedure, see Par. O-7.

N-2. Pivot Pin Replacement
All Elliot-Type Axles

The only parts of the front axle, subjected to wear, which may require replacement are the pivot pins and bushings. To accomplish this replacement follow the procedure outlined below. See Fig. 226.

a. Jack up the front axle to free the wheels.

b. Remove the hub and dust caps.

c. Remove the cotter pin, the wheel retaining nut and washer.

d. Remove the wheel with the hub, bearings and oil retainer.

e. Disconnect the hydraulic brake tube.

f. Remove the brake backing plate.

g. Remove the tapered pivot pin lock.

h. These axles are equipped with bushings at both the top and bottom and the top hydraulic lubricator is located at an angle and to one side of the pivot pin. Remove the top expansion plug and drive the pin out through the bottom with the lower plug. When the spindle is dismantled use care not to lose the spacing shim placed between the upper face of the axle and the spindle.

i. Remove the thrust bearing and bushings. Assembly is the reverse of disassembly. Be sure the oil holes in the bushings are correctly aligned with the hydraulic lubricators. Ream the bushings for running clearance with the pivot pin. Check the thrust bearing to be sure it is not worn or damaged. When installing the pivot pin, align the notch for the taper retaining pin with the pin hole. When assembling the knuckle, guard against lost motion between the axle and inner face of the knuckle. Adjustment is made by selective fitting of the spacing shim between the upper face of the axle and the inner face of the knuckle. Shims .011″, .033″ and .035″ (.279, .838 and .889 mm.) in thickness are available. Do not overlook bleeding the brakes after the axle end has been reassembled.

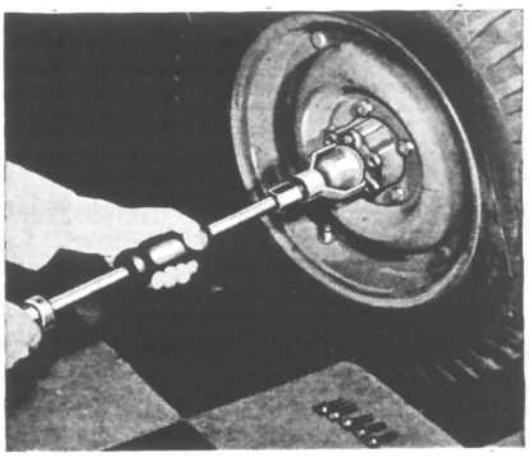


FIG. 227—HUB CAP PULLER

N-3. Front Axle Overhaul and Adjustment
All 4-Wheel-Drive Models

A "live" type front axle is required to provide four-wheel drive. The differential is mounted in a housing similar to that used in the rear axle except that the pinion shaft faces toward the rear instead of the front and to the right of the center of the axle. This design allows the placing of the front propeller shaft along the right side of the engine oil pan to avoid reducing road clearance under the engine.

The axle is of the full floating type and the axle shafts can be removed without dismantling the steering knuckle housing. Overhaul of the "live" driving unit is the same as the rear axle. Refer to that Section for full information.

To remove an axle shaft and universal joint assembly, the following operations must be performed:

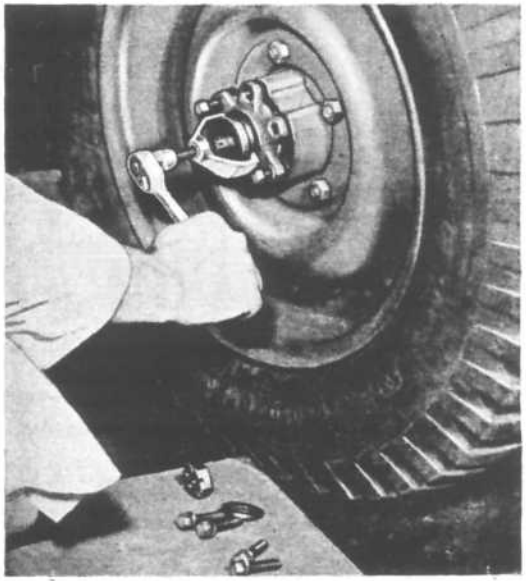


FIG. 228—AXLE SHAFT DRIVE FLANGE PULLER

a. Remove the wheel.

b. Remove the hub cap with a puller as shown in Fig. 227.

c. Remove the axle shaft driving flange bolts.

d. Apply the foot brakes and remove the axle shaft flange with puller, Tool No. W-163, which is illustrated in Fig. 228.

e. Release the locking lip on the lock washer and remove the outer nut, lock washer, adjusting nut, and bearing lock washer. Use wrench, Tool No. W-144, Fig. 229, for removal of the nut.

f. Remove the wheel hub and drum assembly with the bearings. Be careful not to damage the oil seal.

g. Remove the hydraulic brake tube and the brake backing plate screws.

h. Remove the spindle.

i. Remove the axle shaft and universal joint assembly.

N-4. UNIVERSAL JOINTS

The Rzeppa type illustrated in Figs. 230 and 231 and the Spicer type illustrated in Fig. 234 are used in production. Service procedure covering these type joints is outlined below.



FIG. 229—WHEEL BEARING NUT WRENCH

N-5. Rzeppa Universal Joint

After the assembly has been removed, the universal joint may be disassembled as follows:

a. Inspect to determine the method of attachment of the front axle shaft to the joint. Where three screws are used, follow step b. Where there are no screws, follow step c. After the axle shaft has been separated from the joint, follow steps d through h for both types.

b. Remove the three screws holding the front axle shaft to the joint. Pull the shaft free of the splined inner race. To remove the axle shaft retainer, remove the retainer ring on the axle shaft.

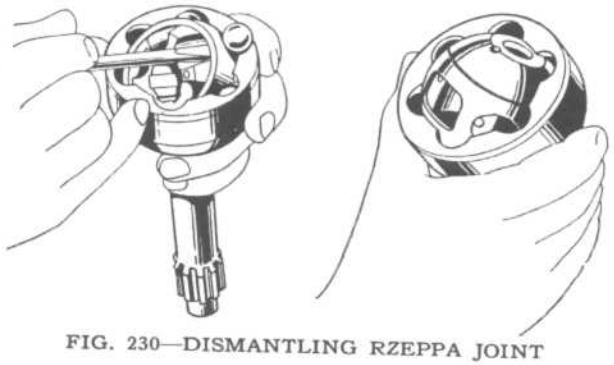


FIG. 230—DISMANTLING RZEPPA JOINT

c. To remove the axle shaft from the joint, use a wooden pry and exert force in the direction of the axis of the axle shaft. Use a mallet, if necessary, to exert enough force to drive the retaining ring, installed on the end of the axle shaft, into its groove in the spline, permitting the joint to be slipped off the axle shaft.

d. Lift out the axle centering pin.

e. Push down on various points of the inner race and cage until the balls can be removed with the help of a small screw driver in the manner illustrated in Fig. 230.

f. After removing the balls, turn the inner race and cage over so the pilot cup is up. Remove the pilot cup.

NOTE: This pilot cup was deleted from production of later joints.

g. There are two elongated and four small holes in the cage. Turn the cage so the two bosses on the spindle shaft will drop into the elongated holes. Lift out the cage.

h. Turn the inner race so that one of the bosses will drop into an elongated hole in the cage. Shift the race to one side and lift it out.

Reassemble the joint in reverse order. Be careful not to damage parts and see that they are clean of all dirt and grit.

N-6. Installation

To install the Rzeppa axle shaft and universal joint assembly in the housing, proceed as follows:

a. Clean all parts of dirt and foreign matter.

b. Enter universal joint and axle shaft assembly in the housing, taking care not to knock out the inner oil seal. Enter the splined end of the axle shaft into the differential and push into place.

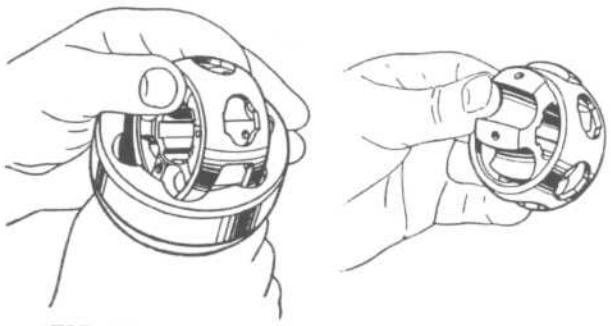


FIG. 231—REMOVING RZEPPA JOINT CAGE

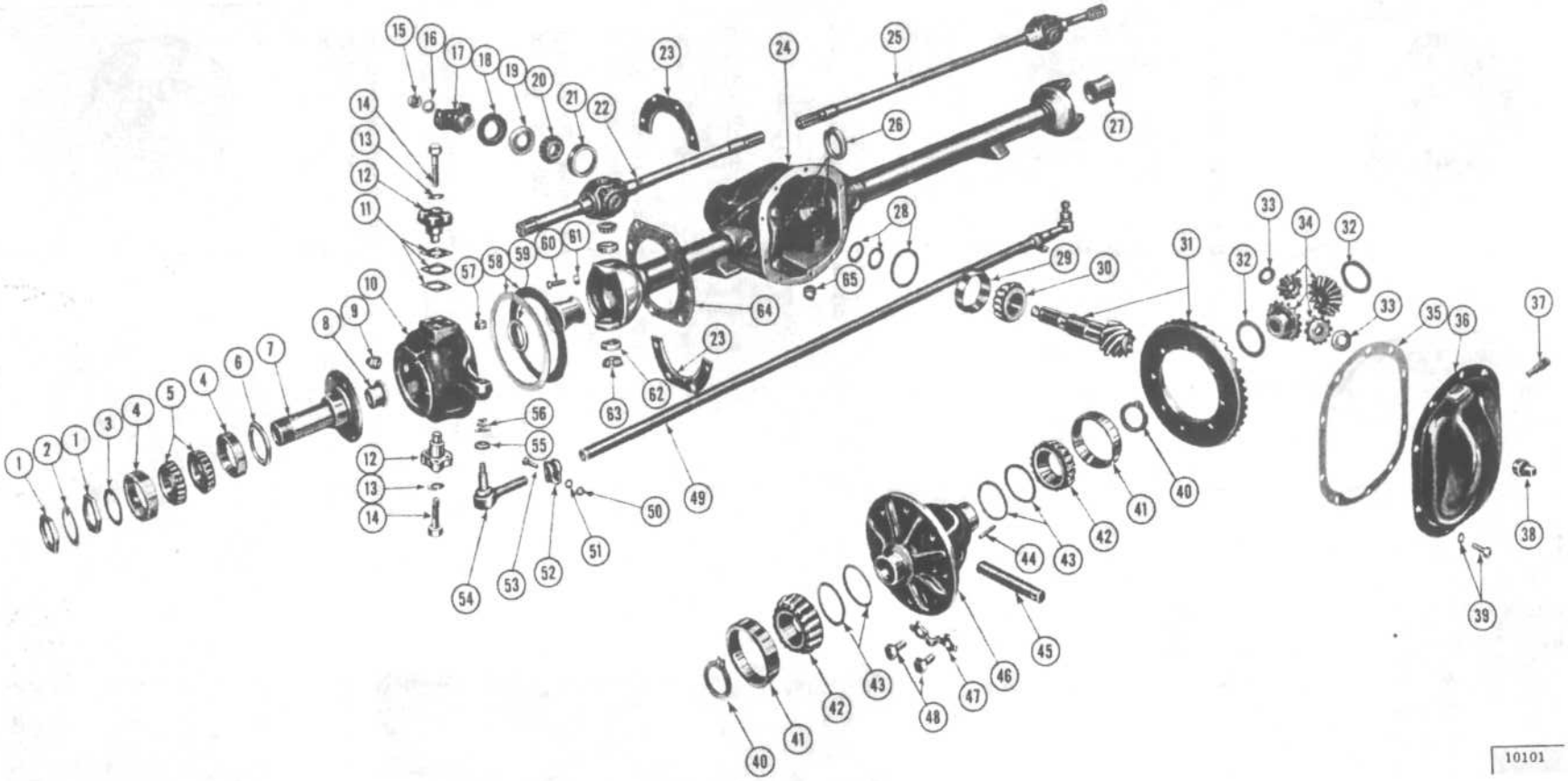


FIG. 232—FRONT AXLE—4-WHEEL DRIVE MODELS

1—Wheel Bearing Nut
2—Locking Washer
3—Wheel Bearing Washer
4—Wheel Bearing Cup
5—Wheel Bearing Cone and Rollers
6—Wheel Bearing Oil Seal
7—Wheel Spindle
8—Wheel Spindle Bushing
9—Knuckle Housing Filler Plug
10—Knuckle and Arm—Left
11—Adjusting Shims
12—Bearing Cap
13—Lockwasher
14—Bearing Cap Bolt
15—Pinion Nut
16—Pinion Washer
17—Universal Joint Yoke
18—Pinion Shaft Oil Seal
19—Bearing Oil Slinger
20—Bearing Cone and Rollers
21—Bearing Cup
22—Right Universal Joint and Shaft
23—Knuckle Oil Seal Retainer
24—Front Axle Housing
25—Left Universal Joint and Shaft
26—Axle Shaft Oil Seal
27—Axle Shaft Guide
28—Pinion Bearing Adjusting Shims
29—Pinion Shaft Bearing Cup
30—Pinion Shaft Bearing Cone and Rollers
31—Ring Gear and Pinion
32—Side Gear Thrust Washer
33—Pinion Mate Thrust Washer
34—Differential Gears
35—Housing Cover Gasket
36—Housing Cover
37—Housing Breather
38—Fill Plug
39—Housing Cover Screw and Lockwasher
40—Retaining Ring
41—Differential Bearing Cup
42—Differential Bearing Cone and Rollers
43—Differential Bearing Adjusting Shims
44—Pinion Shaft Lock Pin
45—Pinion Shaft
46—Differential Case
47—Ring Gear Lock Strap
48—Ring Gear Bolts
49—Steering Tie Rod
50—Tie Rod Clamp Nut
51—Lockwasher
52—Tie Rod Socket Clamp
53—Tie Rod Clamp Screw
54—Tie Rod Socket
55—Dust Cover
56—Spring
57—Tie Rod Stud Nut
58—Oil Seal and Backing Ring
59—Universal Joint Thrust Washer
60—Knuckle Stop Bolt
61—Stop Bolt Nut
62—King Pin Bearing Cup
63—King Pin Bearing Cone and Rollers
64—Steering Knuckle Oil Seal
65—Housing Drain Plug

c. Install wheel bearing spindle Fig. 232, No. 7.

d. Install the brake tube and brake backing plate.

e. Grease and assemble wheel bearings and install the wheel hub and drum on the wheel bearing spindle. Install the wheel bearing washer and adjusting nut. Tighten nut until there is a slight drag when the hub is turned. Then back off approximately one-sixth turn. Install locking washer and nut, tighten nut, and then bend the lock washer over the lock nut.

f. Install axle shaft washer, nut and cotter pin.

g. Install the hub cap.

h. Install the wheel.

i. Check front wheel alignment as outlined in Section P.

j. Bleed the brake.

k. Fill the universal joint housing with lubricant through the filler plug opening.

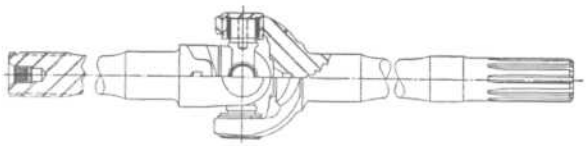


FIG. 233—SPICER UNIVERSAL JOINT

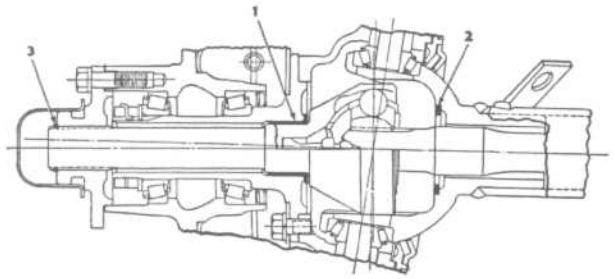


FIG. 234—RZEPPA UNIVERSAL JOINT

N-7. Steering Knuckle Pivot Pins

All 4-Wheel-Drive Models

The steering knuckle pivot pins pivot on tapered roller bearings. Replacement of these bearings requires removal of the hub and brake drum assembly, wheel bearings, axle shaft, spindle, steering tie rod, and steering knuckle. Disassemble the steering knuckle as follows:

a. Remove the eight screws shown in Fig. 232 which hold the oil seal retainer (23) in place.

b. Remove the four screws holding the lower pivot pin bearing cap (12).

c. Remove the four screws holding the upper bearing cap in place. Remove the bearing cap. The steering knuckle (10) can now be removed from the axle.

d. Wash all parts in cleaning solvent. Replace any damaged or worn parts. Inspect the bearing and races for scores, cracks, or chips. Should the bearing cups be damaged, they may be removed and installed with Special Driver, Tool W-138, as shown in Fig. 235.

N-8. Reassembly

Reverse the procedure of Par. N-7 to reassemble the unit. When reinstalling the steering knuckle, sufficient shims must be installed under the bearing top caps to obtain correct preload on the bearings. Shims are available in these thicknesses:

.003″ [0,076 mm.]	.010″ [0,254 mm.]
.005″ [0,127 mm.]	.030″ [0,762 mm.]

Install one each of the above shims at the top only.

NOTE: A shim pack of .058″ [1,47 mm.] thickness is added to the bottom face of the king pin boss on the steering knuckles at production. Maintain this shim pack at the bottom and make adjustments at the top only.

Install the bearing caps, lockwashers, and screws, and tighten securely.

Check the preload on the bearings by hooking a spring scale in the hole in the knuckle arm for the tie rod socket. Take the scale reading when the knuckle has just started its sweep. The load should be 6 to 9 lbs. or 3 to 5 lb-ft. [2,7 a 4,1 kg—0,4 a 0,7 kg-m.] without the oil seal installed. Remove or add shims as required to obtain this preload.

N-9. Spicer Universal Joints

The Spicer Universal Joint is shown in Fig. 233 and is a cardan cross joint with needle bearings similar in design to the Spicer propeller shaft universal joint. On Spicer axle joints, the snap ring slots are in the bearing retainer, as shown in Fig. 233. On Spicer propeller shaft joints, the snap ring slots are in the joint yokes as shown in Fig. 221 and 222.

The axle shaft and joint are removed and installed in the same manner as the Rzeppa joints. Service procedures will be found in Section M.

N-10. Replacing Steering Knuckle Oil Seal

Remove the old steering knuckle oil seal by removing the eight screws which hold it in place. Earlier production vehicles are equipped with seals consisting of two oil seal halves. Later production vehicles are equipped with oil seal assemblies consisting of a split oil seal and backing ring assembly, an oil seal felt, and two seal retainer plate halves.

Examine the spherical surface of the axle for scores or scratches which could damage the seal. Smooth any roughness with emery cloth.

Before installing the oil seal felt, make a diagonal cut across the top side of the felt so that it may be slipped over the axle. Install the oil seal assembly in the sequence given above, making sure the backing ring (of the oil seal and backing ring assembly) is toward the wheel.

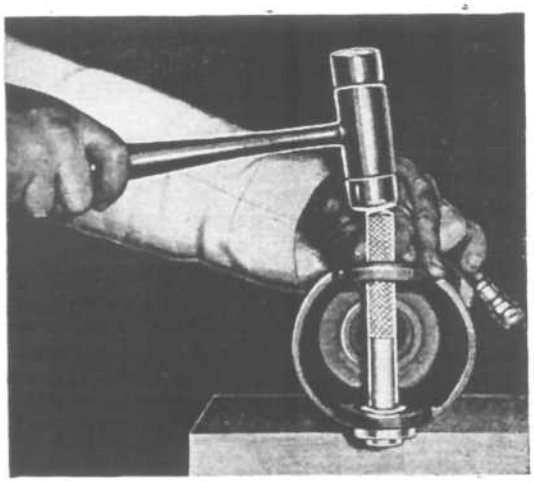


FIG. 235—SPINDLE PIN BEARING CUP DRIVER

After driving in wet, freezing weather swing the front wheels from right to left to remove moisture adhering to the oil seal and the spherical surface of the axle housing. This will prevent freezing with resulting damage to the seals. Should the vehicle be stored for any period of time, coat these surfaces with light grease to prevent rusting.

N-11. Removing and Overhauling Differential

Adjustment and overhaul of the front axle differential assembly is outlined in the "Rear Axle" section. Removal of the full floating axle shaft is explained in Par. O-4.

N-12. Steering Tie Rod and Bell Crank

These parts of the front axle are covered in the "Steering" Section.

N-13. Front Suspension

Early F4-134 4x2 Models.

The Planar type independent front suspension is illustrated in Figs. 237 and 238. To replace the pivot pins and bearings follow the outline below:

a. Remove the hub and dust caps.

b. Remove the wheel retaining cotter pin, nut and washer. Remove the wheel with the hub, bearings and oil seal.

c. Disconnect the brake hydraulic tube and remove the brake backing plate with the brake assembly attached.

d. Remove the tapered pivot pin lock pin.

e. Use a sharp drift to remove the pivot pin lower expansion plug.

f. Use a brass drift to drive the pivot pin up until the upper needle bearing assembly is removed.

g. Use a brass drift to drive the pivot pin out through the bottom.

h. Remove the bushing from the lower part of the spindle.

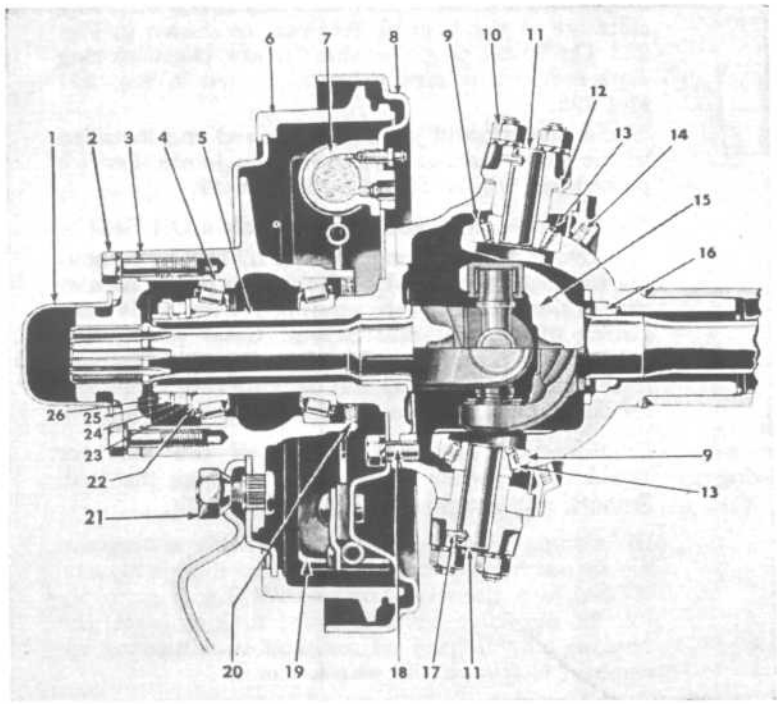
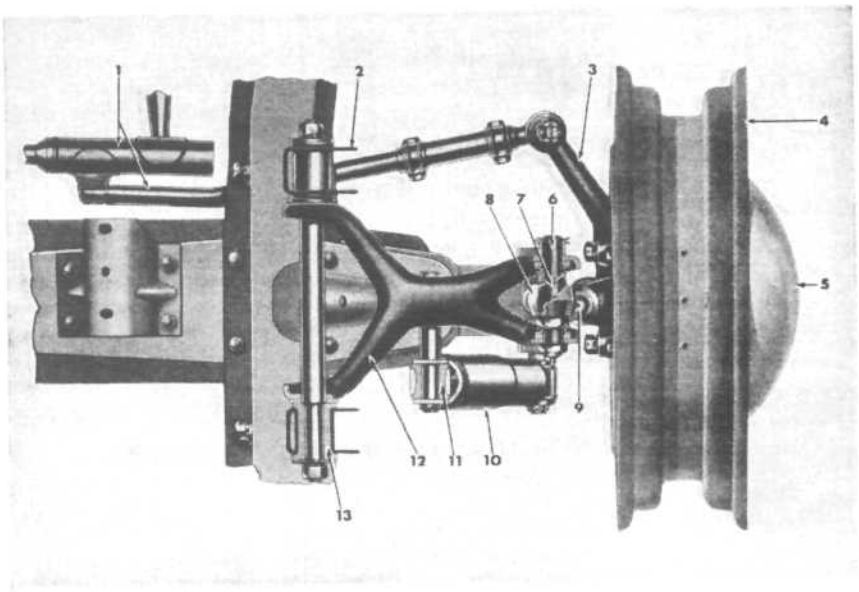


FIG. 236—FRONT STEERING KNUCKLE
(With Spicer Universal Joints)

1—Wheel Hub Cap
2—Driving Flange Cap Screw
3—Axle Shaft Drive Flange Gasket
4—Wheel Bearing Cup
5—Front Wheel Spindle
6—Brake Drum
7—Front Brake Cylinder
8—Brake Backing Plate
9—Pivot Pin Bearing Cap
10—Pivot Pin Bearing Cap Nut
11—Pivot Pin
12—Pivot Bearing Adjusting Shims
13—Pivot Pin Cone and Rollers
14—Steering Knuckle Oil Sea
15—Front Axle Universal Joint
16—Axle Shaft Bushing
17—Pivot Pin Locking Pin
18—Brake Backing Plate Screw
19—Brake Shoe and Lining
20—Hub Oil Seal
21—Wheel Hub Bolt Nut
22—Wheel Bearing Cone and Rollers
23—Wheel Bearing Washer
24—Wheel Bearing Retaining Nut
25—Wheel Adjusting Nut Lock Washer
26—Wheel Bearing Retaining Nut



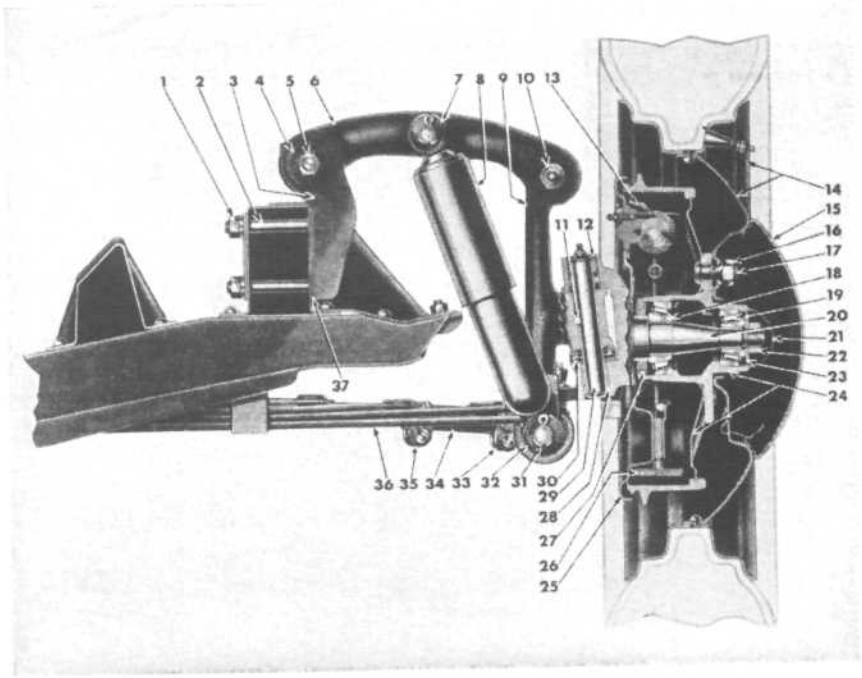
1. Steering Tie Rod
2. Frame Bracket
3. Steering Knuckle Arm
4. Wheel and Rim
5. Hub Cap
6. Control Arm Pin
7. Control Arm Pin Bushing
8. Steering Knuckle Support
9. Hydraulic Fitting
10. Shock Absorber
11. Shock Absorber Bushing
12. Arm Assembly
13. Control Arm Bushing

FIG. 237—PLANAR FRONT SUSPENSION—TOP VIEW

Assembly is the reverse of the above. When reaming the bushing to size, use a pilot type reamer to be sure that the bushing is square with the upper needle bearing. Examine the ball thrust bearing and replace it if worn or damaged. Do not overlook bleeding the brakes.

Should it be necessary to disassemble the front suspension be sure that the steering knuckle supports, No. 9, Fig. 238, are reinstalled on the proper side. The left support will interchange with the right, however, the wheel camber will be incorrect, resulting in unstable steering. The supports have the part number on the forging for identification. Later production parts may be identified by a letter "L" indicating left and a letter "R" indicating right stamped on the front face at the center.

When mounting the upper control arm pin bushing, No. 7, Fig. 237, in the steering knuckle support, No. 8, tighten it to 175 ft. lbs. (24.2 kg.-m.) torque. Centralize the control arm assembly, No. 12, over



1. Frame Bracket Mounting Nut
2. Frame Bracket Mounting Screw
3. Frame Bracket
4. Support Arm Mounting Washer
5. Support Arm Mounting Nut
6. Support Arm Assembly
7. Shock Absorber Mounting Washer
8. Shock Absorber
9. Knuckle Support
10. Support Arm Pin
11. Pivot Pin Locking Pin
12. Steering Knuckle Bearing
13. Wheel Brake Hydraulic Cylinder
14. Front Wheel
15. Hub Cap
16. Wheel Mounting Nut
17. Wheel Mounting Bolt
18. Inner Bearing Cone and Rollers
19. Outer Bearing Cone and Rollers
20. Steering Knuckle
21. Grease Cap
22. Wheel Retaining Nut
23. Wheel Nut Tongue Washer
24. Wheel Hub
25. Brake Backing Plate
26. Brake Shoe Lining
27. Dust Washer
28. Steering Knuckle Bushing
29. Pivot Pin
30. Pivot Bearing
31. Shock Absorber Mounting Washer
32. Shock Absorber Rubber Bushing
33. Steering Tie Rod Clamp
34. Steering Tie Rod Sleeve
35. Steering Tie Rod Clamp
36. Front Spring
37. Support Arm Shims

FIG. 238—PLANAR FRONT SUSPENSION—SIDE VIEW

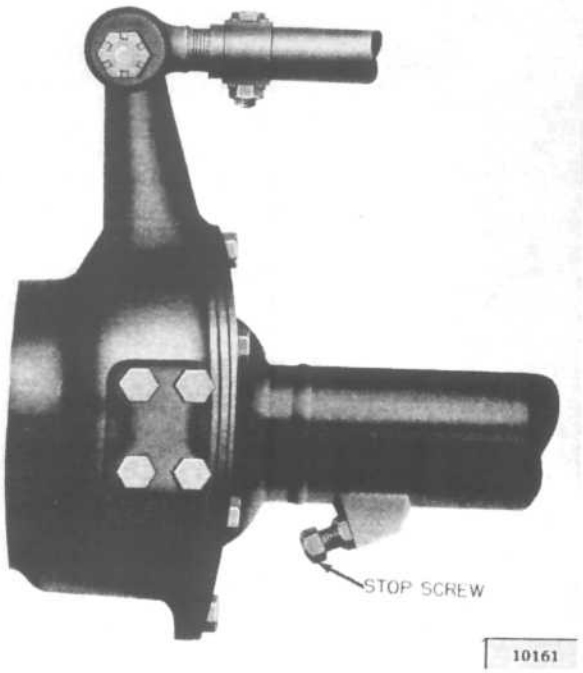


FIG. 239—TURNING ANGLE STOP SCREW

the steering knuckle support, No. 8, before starting to thread pivot pin, No. 6 through the steering knuckle support. This is necessary to provide the proper caster effect and equal clearance at each side of the support for the rubber dust seals. Also for the same reasons centralize the spring eye in the lower end of the knuckle support before starting the spring pivot bolt.

Wheel camber is controlled by shim pack, No. 37, Fig. 238, installed between the frame and the support arm frame bracket. Adjustment (see "Steering" Section) is through selection of the correct shim thickness. Shims .060″ and .120″ (1.524 and 3.048 mm.) in thickness are available. Should the shims be removed be sure that each pack is reinstalled on the same side from which it was removed.

N-14. 4-Wheel-Drive Turning Angle

To avoid possible damage to the universal joints on the front axles of 4-wheel drive vehicles, it is advisable to check the turning angle. The 4-wheel-drive vehicles should have a turning angle of not more than 29°. The angle is measured by placing the front wheels on turntables.

The stop screw for setting the turning angle is shown in Fig. 239. To adjust the screw, it is necessary to break the weld holding the screw in position. When the adjustment has been made, reweld the screw in place to prevent any movement.

SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Hard Steering	
Lack of Lubrication	Lubricate
Tires Soft	Inflate
Tight Steering	Adjust. See "Steering" Section
Low Speed Shimmy or Wheel Fight	
Spring Clips and Shackles Loose	Readjust or Replace
Front Axle Shifted	Broken Spring Center Bolt
Insufficient Toe-in	Adjust
Improper Caster	Reset
Steering System Loose or Worn	Adjust or Overhaul Steering Gear, Front Axle or Steering Parts
Twisted Axle	Straighten or Adjust
High Speed Shimmy or Wheel Fight	
Check Conditions Under "Low Speed Shimmy"	
Tire Pressures Low or Not Equal	Inflate
Wheel Out of Balance	Balance
Wheel Runout	Straighten
Radial Runout of Tires	Mount Properly
Wheel Camber	Same on Both Wheels
Front Springs Settled or Broken	Repair or Replace
Bent Steering Knuckle Arm	Straighten or Replace
Shock Absorbers not Effective	Replace or Repair
Steering Gear Loose on Frame	Tighten
Front Springs Too Flexible	Over Lubricated
Tramp	
Wheels Unbalanced	Check and Balance
Wandering	
Improper Toe-in	Adjust—Check for Bent Steering Knuckle Arm
Broken Front Spring Main Leaf	Replace
Axle Shifted	Spring Center Bolt Broken
Loose Spring Shackles or Clips	Adjust or Replace
Improper Caster	Reset
Tire Pressure Uneven	Inflate
Tightness in Steering System	Adjust
Loose Wheel Bearings	Adjust
Front Spring Settled or Broken	Repair or Replace
Axle Noisy on Pull	
Pinion and Ring Gear Adjusted too Tight	Readjust
Pinion Bearings Rough	Replace
Axle Noisy on Coast	
Excessive Back Lash at Ring and Pinion Gears	Readjust
End Play in Pinion Shaft	Readjust
Rough Bearing	Replace
Axle Noisy on Coast and Pull	
Ring and Pinion Adjusted too Tight	Readjust
Pinion Set too Deep in Ring Gear	Readjust
Pinion Bearing Loose or Worn	Readjust or Replace
Back Lash	
Axle Shaft Universal Joint Worn	Replace
Axle Shaft Improperly Adjusted	Readjust
Worn Differential Pinion Washers	Replace
Worn Propeller Shaft Universal Joints	Repair

Emergency (4-Wheel Drive Models)

Where difficulty is experienced with front axle differential making the vehicle inoperative, remove axle driving flanges. This will allow bringing vehicle in under its own power. Be sure front wheel drive shift lever is in the forward (disengaged) position.

FRONT AXLE SPECIFICATIONS

MODEL:	L6-226 4WD	L6-226 4x4	F4-134 4WD	F4-134 4x4
Front Axle:				
Make	Spicer	Spicer	Spicer	Spicer
Model	25	25	25	25
Drive	Thru Springs	Thru Springs	Thru Springs	Thru Springs
Type	Full Floating	Full Floating	Full Floating	Full Floating
Road Clearance	9 11/32" [23,7 mm.]	9" [22,9 mm.]	9 11/32" [23,7 mm.]	9" [22,9 mm.]
Capacity	2000 lb. [907 kg.]	2000 lb. [907 kg.]	2000 lb. [907 kg.]	2000 lb. [907 kg.]
Wheel Bearings:				
Inner	Roller	Roller	Roller	Roller
Outer	Roller	Roller	Roller	Roller
Differential:				
Drive	Hypoid	Hypoid	Hypoid	Hypoid
Gear Ratio	4.88:1	4.27:1	5.38:1	5.38:1
Bearings — Adjustment	Shims	Shims	Shims	Shims
— Type	Roller	Roller	Roller	Roller
Pinion Gear:				
Backlash	.003" to .006" [0,076 a 0,152 mm.]	.003" to .006" [0,076 a 0,152 mm.]	.003" to .006" [0,076 a 0,152 mm.]	.003" to .006" [0,076 a 0,152 mm.]
Adjustment	Shims	Shims	Shims	Shims

MODEL:	L6-226 4x2	F4-134 4x2
Front Axle:		
Make	Clark	Clark
Model	130093	130093
Type	Reverse Elliot	Reverse Elliot
Road Clearance	7 3/8" [18,7 mm.]	7 3/8" [18,7 mm.]
Capacity	1600 lb. [725 kg.]	1600 lb. [725 kg.]
Wheel Bearings:		
Inner	Roller	Roller
Outer	Roller	Roller

REAR AXLE

Contents

SUBJECT	PAR.
Axle Shaft — Full Floating	O-4
— Semifloating	O-3
Differential — Hypoid	
Assembling	O-8
Drive Pinion — Adjustment	O-6
Overhaul	O-5
Side Gears — Adjustment	O-7
Differential — Powr-Lok	O-12
Differential — Spiral Bevel	
Drive Pinion — Overhaul	O-10
Overhaul	O-9
Installing	O-11
Removing	O-2

O-1. GENERAL

All models are equipped with Spicer semifloating hypoid rear axles as standard equipment. Some early production trucks (Models L6-226 4WD and F4-134 4WD) were equipped with Timken rear axles with spiral bevel gears as optional equipment.

Note: Whenever an axle is inspected, see if the ring gear lock straps (Fig. 260, No. 49) are present. These straps should be installed on those axles without them.

O-2. Removing Rear Axle Assembly

To remove a rear axle assembly first raise the rear end of the vehicle with a hoist and safely support the frame ahead of the rear springs. Remove the wheels and disconnect the propeller shaft at the rear universal joint companion flange. Disconnect the brake hydraulic hoses. Remove the spring to axle "U"-bolt clips and slide the assembly from underneath the vehicle.

O-3. Axle Shaft — All Semifloating

To remove an axle shaft from a semifloating axle assembly follow the sequence below:

a. Jack up the wheel and remove the hub cap.

b. Remove the axle shaft nut.

c. Use a puller to remove the wheel hub. (Tool C-319 shown in Fig. 240.)

d. Remove the screws attaching the brake dust shield, grease and bearing retainers, and brake assembly. Remove the shield and retainer.

e. Using care not to lose the adjusting shims, pull out the axle shaft. Should an axle shaft be broken, the inner end can usually be drawn out of the housing with a wire loop after the outer oil seal is removed. However, if the broken end is less than 8″ [20 cm.] long, it may be necessary to remove the differential.

To remove the bearing from an axle shaft use combination bearing puller, Tool No. W-104 shown in Fig. 241.

If both shafts are to be removed, keep the shims from each shaft separate and replace them on the shafts from which they were removed to maintain correct bearing adjustment.

On Timken axles, shims may be installed on one shaft only or the clearance may be divided equally and shims installed on both shafts.

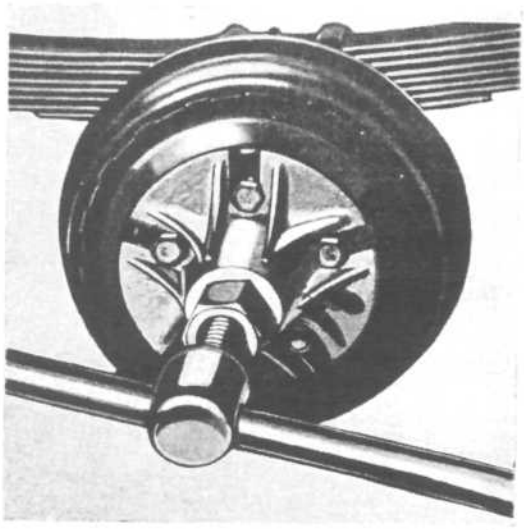


FIG. 240—WHEEL HUB PULLER

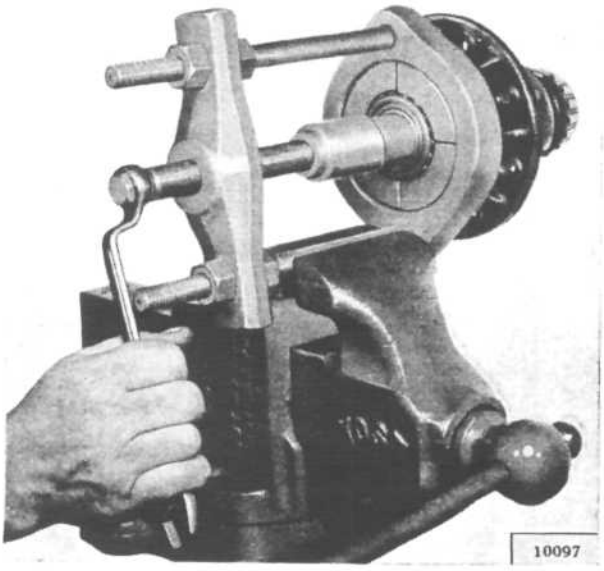


FIG. 241—BEARING PULLER

Assembly is the reverse of dismantling. Check the shaft oil seal, No. 35, Fig. 242, before installing the axle shaft. If replacement is necessary use axle shaft oil seal driver W-186, Fig. 243. Also check the grease retainer, No. 9, Fig. 242, and replace it if there is any doubt of its condition. Adjust the wheel bearings as outlined in Section R.

O-4. Full-Floating Axle Shaft

To remove the full-floating axle shaft the following procedure should be followed:

a. Remove the six screws holding the driving flange to the wheel hub.

b. Screw two flange screws into the threaded holes in the axle flange to loosen the shaft after which it may be readily removed. If a shaft is broken, use a piece of stiff wire and make a loop on one end, slide the wire into the axle housing and over the broken end of shaft for a sufficient distance so when the wire is pulled out, the loop will bind on the shaft and remove it from the differential side gear.

To replace the shaft, reverse the above operations, however, care must be taken when installing the shaft that the inner oil seal, at the differential is not knocked out.

O-5. Overhauling Hypoid Differential

Before dismantling the differential, it is advisable to determine through inspection the cause of difficulty or failure of the parts.

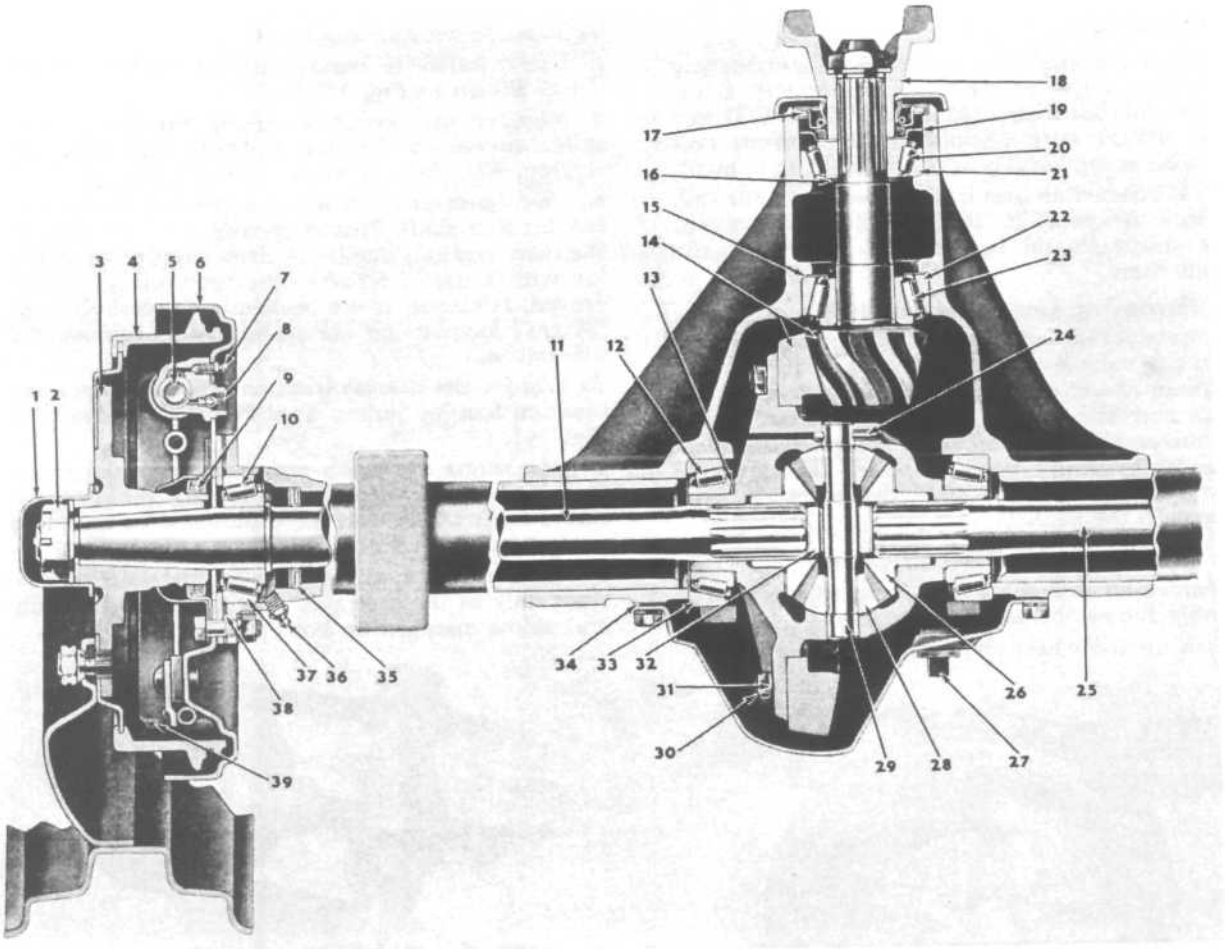


FIG. 242—REAR AXLE ASSEMBLY

1—Wheel Hub Cap, Left or Right
2—Axle Shaft Nut
3—Wheel Hub
4—Brake Drum
5—Brake Cylinder Assembly, Rear
6—Backing Plate, Front and Rear Brake Assembly
7—Brake Cylinder Bleeder Screw
8—Brake Hose Connection
9—Axle Shaft Grease Retainer, Outer
10—Cone and Rollers, Axle Shaft Bearing
11—Axle Shaft, Left
12—Differential Bearing, Cone and Roller
13—Differential Bearing Adjusting Shims
14—Differential Ring Gear and Pinion Set (Matched)
15—Pinion Bearing Positioning Shims
16—Pinion Bearing Cone Shims
17—Drive Pinion Oil Seal
18—Universal End Yoke Assembly
19—Drive Pinion Bearing Oil Slinger
20—Drive Pinion Bearing Cone and Rollers, Front
21—Drive Pinion Bearing Cup, Front
22—Drive Pinion Bearing Cup, Rear
23—Drive Pinion Bearing Cone and Rollers, Rear
24—Differential Bevel Pinion Mate Shaft Lock Pin
25—Axle Shaft, Right
26—Differential Bevel Side Gear
27—Differential Oil Filler Plug
28—Differential Bevel Pinion Mate
29—Differential Bevel Pinion Mate Shaft
30—Hypoid Bevel Drive Gear Screw
31—Drive Gear Screw Locking Strap
32—Differential Center Block
33—Differential Bearing Cup
34—Differential Gear Carrier Cover Gasket
35—Axle Shaft Grease Retainer, Inner
36—Axle Shaft Bearing Grease Connection
37—Axle Shaft Bearing, Cone and Roller
38—Wheel Bearing Shims
39—Brake Shoe and Lining Assembly

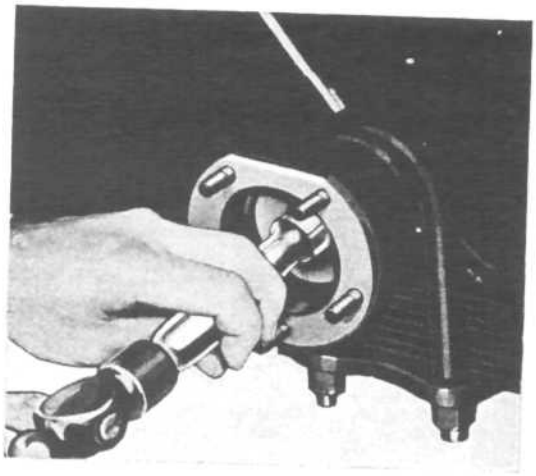


FIG. 243—OIL SEAL DRIVER

Drain lubricant from the gear carrier housing and then remove the gear carrier cover. Wash the differential parts thoroughly with a suitable solvent so the parts can be carefully inspected.

After this inspection, should it be determined that the differential requires overhauling the rear axle assembly must be removed from the vehicle.

Disassemble the differential as outlined below:

a. Remove the axle shafts. Refer to Par. 0-3 or O-4.

b. Remove the housing cover and the four screws holding the two differential side bearing caps in position. Note the markings on the caps and the housing so that each cap can be reinstalled in the same location and position.

c. Use the housing spreader, Tool W-129 as shown in Fig. 244, to spread the housing. Then remove the differential assembly. Should the spreader tool be unavailable, use two pry bars, one on each side of the differential case opening, to pry out the differential assembly as shown in Fig. 245.

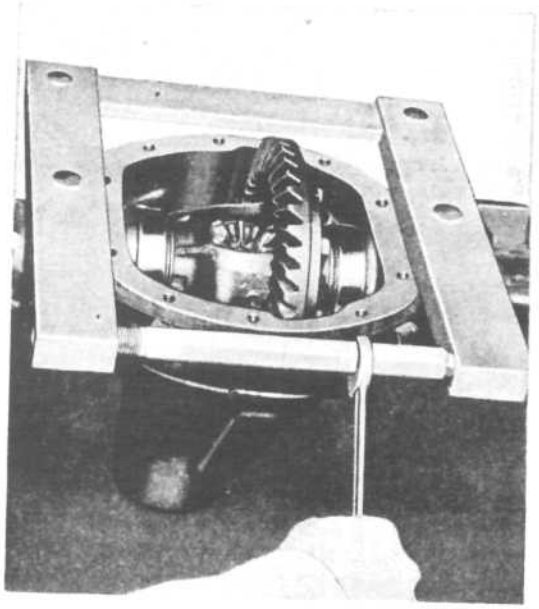


FIG. 244—DIFFERENTIAL CARRIER SPREADER

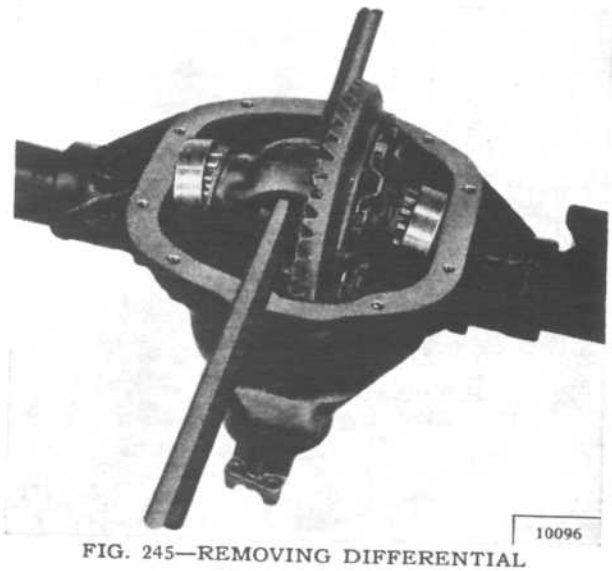


FIG. 245—REMOVING DIFFERENTIAL

d. If the differential carrier bearings are to be removed, use bearing puller W-104 as shown in Fig. 241.

e. Remove the screws holding the differential ring gear to the differential case.

f. The differential shaft (Fig. 242, No. 29) is held in place by a lock pin (24). Use a small punch as shown in Fig. 246 to drive out the lock pin. Remove the differential shaft.

g. Using care not to lose the pinion thrust washers, remove the differential pinion gears.

h. Remove the axle shaft gears and thrust washers.

i. To remove the drive pinion, first remove the universal joint end yoke assembly. Use Tool C-784 to hold the shaft as shown in Fig. 247 while removing the nut. Use puller, Tool W-172, to remove the end yoke as shown in Fig. 208. Both of these tools are included in gauge set W-99-A.

j. With a hammer and brass drift, drive on the end of the pinion shaft to force the pinion into the gear carrier housing so it can be removed.

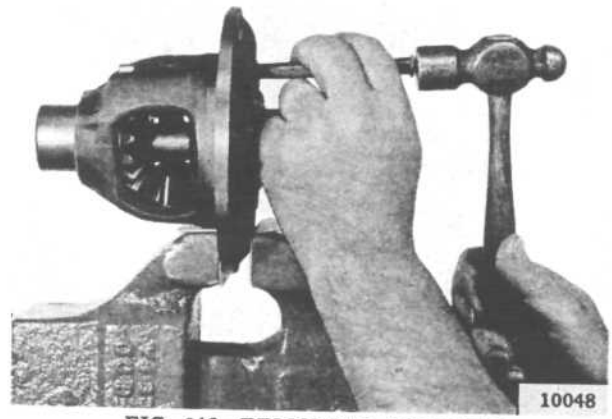


FIG. 246—REMOVING LOCK PIN

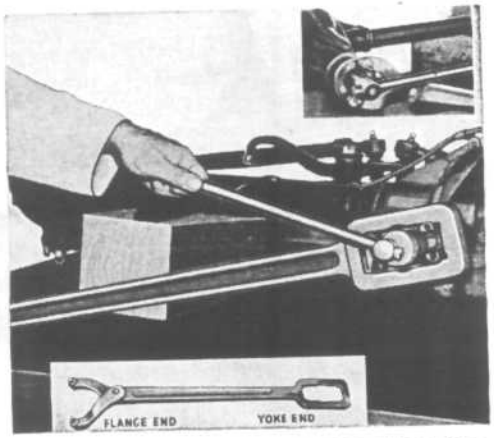


FIG. 247—FLANGE HOLDING WRENCH

k. Remove the pinion shaft oil seal.

l. Remove the pinion shaft bearing cone and rollers. Remove the pinion shaft bearing cups with a puller, Tool W-100. With the basic W-100 puller, use adapter W-100-4 for pulling the rear bearing cup (Fig. 249) and adapter W-100-6 for pulling the front bearing cup (Fig. 250). The puller and the adapters are a part of gauge set W-99-A.

m. Remove the rear pinion bearing from the pinion shaft with bearing puller, Tool W-104, shown in Fig. 251. If this tool is not available, the bearing may be removed with an arbor press as shown in Fig. 252.

Wash all parts in suitable cleaning solvent using care not to lose any of the shims which adjust the pinion shaft bearings.

O-6. Adjusting the Drive Pinion

Before attempting to adjust the bevel gear or differential parts, the drive pinion should be carefully checked and adjusted. The pinion is correctly positioned in relation to the ring gear by the use of shims which are placed between the rear bearing cup and the housing. These shims are available in thickness of .003″, .005″ and .010″ (.076, .127, .254 mm.).



FIG. 248—END YOKE PULLER

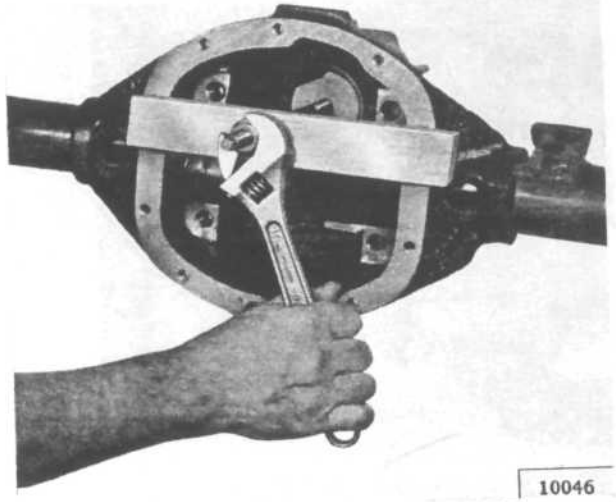


FIG. 249—PULLING PINION SHAFT REAR BEARING CUP

Should it be necessary to remove and replace the pinion shaft bearing cups, this may best be accomplished by using pinion shaft bearing cup pullers, the same ones as described in Par. O-5 for pulling the cups. Proper adjustment of the drive pinion is best accomplished by the use of ring gear and pinion setting gauge W-99-A illustrated in Fig. 255. When using this gauge do not install the oil seal until the pinion is adjusted and use sleeve, Tool No. W-162-6 in place of the universal joint yoke to hold the pinion in position for adjustment.

This gauge is equipped with a dial indicator which measures the distance from the finished surface on the head of the pinion to the center line of the differential carrier bearing. By establishing this distance, the correct amount of shims to be installed can be determined, to provide the required position of the drive pinion.

All pinions are marked on the head with a dimension indicating the proper number of thousandths of an inch they must be adjusted either plus or minus from standard. For example, a pinion marked plus three means it must be adjusted .003″ (.076 mm.) further away from the ring gear center than standard and the gauge dial must read plus .003″ when the pinion is correctly shimmed.

Master gauge blocks are supplied with this tool so that the original zero or standard dimension is



FIG. 250—PULLING PINION SHAFT FRONT BEARING CUP

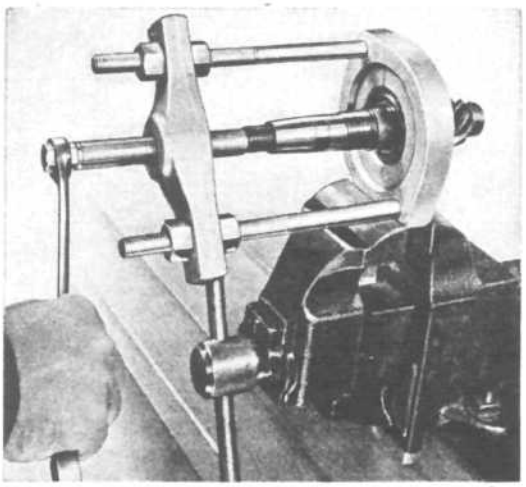


FIG. 251—BEARING PULLER

accurately and easily established. The gauge blocks provide seven different standards for seven different axles. The seven standards are indicated with A, B, C, D, E, F and G markings stamped on the gauge blocks. Use only the blocks listed below for the axles covered here.

Front Axles

Use block D for front axles with 5.38:1 and 4.88:1 gear ratios. Use block G for front axles with a 4.27:1 gear ratio. The 4.27:1 gear ratio is used on some late production Model L6-226 4-wheel-drive vehicles.

Rear Axles

Use block F for all Model L6-226 4WD and Model F4-134 4WD rear axles.

Use block E for all Model L6-226 4x4, L6-226 4x2, and F4-134 4x4 rear axles.

Use block E for late production Model F4-134 4x2, which is equipped with Spicer Model 44 rear axle. Use block D for early production Model F4-134 4x2, which are equipped with Spicer Model 23 rear axle. The axle model number will be found on the lower right rib of the gear carrier housing when viewed from the rear of the vehicle.

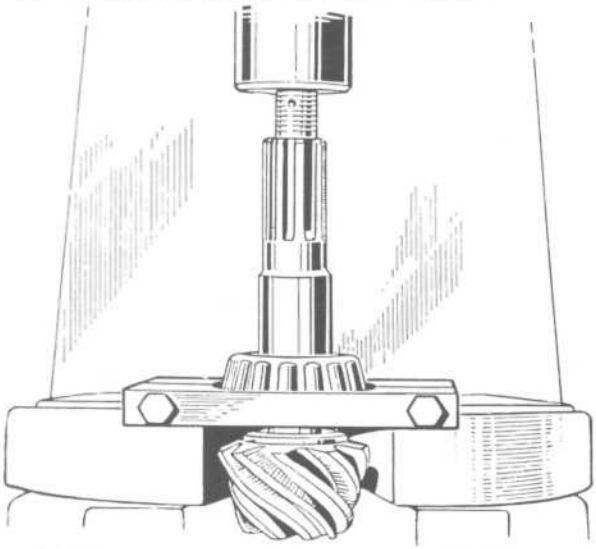


FIG. 252—REMOVING PINION BEARING

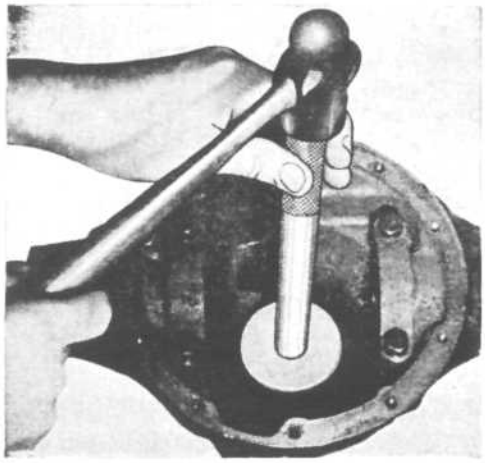


FIG. 253—PINION SHAFT REAR BEARING CUP DRIVER

The dial gauge is set to the master gauge for the different axles as shown in Fig. 256. Use the correct master gauge surface for the model axle being adjusted. Hold the dial indicator and gauge as shown in Fig. 256 and set the dial bezel to position the hand at zero with one-half turn tension on the gauge pin. This sets the dial to register at zero when mounted in the axle, when the distance between the finished head of a standard pinion and the center of the differential carrier is spanned. After setting the dial use care not to jar it or turn the bezel to disturb the setting.

Assemble the pinion in the case with the same thickness shim packs originally installed and without the oil seal. Use Spacer Tool No. W-126-6 in place of the universal joint yoke.

Assemble the dial gauge head to the "C" clamp by slipping the housing over the stationary guide pin, Fig. 255. Hold the gauge head and the large end of the "C" clamp in one hand and position it over the pinion and press the guide pin at the small end of the "C" clamp into the threaded end of the pinion and lock it into position with a thumb screw.

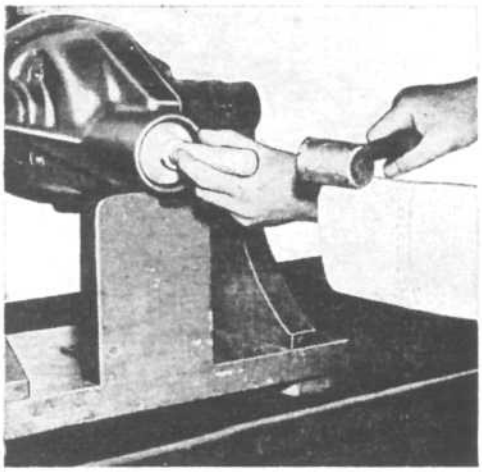


FIG. 254—PINION SHAFT FRONT BEARING CUP DRIVER

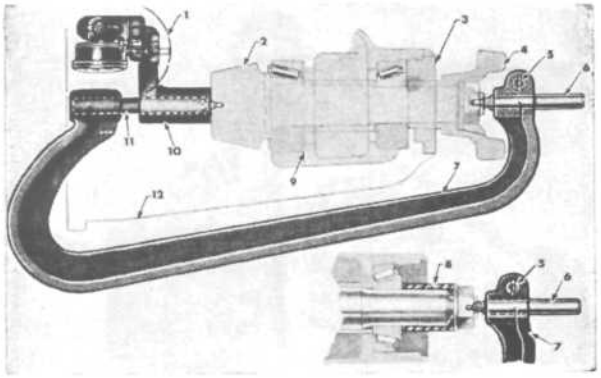


FIG. 255—PINION ADJUSTING FIXTURE

With the "C" clamp correctly seated in the drive pinion shaft lathe center and the dial indicator contact point bearing against the differential carrier side bearing bore, hold the dial gauge body (fixture), No. 1, Fig. 255, against the drive pinion head. Swing the dial gauge body back and forth across the bearing bore and watch the dial reading. The lowest reading indicates the center of the bearing bore and if the shim pack is of the correct thickness, the dial gauge reading will be the same as the etched marking on the pinion head. For example, if the pinion is marked plus three, the dial should indicate plus .003″. If the pinion is marked minus three, the dial should indicate minus .003″. Should the dial reading fail to agree with the marking on the pinion head note the difference and a corresponding amount of shims should be added or removed to secure the correct adjustment (reading on dial and pinion marking agree).

Recheck the adjustment if any shim changes are made and be sure to set the dial to the correct face of the master gauge. After correctly locating the pinion, check it for bearing preload. The shaft should turn with a slight drag only and without end float. To secure this adjustment add or replace shims back of the front bearing cone.

Do not install the oil seal until the differential has been assembled and the entire unit checked. When installing the universal joint flange use flange installing tool, W-162, Fig. 258.

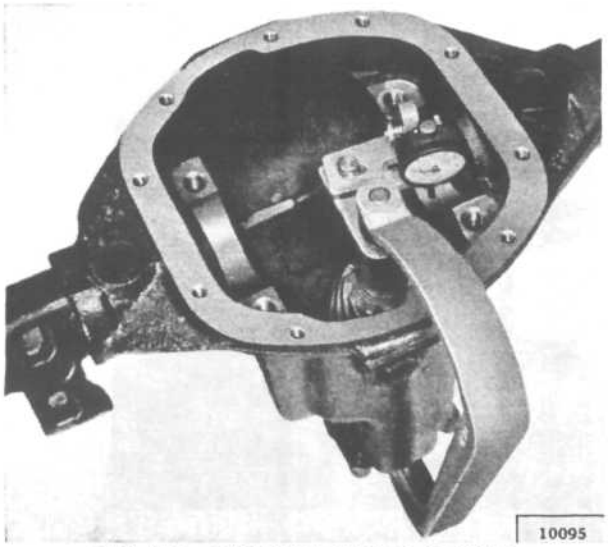


FIG. 256—PINION SETTING GAUGE

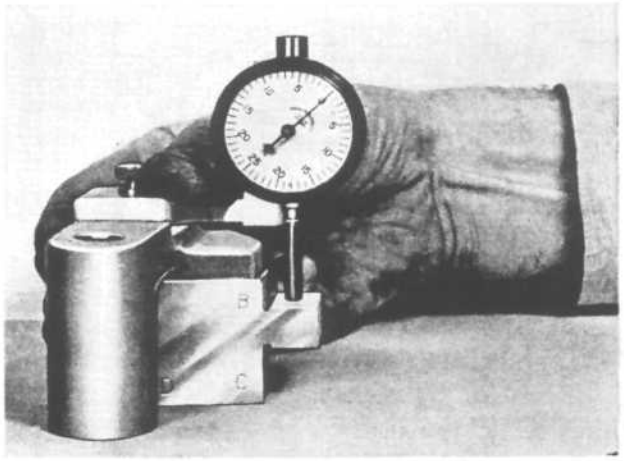


FIG. 257—PINION MASTER GAUGE

O-7. Adjusting Differential Side Gears

Clearance between the differential side gears and differential case should be .000″ to .006″ [0,00 a 0,15 mm.]. Use this procedure to check the clearance.

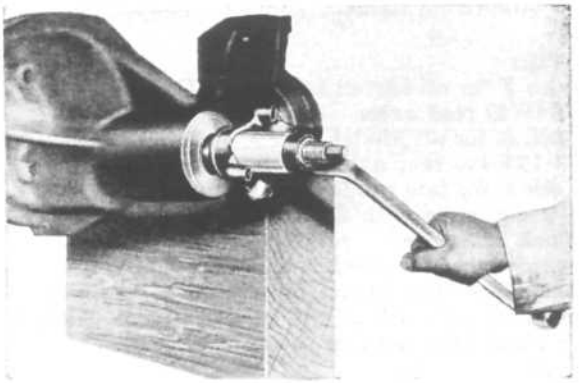


FIG. 258—UNIVERSAL JOINT FLANGE INSTALLING TOOL



FIG. 259—CHECKING SIDE GEAR CLEARANCE

a. With the differential positioned as shown in Fig. 259, bounce the differential lightly on a flat surface so the differential gears settle.

b. Measure the clearance between side gears and the case as illustrated.

c. If the clearance exceeds .006″, add shims between the side gears and the case. To bring the clearance within specified tolerance, shims in these thicknesses are available:

.004″]0,10 mm.] .008″ [2,03 mm.]
.006″ [0,15 mm.]

When shims are required, there must be at least one shim on each side. Also, keep the shim packs as equal as possible. After adding shims, repeat the clearance check.

O-8. Assembling Differential Unit

The relative assembled position of the internal parts of the differential are shown in Fig. 260. Reassemble the differential pinions, side gears, thrust washers and shaft in place and do not overlook installing the differential shaft lock pin. In order to prevent the lock pin from working out, stake it in position with a punch.

Carefully examine the surfaces of the differential case and bevel gear to make sure there are no foreign particles or burrs on the two contacting sur-

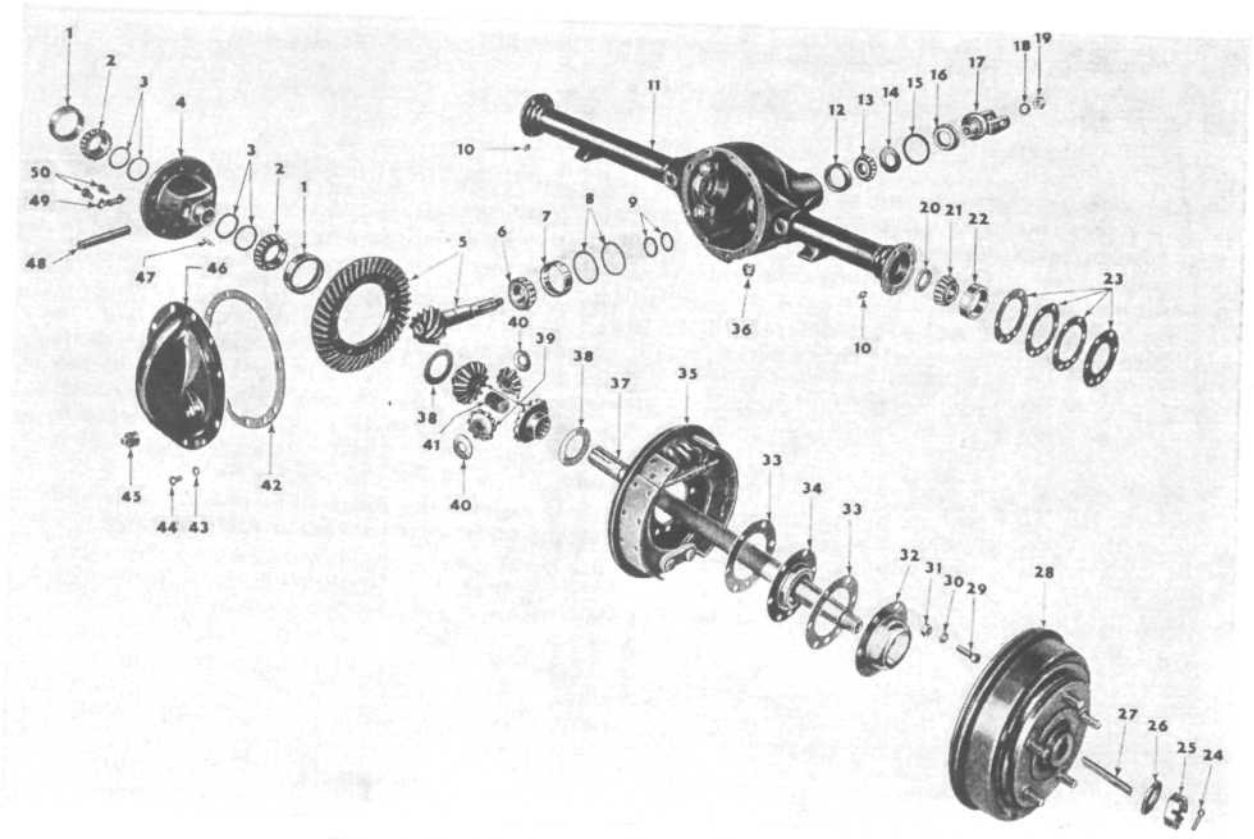


FIG. 260—SEMIFLOATING, HYPOID REAR AXLE

1—Differential Bearing Cup
2—Differential Bearing Cone
3—Differential Bearing Shim
4—Differential Case
5—Ring Gear and Pinion
6—Pinion Shaft Rear Bearing Cone
7—Pinion Shaft Rear Bearing Cup
8—Pinion Shaft Bearing Shim
9—Pinion Shaft Bearing Shims
10—Lubrication Fitting
11—Housing Assembly
12—Pinion Shaft Front Bearing Cup
13—Pinion Shaft Front Bearing Cone
14—Pinion Bearing Oil Seal
15—Pinion Shaft Oil Seal Gasket
16—Drive Pinion Oil Slinger
17—Universal Joint Yoke
18—Pinion Nut Washer
19—Pinion Nut
20—Inner Oil Seal
21—Wheel Bearing Cone
22—Wheel Bearing Cup
23—Axle Bearing Shims
24—Cotter Pin
25—Axle Shaft Nut
26—Axle Shaft Washer
27—Axle Shaft Key
28—Hub and Drum
29—Bolt—Brakes to Housing
30—Lockwasher
31—Nut—Brakes to Housing
32—Brake Grease Protector
33—Brake Grease Protector Gasket
34—Grease Retainer
35—Brake Assembly
36—Drain Plug
37—Axle Shaft
38—Side Gear Thrust Washer
39—Differential Gear Set
40—Differential Pinion Thrust Washer
41—Axle Shaft Spacer
42—Housing Cover Gasket
43—Lock Washer
44—Housing Cover Screw
45—Filler Plug
46—Housing Cover
47—Pinion Shaft Lock Pin
48—Pinion Mate Shaft
49—Bolt Lock Strap
50—Ring Gear Screws

faces. Line up the holes in the bevel gear with those on the differential case and then place it in position on the case by tapping it lightly with a mallet. Install the screws which hold the bevel gear to the differential case. Make certain that the screw locks are bent around the heads so there is no possibility of the screws working loose.

Note: If ring gear bolt locking straps (Fig. 260, No. 49) are not present, install them using longer screws (50).

The adjustment of the differential bearings is maintained by the use of shims placed between the differential case and the bearing cones with an .008" (2.03 mm.) pinch fit when assembled in the axle housing. If shims are installed between the differential case and bearing cones, remove the bearing cones and shims as shown in Fig. 241. Reinstall bearing cones, without shims, with bearing driver Tool No. W-142, Fig. 261 and place the assembly in the housing with bearing cups and force the assembly to one side. Check the clearance between the bearing cup and the case with a feeler gauge as shown in Fig. 262.

After the clearance has been determined add .008". This will give thickness of shims required for proper bearing adjustment. Remove the bearings and install equal thickness of shims on each side and replace the bearings.

When overhauling the full-floating type differential used on all front axles of four-wheel drive vehicles, check the inner axle oil seals, to determine if they are satisfactory. Should new seals be required install them with Tool No. W-128 as shown in Fig. 263.

Install the differential assembly in the housing. In the absence of Tool No. W-129, Fig. 244. differential carrier spreader, the assembly may be installed by cocking the bearing cups slightly when the differential is placed in the housing and then tapping them lightly with a mallet, see Fig. 264.

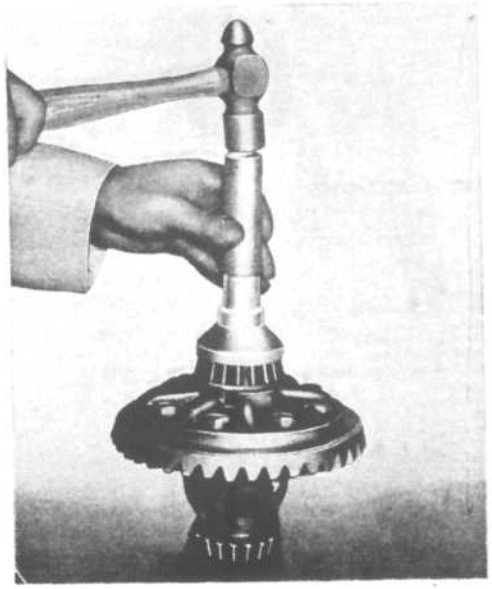


FIG. 261—DIFFERENTIAL BEARING DRIVER

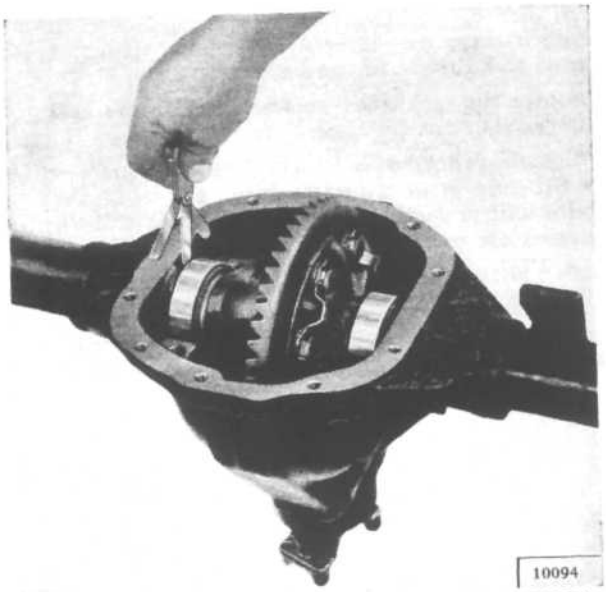


FIG. 262—CHECKING DIFFERENTIAL BEARINGS

CAUTION: When installing the differential in the housing be sure that the ring gear teeth mesh with the pinion teeth before tapping the bearings into place.

After the bearing cups are placed firmly in position in the housing, install the differential bearing caps. It is important that the caps be installed in the same position from which they were removed. Each cap should be installed so numeral corresponds with the numeral on the housing. Torque wrench reading, 38–42 ft. lbs. (5.2–5.8 kg. m.).

Securely tighten the differential bearing caps and check the bevel gear for runout and backlash.

If the bevel gear and pinion have some backlash, check the back face of the ring gear for runout. Mount the dial indicator on the case with the dial gauge contact point against the rear face of the bevel gear. As the gear is turned the total indicator reading in excess of .003" (.076 mm.) indicates a sprung differential case or an improperly installed

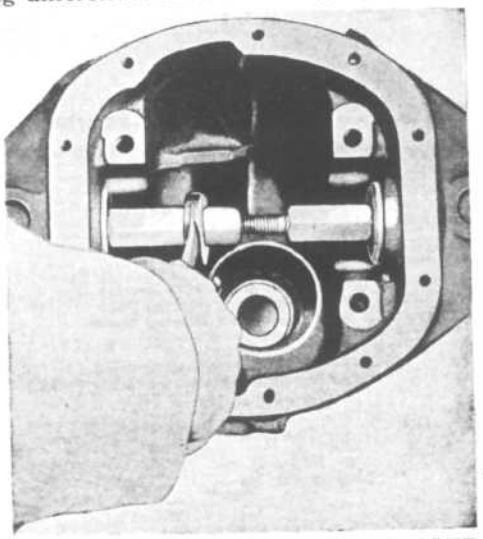


FIG. 263—INNER OIL SEAL INSTALLER



FIG. 264—INSTALLING DIFFERENTIAL

bevel gear. In either case the assembly must be taken apart and rechecked thoroughly.

Check the backlash by mounting the dial indicator on the rear axle housing directly in line with the gear and with the contact point of the indicator contacting the corner of one of the gear teeth. Fig. 266. Move the bevel gear by hand to indicate the amount of backlash. Correct backlash between the ring gear and pinion is given in the Specifications at the end of Sections N and O.

In the event the backlash is not correct, it will be necessary to change the shims back of the differential case bearings. Changing the position of a .005" (.127 mm.) shim from one side to the other will change the amount of backlash approximately .0035" (.0889 mm.).

In order to assist in determining whether the gears are properly adjusted, if the pinion and ring gear gauge set No. W-99-A is not available, paint the bevel gear teeth with red lead or prussian blue and turn the bevel gear so the pinion will make an impression on the teeth. The correct procedure to follow in the event of an unsatisfactory tooth contact is shown in Fig. 265.

After the differential has been assembled and adjusted, the pinion shaft oil seal should be installed. Remove the sleeve previously installed in place of the universal joint yoke and install the oil seal with Tool No. W-147, Fig. 267. Install the universal joint yoke and tighten the nut solidly in place and then install a cotter pin.

Install the axle shafts as instructed under "Axle Shaft" and replace the differential housing cover. Fill the differential housing with the proper amount of lubricant. See "Lubrication Chart", and check the axle shaft oil seals.

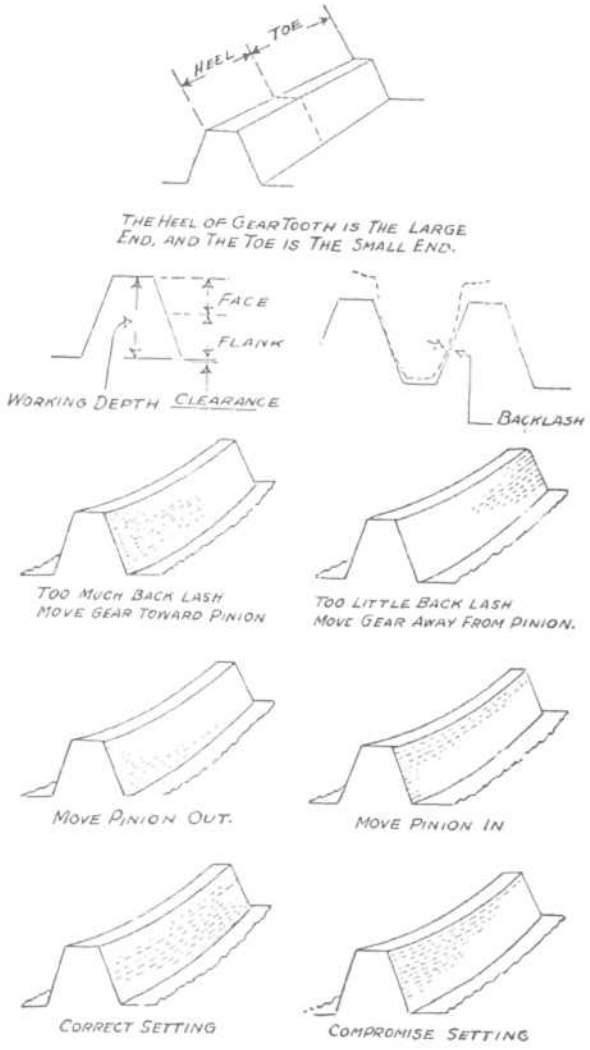


FIG. 265—GEAR TOOTH CONTACT

O-9. Overhauling Spiral Bevel Differential

It is necessary to divide the axle housing at the center to inspect or remove the differential. The differential may be removed without removing the pinion shaft and the pinion shaft and bearings assembly may be removed without dividing the axle housing. Drain the lubricant from the housing. Raise the vehicle to remove weight from the rear wheels and

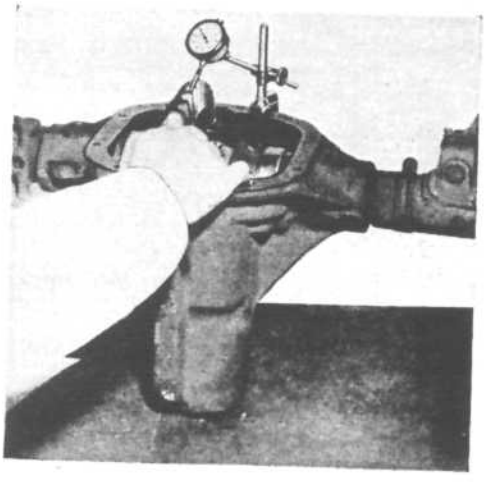


FIG. 266—BACK LASH CHECKING GAUGE

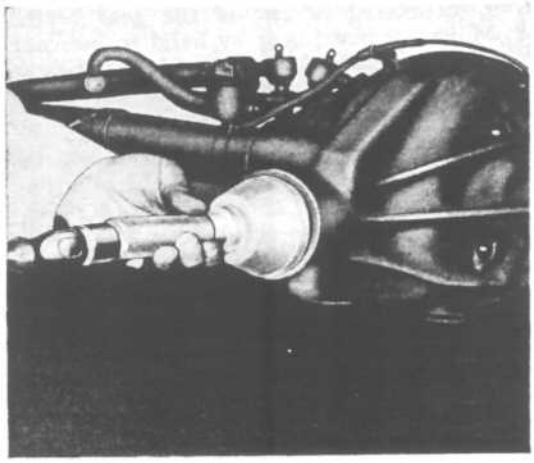


FIG. 267—PINION SHAFT OIL SEAL INSTALLER

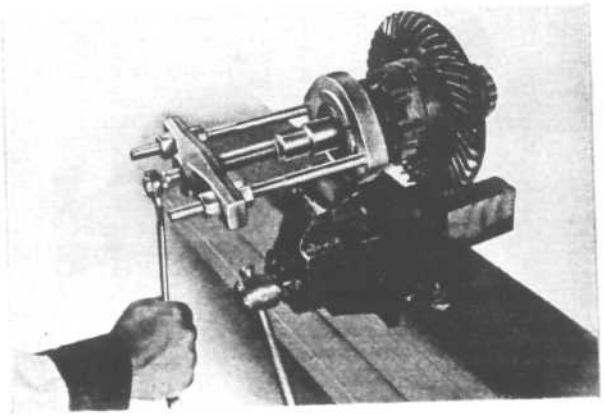


FIG. 268—DIFFERENTIAL BEARING PULLER

axle. Remove the spring clips which attach the left side of the axle housing to the spring. Place a jack under the right housing next to the differential to support the weight when the left half is removed. Remove the eleven screws connecting the two housing halves. Skid the left housing to the left to separate the two housing halves, pulling the left axle shaft from the differential splines. The differential as an assembly may then be removed from the right housing.

Wash the assembly in solvent and examine it for wear or damage.

The ring gear is riveted to the differential case, however, the differential gears and thrust washers may be installed without removing the ring gear by dividing the differential case. To divide the case cut

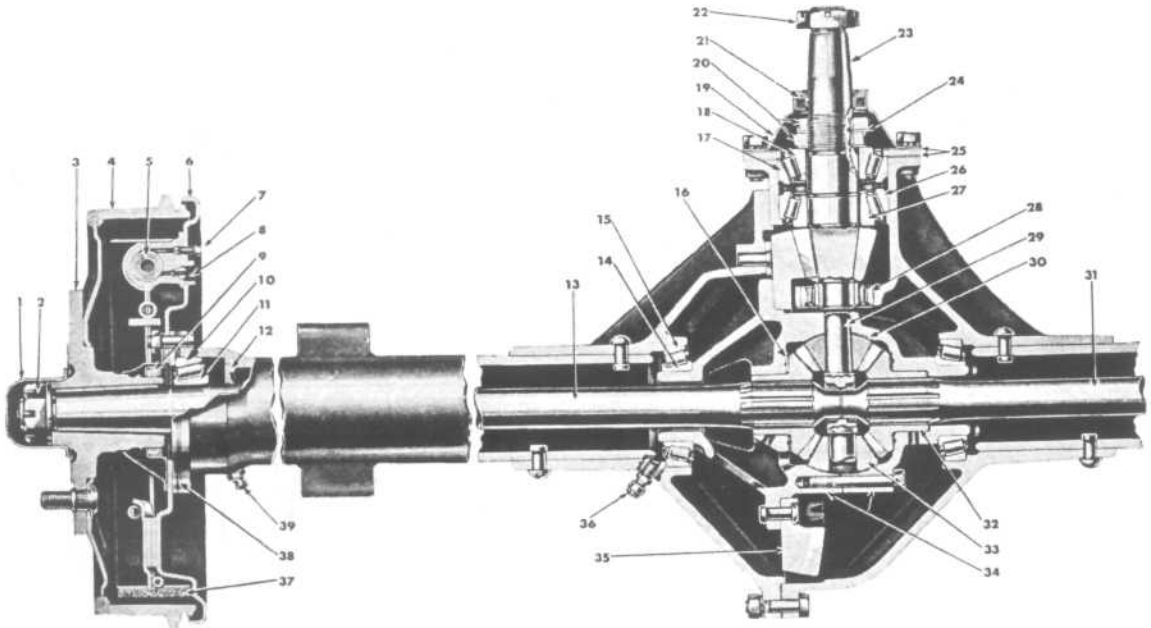


FIG. 269—SPIRAL BEVEL REAR AXLE

1. Wheel Hub Cap—Left or Right
2. Axle Shaft Nut
3. Wheel Hub
4. Brake Drum
5. Brake Cylinder Assembly—Rear
6. Brake Backing Plate
7. Brake Cylinder Bleeding Screw
8. Brake Hose Connection
9. Axle Shaft Grease Retainer—Outer
10. Axle Shaft Bearing Race
11. Axle Shaft Bearing Cone and Rollers
12. Axle Shaft Grease Retainer—Inner
13. Axle Shaft—Left
14. Differential Bearing Cone and Rollers
15. Differential Bearing Race
16. Differential Side Gear Thrust Washer
17. Pinion Shaft Bearing Race
18. Pinion Shaft Bearing Cone and Rollers
19. Pinion Front Bearing Cover
20. Pinion Front Bearing Adjusting and Lock Nut
21. Pinion Cover Oil Seal
22. Pinion Nut
23. Pinion
24. Pinion Adjusting Nut Lock
25. Pinion Cover Gaskets
26. Pinion Bearing Race
27. Pinion Bearing Cone and Rollers
28. Pinion Rear Bearing
29. Differential Spider
30. Differential Pinion Thrust Washer
31. Axle Shaft Right
32. Differential Side Gear
33. Differential Pinion
34. Differential Case
35. Spiral Bevel Ring Gear
36. Axle Breather
37. Brake Shoe Assembly
38. Axle Shaft Bearing Shim
39. Lubricator

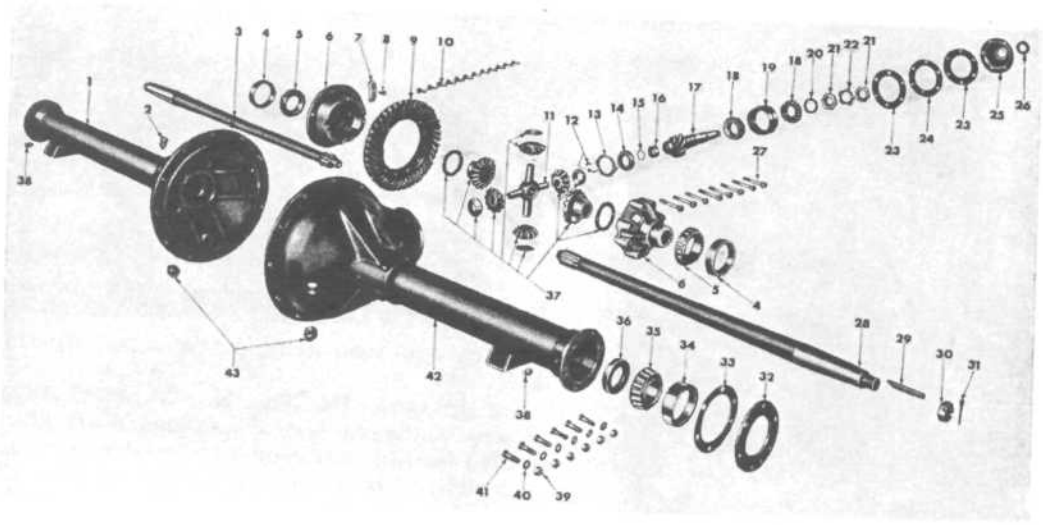


FIG. 270—SPIRAL BEVEL REAR AXLE

1. Left Axle Housing
2. Axle Vent
3. Axle Shaft—Left
4. Differential Bearing Cup
5. Differential Bearing Cone and Rollers
6. Differential Case
7. Thrust Block
8. Thrust Block Pin
9. Axle Ring Gear
10. Ring Gear Rivet
11. Differential Spider
12. Bearing Retainer Rivet
13. Bearing Retainer
14. Rear Pinion Bearing
15. Rear Pinion Bearing Lock Ring
16. Rear Pinion Bearing Race
17. Drive Pinion
18. Pinion Bearing Cone and Roller
19. Pinion Bearing Cup—Front
20. Thrust Washer
21. Pinion Bearing Adjusting Nut
22. Adjusting Nut Lock Nut
23. Cover Gasket
24. Pinion Bearing Spacer
25. Pinion Bearing Cover
26. Cover Oil Seal
27. Differential Case Bolt
28. Axle Shaft—Right
29. Axle Shaft Key
30. Axle Shaft Nut
31. Cotter Pin
32. Flange Retainer
33. Axle Shaft Bearing Shim
34. Axle Shaft Bearing Cup
35. Axle Shaft Bearing Cone and Rollers
36. Axle Shaft Inner Oil Seal
37. Differential Gear Set
38. Hydraulic Fitting
39. Nut
40. Lockwasher
41. Flange Bolt
42. Axle Housing—Right
43. Axle Housing Plug

the locking wire and remove the nine screws holding the halves together.

Should it be necessary to remove the differential mounting cone and rollers use Tool No. W-104-20, Fig. 268 to pull them. The bearing cups may be pulled from the housing with Tool No. W-200 as shown in Fig. 271.

Assembly is the reverse of disassembly. The differential gears and thrust washers are supplied only as matched sets, however, the spider is supplied separately. If any of the following parts must be replaced, the complete set should be installed:

a. Differential pinions.

b. Differential pinion thrust washers.

c. Side gears.

d. Side gear thrust washers.

As an example, the use of three new and one used pinion thrust washer would probably result in premature failure.

Install the differential mounting cone and rollers. The cups may be installed in the axle housing with Tool No. W-204 as shown in Fig. 272.

Before installing the differential assembly examine the ring gear bronze thrust block, No. 7, Fig. 270 which is mounted in the left housing, for scores or roughness. This is riveted to the housing and may be readily replaced.

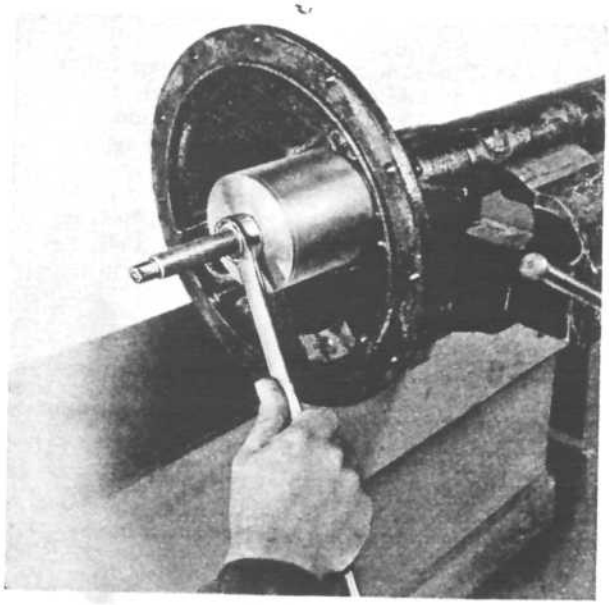


FIG. 271—DIFFERENTIAL BEARING CUP PULLER

O-10. Overhauling Drive Pinion

All Spiral Bevel Gear Axles

The pinion shaft and bearings assembly may be removed without disturbing the differential assembly or dividing the axle housing. Should this be done,

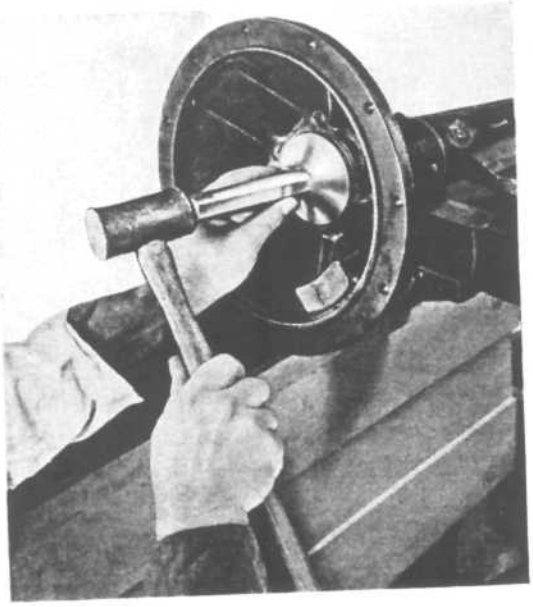


FIG. 272—DIFFERENTIAL BEARING CUP DRIVER

however, check the bearing preload before reinstalling in the housing.

To remove the pinion and bearings assembly first remove the pinion shaft cover, No. 25, Fig. 270, with the oil seal. Remove the six screws attaching the cover to the housing and remove the cover, the spacer (bearing retainer) and the gaskets. Pull the pinion shaft assembly with Puller Tool No. W-203, Fig. 273.

The pinion shaft is mounted on two tapered roller bearings with a double cup made as a single piece. To remove the bearings put the drive pinion in a vise protected with brass vise jaws. Bend up the locking lips on locking washer, No. 24, Fig. 269, and remove the locking nut, the washer and the adjusting nut. The front cone and the double bearing cup may be easily removed as the cone is a slip fit

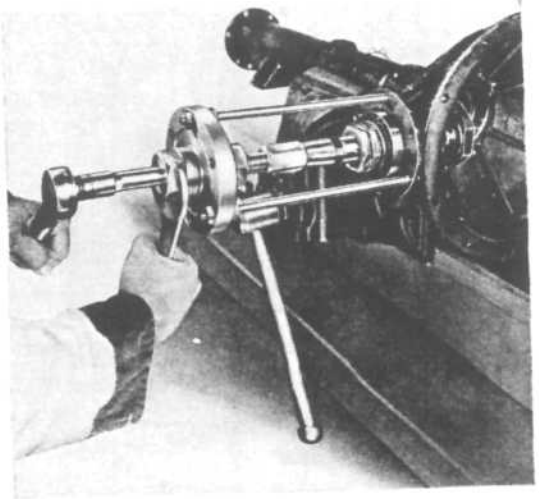


FIG. 273—PINION AND BEARING REMOVER AND REPLACER

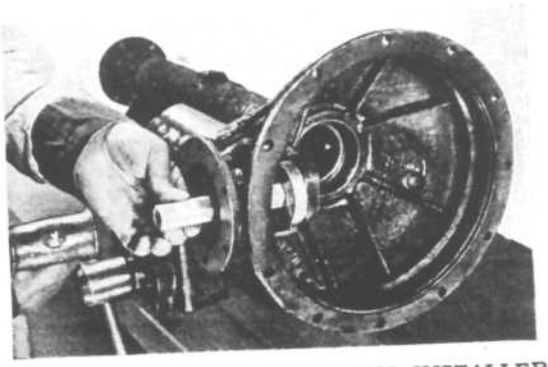


FIG. 274—PINION PILOT BEARING INSTALLER

on the shaft. Use Tool No. W-104-32, Fig. 251 to remove the rear cone. The pinion shaft pilot (straddle) bearing is mounted in the axle housing and is positioned by retainer plate No. 13, Fig. 270. Two tubular type rivets hold the plate against the housing. To remove the pilot bearing, first drive out the rivets from the front side of the axle, remove the retainer plate and using a brass drift drive the bearing from the housing.

The axle parts are precision machined and no adjustment of ring gear and pinion mesh is provided. The ring gear and pinion are supplied only in matched sets and the pinion shaft pilot bearing race is supplied mounted on the shaft pilot.

To assemble pinion and bearings:

- **a.** Install pilot bearing retainer and drive the bearing into place with Tool No. W-207, Fig. 274.
- **b.** If necessary (new pinions supplied with cup and snap ring installed) press the pinion pilot bearing inner cup onto the pinion shaft. Install the snap ring.
- **c.** Press rear pinion shaft bearing firmly against pinion shoulder. Use Tool No. W-205, Fig. 275.

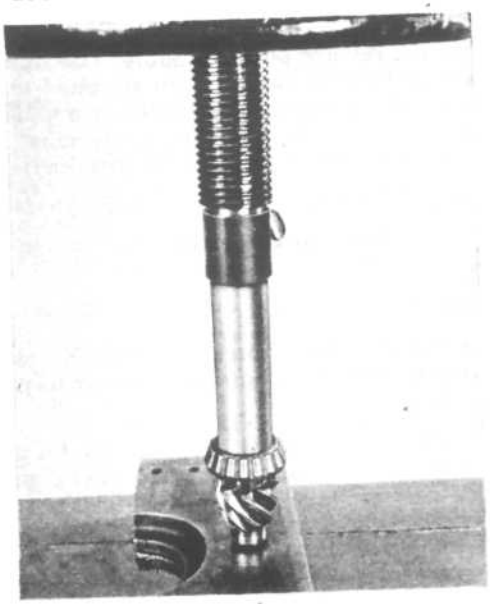


FIG. 275—PINION REAR BEARING INSTALLING SLEEVE

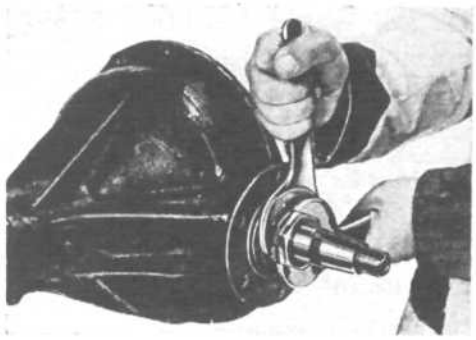


FIG. 276—PINION BEARING ADJUSTING WRENCHES

d. Position cup over rear bearing.
e. Install the front bearing.
f. Install washer, adjusting nut, locking washer and lock nut.

Use wrenches Tool No. W-201, Fig. 276 to set the adjusting nut to sufficiently preload the bearings to provide 12 – 18 inch pounds (.14 – .21 kg.-m.) torque on the pinion shaft with the adjusting nut lock nut tightened. This preload is necessary for satisfactory pinion shaft bearing operation because these bearings carry the thrust as well as radial load. Guard against overtightening however, as heating and bearing failure might result. Do not overlook bending over the lip of the locking washer. Install the pinion shaft and bearings assembly in the axle housing with Installer Tool No. W-203, Fig. 273 being sure the pilot race enters the pilot bearing in the housing.

Check the oil seal in the pinion shaft cover. Should replacement be necessary install a new seal, Fig. 277. Position new gaskets and the bearing spacer (retainer) with the oil drain hole in alignment with the opening in the housing. Install the cover.

Install the differential assembly and assemble the axle housing halves. When assembly is completed check the backlash between the ring gear and pinion which must be between .004″ and .018″ (.102 – .457 mm.).

O-11. Installing Rear Axle in Vehicle

To install the axle under the vehicle, have the end of the vehicle securely supported with a chain hoist or a support under the frame just ahead of the rear springs. Place the axle assembly in position and raise it so the spring clips and front spring bolts may be installed. Next connect the brake line hose at frame, install lock clip and attach the brake line. Connect the propeller shaft at the rear universal joint. The wheels may then be installed and the vehicle lowered to the floor. Bleed the brakes to remove any air from the lines, first making certain that there is an ample supply of brake fluid in the master cylinder reservoir.

See "Brake" Section for further instructions.

Fill the housing with the proper lubricant. See "Lubrication" Section.

O-12. POWR-LOK DIFFERENTIAL

Optional equipment —

Identification, application, servicing, and trouble shooting of the Powr-Lok differential are explained in the following paragraphs.

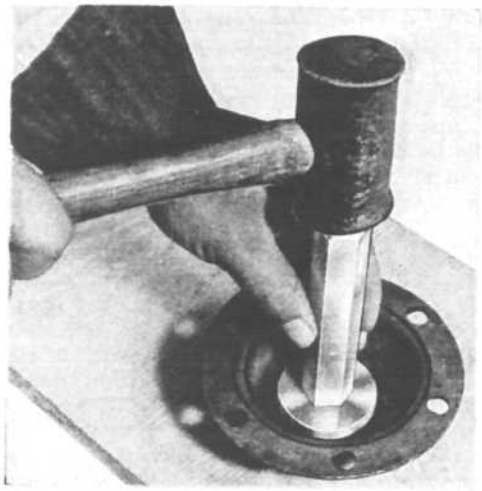


FIG. 277—PINION OIL SEAL INSTALLER

CAUTION: Do not operate the vehicle when one wheel of a Powr-Lok axle is jacked up.

O-13. Identification

Powr-Lok differentials are identified by a brass tag stamped with the letter **T** under one of the differential carrier housing cover screws. This tag is usually placed opposite the axle ratio tag.

O-14. Application

Both cone type and disc type Powr-Lok differentials have been used on vehicles with the model 44 rear axle. The disc type only is now available for these models. However, as it is interchangeable as a complete assembly with the cone type, no service problem is presented.

The Powr-Lok differential can be installed in the axle assembly of some models which did not have Powr-Lok as original equipment.

Note: When converting a standard axle to a Powr-Lok axle, if possible fashion a metal tag marked with the letter T for installing as described under Identification above.

On other models, a complete axle assembly and any related parts will be required to install Powr-Lok.

All vehicles with Model 44 rear axle can be converted by installing the proper Powr-Lok differential in place of the standard differential if the original axle shafts have involute splines. If not, the proper involute splined shafts for the vehicle will have to be installed.

The model 53 axle requires the complete replacement of the rear axle assembly.

O-15. Servicing Powr-Lok

Whenever a conversion or replacement Powr-Lok differential assembly is installed in an axle which has previously been in service and acquired mileage, be sure to record the amount of backlash between the ring gear and pinion at the time of disassembly. When the axle is again assembled the ring gear and pinion must be set to this same amount of backlash.

The Powr-Lok differential is serviced as a unit. Since no individual components will be available, it is of no particular use to disassemble the differential if just a single component is faulty. Other servicing operations, such as ring gear and pinion

replacement or pinion bearing adjustments, are performed in the same manner prescribed for Spicer axles.

O-16. Trouble Shooting Powr-Lok

Improper operation of the Powr-Lok differential is generally evident from one of two conditions.

a. Differential chatter. This is usually caused by use of the wrong lubricant in the axle differential. To eliminate the chatter, completely drain the old lubricant from the differential. Do not flush the differential. Refill with Willys Powr-Lok differential oil, Part No. 94557. In some cases, a second change of lubricant may be necessary. In an occasional extreme case, where the chatter still persists after a second change of lubricant, disassemble the axle and thoroughly remove all traces of lubricant from the carrier and the axle housing. The lubricant should be removed only by wiping with clean rags; do not use cleaning solvent of any kind. Then re assemble the axle and fill with Willys Powr-Lok differential oil.

b. Excessive backlash in the vehicle drive line. Excessive backlash can develop in the transmission, propeller shaft spline, universal joint, ring gear and pinion, axle shaft spline, or the differential. Backlash in the axle can be measured as follows: Jack up one rear wheel. CAUTION: Do not operate the vehicle as long as one wheel is jacked up.

Put the transmission in gear. Measure the travel of the jacked-up wheel on a 10″ [25 cm.] radius from the wheel center. Total movement should not exceed 1¼″ [3,2 cm.] for a new axle. To restrict the backlash to the axle only, make sure that the axle end yoke does not move during the check. If all the above causes of excessive backlash have been eliminated with the exception of the differential, replace the differential with a new one.

SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Axle Noisy on Pull and Coast	
Excessive Back Lash Bevel Gear and Pinion	Adjust
End Play Pinion Shaft	Adjust
Worn Pinion Shaft Bearing	Replace
Pinion Set Too Deep in Bevel Gear	Adjust
Pinion and Bevel Gear Too Tight	Adjust
Axle Noisy on Pull	
Pinion and Bevel Gear Improperly Adjusted	Adjust
Pinion Bearings Rough	Replace
Pinion Bearings Loose	Adjust
Axle Noisy on Coast	
Excessive Backlash in Bevel Gear and Pinion	Adjust
End Play in Pinion Shaft	Adjust
Improper Tooth Contact	Adjust
Rough Bearings	Replace
Backlash	
Worn Differential Pinion Gear Washers	Replace
Excessive Backlash in Bevel Gear and Pinion	Adjust
Worn Universal Joints	Replace

REAR AXLE SPECIFICATIONS

MODEL:	L6-226 4WD	L6-226 4x4	L6-226 4x2	F4-134 4WD	F4-134 4x4	F4-134 4x2
Rear Axle:						
Type	Semifloating	Semifloating	Semifloating	Semifloating	Semifloating	Semifloating
Make	Spicer	Spicer	Spicer	Spicer	Spicer	Spicer
Model	53	44	44	53-2	44	44
Drive	Thru Springs	Thru Springs	Thru Springs	Thru Springs	Thru Springs	Thru Springs
Road Clearance	8⅛″ [20,7 cm.]	8½″ [21,6 cm.]	7⅝″ [19,4 cm.]	8⅛″ [20,7 cm.]	8½″ [21,6 cm.]	7⅝″ [19,4 cm.]
Capacity	4500 lb.	3700 lb.	3700 lb.	4500 lb.	3700 lb.	3700 lb.
Differential:						
Type	Hypoid	Hypoid	Hypoid	Hypoid	Hypoid	Hypoid
Ratio	4.88:1	4.27:1	4.27:1	5.38:1	5.38:1	4.89:1
Differential Pinions	2	2	2	2	2	2
Pinion Adjustment	Shim	Shim	Shim	Shim	Shim	Shim
Pinion Bearing Adjustment	Shim	Shim	Shim	Shim	Shim	Shim
Pinion and Gear:						
Backlash	.003″ to .006″ [0,076 a 0,152 mm.]	.003″ to .006″ [0,076 a 0,152 mm.]	.003″ to .006″ [0,076 a 0,152 mm.]	.003″ to .006″ [0,076 a 0,152 mm.]	.003″ to .006″ [0,076 a 0,152 mm.]	.003″ to .006″ [0,076 a 0,152 mm.]
Adjustment	Shim	Shim	Shim	Shim	Shim	Shim
Wheel Bearings	Taper Roller	Taper Roller	Taper Roller	Taper Roller	Taper Roller	Taper Roller

STEERING SYSTEM

Contents

SUBJECT	PAR.
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Camber	P-12
Caster	P-13
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Front Wheel Shimmy	P-15
Front Wheel Turning Angle	P-14
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— Installation	P-4
— Overhaul	P-5
— Removal	P-3

P-1. GENERAL

The stability and proper functioning of the steering system depends in a large measure upon correct alignment, and a definite procedure for inspection of the steering system is recommended. In so doing, nothing is overlooked and any trouble is ascertained in the shortest possible time. It is suggested that the following sequence be used:

a. Equalize tire pressures and level vehicle.
b. Inspect spindle pivot pins and wheel bearing looseness.
c. Check wheel runout.
d. Test wheel balance and bearing adjustment.
e. Check for spring sag.
f. Inspect brakes and shock absorbers.
g. Check steering assembly and the steering connecting rods.
h. Check caster.
i. Check toe-in.
j. Check toe-out on turns.
k. Check camber.
l. Check king pin inclination.
m. Check tracking of front and rear wheels.
n. Check frame alignment.

When adjusting a steering gear remove all loads from the unit by disconnecting the steering connecting rod (drag link) from the steering arm and also loosen the instrument panel bracket and the steering gear to frame bolts to allow the steering post to correctly align itself. When retightening the 7/16" [11,1 mm.] steering-gear-to-frame bolts, torque them to 45 to 55 lb-ft. [6,22 a 7,6 kg-m.]. Early production Model F4-134 4x2 vehicles were equipped with 3/8" [9,5 mm.] bolts which should be torqued 30 to 40 lb-ft. [4,15 a 5,5 kg-m.].

Do not tighten the steering gear to dampen out steering trouble. Adjust the steering only to remove lost motion or play within the unit.

P-2. Steering Gear Adjustment

The steering gear is the cam and lever, variable ratio type illustrated in Fig. 278.

Adjustment of the ball thrust bearings No. 31 to eliminate up and down play of the steering shaft is accomplished by removing shims which are installed between the steering gear housing and the upper cover. Before making this adjustment loosen the housing side cover adjusting screw No. 21 to free the pins in the cam groove. Loosen the housing cover to cut and remove a shim or more as required. Install the screws and tighten. Adjustment should be made to have a slight drag but allow the steering wheel to turn freely with thumb and forefinger lightly gripping the rim.

Shims installed for adjustment are .002", .003", and .010" (.0508, .0762 and .254 mm.) in thickness.

Adjustment of the tapered pins in the cam groove is accomplished by adjusting screw No. 21. Unlock the adjusting screw and turn it in until a very slight drag is felt through the mid-position when turning the steering wheel slowly from one extreme position to the other.

Backlash of the pins in the groove shows up as end play of lever shaft, also as backlash of steering arm.

The cam groove is purposely cut shallow in the straight ahead driving position for each pin. This feature permits a close adjustment for normal straight ahead driving and provides precision steering and permits take up of backlash at this point after the wear occurs without causing a bind elsewhere. Always adjust within the high range through the mid-position of pin travel. Do not adjust off "straight ahead" position. Backlash in turned positions is not objectionable.

P-3. Steering Gear Removal

It is necessary to pass the steering gear down through the floor pan.

1. Disconnect the remote control rods from the transmission control levers on models equipped with remote control.

2. Remove the horn button and steering wheel.
3. Remove the steering post bracket at the instrument panel.
4. Remove the gear shift lever (remote control type only).
5. Remove the exhaust pipe from the manifold. (Not necessary on L6-226 Models.)
6. Remove the steering column cover plate on the toe board.
7. Remove two screws attaching remote control housing to the steering column.
8. Disconnect horn wire.
9. Remove the remote control assembly down through the floor pan.
10. Remove steering connecting rod from steering gear arm ball.
11. Remove bolts attaching steering gear housing to frame.
12. Remove the assembly by bringing it down through the floor pan and over the outside of the frame side rail.

P-4. Steering Gear Installation

Installation of the steering gear assembly is the reverse of the removal outlined above. Do not overlook adjustment of the remote control shift rod as outlined in the "Transmission" section.

P-5. Steering Gear Overhaul

All models are equipped with the cam and lever, variable ratio type steering gear.

While the various models are slightly different in detail the following outline for dismantling and assembly may be followed:

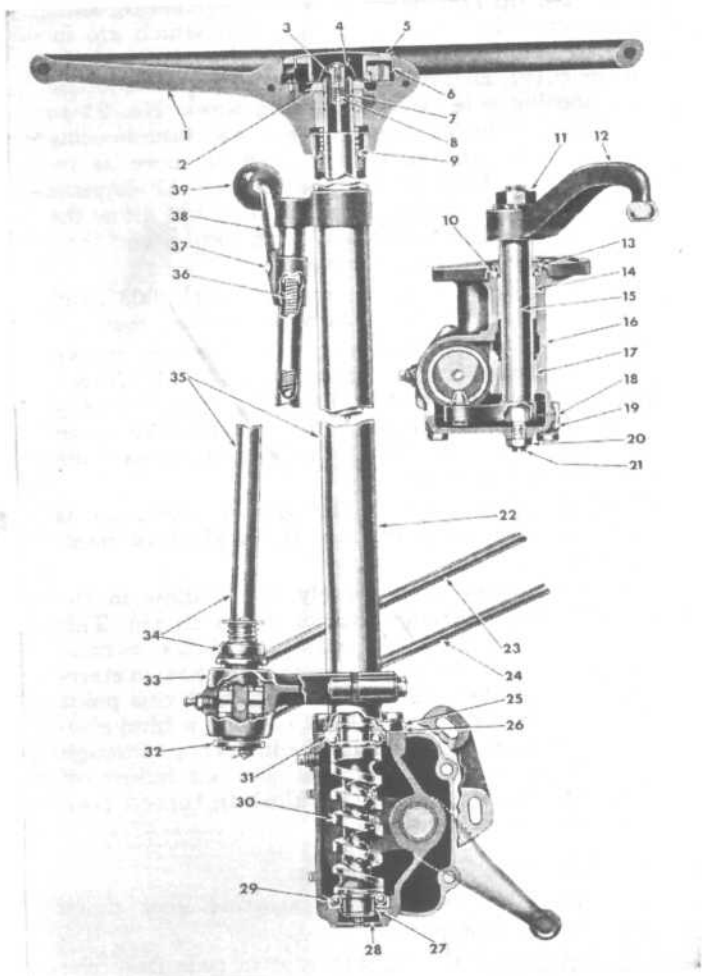
a. Remove the steering gear arm (Fig. 278, No. 12) with a puller.

b. Loosen the lock nut and unscrew the adjusting screw (21) two turns.

c. Remove the side cover screws and washers. Remove the side cover (19) with its gasket.

d. Remove the lever shaft (15).

e. Remove the upper cover plate screws. Remove the cover (25), cam, and wheel tube and bearing assembly from the housing.



1. Steering Wheel
2. Steering Wheel Nut
3. Horn Button Ferrule
4. Contact Button Cup
5. Horn Button
6. Trim Ring
7. Horn Button Spring
8. Horn Button Spring Cup
9. Steering Column Bearing
10. Lever Shaft Oil Seal
11. Lever Shaft Nut
12. Steering Gear Arm
13. Lever Shaft Oil Seal Gasket
14. Outer Housing Bushing
15. Shaft and Lever
16. Steering Gear Housing
17. Inner Housing Bushing
18. Side Cover Gasket
19. Housing Side Cover
20. Adjusting Screw Lock Nut
21. Adjusting Screw
22. Steering Gear Column
23. Low and Reverse Remote Control Rod
24. High and Intermediate Remote Control Rod
25. Housing Upper Cover
26. Upper Cover Shim
27. Bearing Snap Ring
28. End Cover and Tube
29. Cam Bearing Ball
30. Steering Gear Tube and Cam
31. Cam Bearing Cup
32. High and Intermediate Lever with Clutch
33. Remote Control Bracket with Cap
34. Remote Control Shifting Shaft
35. Control Shaft with Column
36. Bias Spring
37. Control Lever Pin
38. Gear Shift Control Lever
39. Control Lever Ball

FIG. 278—STEERING GEAR

After dismantling as outlined above is completed, inspect cam grooves for wear, chipping and scoring, also the ball races on the cam ends and the separate ball cups. Existence of any of these conditions indicates the necessity for parts replacement.

Inspect the tapered stud mounted on the lever shaft for flat spots and chipping. In the case of either, replacement is usually advisable. Inspect the lever shaft for wear and test the fit of the shaft in the bushings.

Inspect condition of the oil seal at outer end of lever shaft and the bearing at top end of steering column.

Reassemble all parts to wheel tube in reverse order of dismantling.

Assemble cam, wheel tube and bearing assembly in housing, seating the lower bearing ball cup, No. 29, Fig. 278, in the housing.

With adjusting shims in place, assemble upper cover and adjust the cam bearings (29 & 31).

Assemble lever shaft, No. 15 in housing and with gasket in place assemble the side cover and set adjusting screw No. 21 for a minimum backlash of the studs in the cam groove, with the steering gear at the center point of travel.

When assembling upper bearing spring and spring seat in jacket tube make sure that the spring seat is positioned correctly. It must be installed with the lengthwise flange down against the bearing and not up inside of spring coil.

Install steering gear assembly in chassis in the reverse order in which it was removed.

After installing the assembly in the vehicle, place the front wheels in the straight ahead position. Temporarily install the steering wheel to locate the mid-position of the steering gear. To locate the mid-position, turn the steering wheel as far to the right as possible and then turn in the opposite direction as far as possible, noting the total number of turns. Turn the wheel back just ½ of the total movement to place the gear in mid-position.

With the steering gear in mid-position and the wheels in the straight ahead position, install steering gear arm (12) on the lever shaft (15).

When the steering gear arm is installed on early production Model F4-134 vehicles, the line across the face of the arm and the end of the shaft should be in alignment. On later production F4-134 and all L6-226 vehicles, blind splines on the lever shaft and in the steering gear arm ensure correct positioning of the arm.

Remove the steering wheel without disturbing the mid-position of the steering gear. Reinstall it with the spokes positioned parallel with the vehicle floor.

Do not overlook adjustment of the transmission remote control shift rods as outlined in the "Transmission Section".

P-6. Steering Connecting Rod

The steering connecting rod is of the ball and socket type. All ball seat springs and adjusting plugs are identical, the only difference between front and rear end being the relative location of the springs. The correct assembly of the steering connecting rod used on all models discussed here is shown in Fig. 386. At the front or axle end, the spring and spacer are assembled between the rod and ball seat, while at the steering gear end, spring and spacer are between the ball seat and the end plug. In the illustration the front end is to the left.

When removing springs and seats for any reason, make sure they are reassembled as shown in the illustration because this method of assembly relieves road shock from the steering gear in both directions. To adjust the ball joint, screw in the plug firmly against the ball, then back off one half turn and lock with a new cotter pin inserted through holes in the tube and the slot in the adjusting plug. To adjust the ball joint at the steering gear arm, screw in the end plug firmly against the ball, then back off one full turn and lock with a new cotter

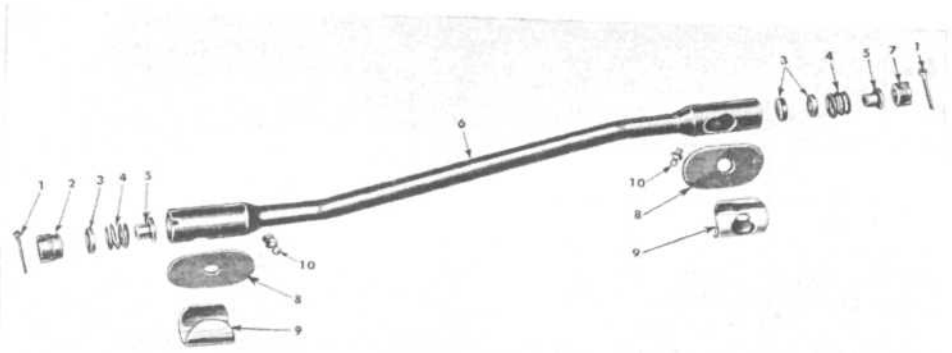


FIG. 279—STEERING CONNECTING ROD

1. Cotter Pin
2. Adjusting Plug
3. Ball Seat
4. Ball Seat Spring
5. Plug Spring
6. Connecting Rod
7. Adjusting Plug
8. Dust Cover
9. Dust Cover Shield
10. Lubricating Fitting

pin inserted through holes in the tube and the slot in the adjusting plug.

The above adjustments will give the proper spring tension and avoid any tightness when swinging the wheels from maximum left to right turn.

The ball joints must be tight enough to prevent end play and yet loose enough to allow free movement.

P-7. Tie Rod

The tie rods are of three piece construction consisting of the rod and two ball and socket end assemblies. Ball and socket end assemblies are threaded into each rod and locked with clamps around each end of the rod. Right and left hand threads on tie rod end assemblies provide toe-in adjustment without removing the tie rod ends from the steering arms.

A single tie rod connects the steering knuckle arms on all models except early production Model F4-134 4x2 vehicles.

The twin or divided type of tie rod used on early production F4-134 4x2 vehicles requires that each wheel be adjusted independently. See Fig. 237.

When wear takes place in the tie rod end ball and socket, it will be necessary to replace the ball and socket assembly and also the rubber seal. Due to the location of the tie rod ball and socket assemblies lubrication is of utmost importance. Lubricate them regularly each 1000 miles (1600 km.).

P-8. Front Wheel Alignment

Proper alignment of front wheels must be maintained in order to insure ease of steering and satisfactory tire life.

The most important factors of front wheel alignment are wheel camber, axle caster and wheel toe-in.

Wheel toe-in is the distance the wheels are closer together at the front than at the rear.

Wheel camber is the amount the wheels incline outward at the top from a vertical position.

Front axle caster is the amount in degrees that the steering pivot pins are tilted towards the front or rear of the vehicle. Positive caster is inclination of the top of the pivot pin towards the rear of the vehicle. Zero caster is the vertical position of the pivot pin. Negative or reverse caster is the inclination of the top of the pin towards the front of the vehicle.

These points should be checked at regular intervals, particularly when the front axle has been subjected to a heavy impact. When checking wheel alignment, it is important that wheel bearings and knuckle bearings be in proper adjustment. Loose bearings will affect instrument readings when checking the camber, pivot pin inclination and toe-in.

To accurately check camber and caster, use a wheel aligning fixture. Camber and caster of the front wheels are both preset. Camber cannot be altered but caster can be adjusted by installing caster shims between the axle pad and the springs. Wheel toe-in may be adjusted. To measure wheel toe-in, use a wheel aligning fixture or follow the procedure given in Par. P-9.

The front axle alignment specifications are outlined at the end of this section.

P-9. Front Wheel Toe-In

Toe-in as illustrated in Fig. 280 is necessary to offset the effect of camber as shown in Fig. 281.

In the absence of a wheel aligning fixture, toe-in may be set by measuring between the front wheels at the edge of the rim, at the flange or at the tire tread center. When making this adjustment the wheels must be in a straight ahead position.

It is highly important that toe-in be checked regularly and if found to be out of adjustment, correction should be made immediately.

On all vehicles equipped with the planar type front suspension, toe-in adjustment must be made at curb weight.

The correct toe-in of the various models is found in the specifications of this section.

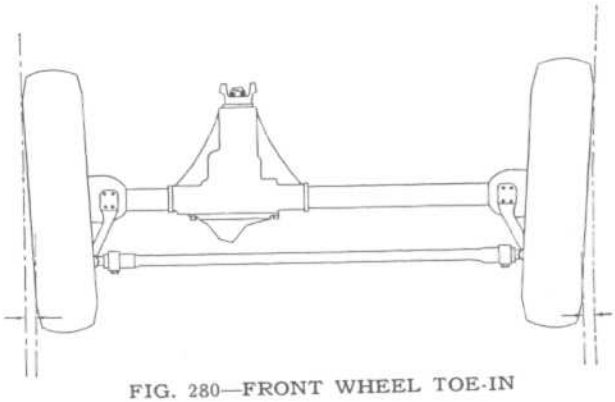


FIG. 280—FRONT WHEEL TOE-IN

P-10. Toe-In Adjustment

All except early F4-134 4x2 vehicles.

To adjust the wheel toe-in of these models, first raise the front of the vehicle to free the front wheels. Turn the wheels to the straight ahead position. Use a steady-rest to scribe a pencil line in the center of each tire tread as the wheel is turned by hand. A good way to do this is to first coat a strip with chalk around the circumference of the tread at the center to form a base for a fine pencil line.

Measure the distance between the scribed lines at the front and rear of the wheels using care that both measurements are made at an equal distance from the floor. The distance between the lines should be greater at the rear than the front by the amount shown in the specifications. To make adjustment to obtain this distance loosen the clamp bolts and turn the tie rod with a small pipe wrench. The tie rod is threaded with right and left hand threads to provide equal adjustment at both wheels. Do not overlook retightening the clamp bolts.

It is common practice to measure between the wheel rims. This is satisfactory providing the wheels

run true. By scribing a line on the tire tread, measurement is taken between the road to tire contact points which will reduce error due to wheel run-out.

P-11. Toe-In Adjustment

Early F4-134 4x2 vehicles.

The toe-in of these models varies slightly in proportion to the vehicle load due to the independent front wheel suspension. The standard toe-in is correct for the vehicle at curb weight, which is the standard weight of the vehicle including fuel, oil, water and spare tire. Guard against setting toe-in when the vehicle is loaded.

To adjust, first jack up the front end of the vehicle to free the front wheels. Turn the steering wheel through its entire range of movement, counting the turns, after which reverse the wheel one-half the total turns. In this position the steering wheel spokes should set parallel to the windshield and the steering gear arm should be in the straight ahead position (steering gear in straight ahead driving position).

With the divided tie rod each wheel is adjusted independently which makes it necessary to first adjust both wheels to a true straight ahead position. Be sure that the steering gear arm points straight forward. If necessary loosen the tie rod adjusting sleeve clamps and adjust the sleeves to position the wheels.

Use chalk to coat a strip at the center of each tire tread for the entire circumference of the tread. Use a steady rest to hold a pencil against the exact tread center and scribe a line in the chalked surface around the tread by turning the wheel by hand. After scribing both tires remove the jack and roll the vehicle back and forth for a few feet to allow the front wheels to return to normal running position.

After positioning the wheels carefully measure between the scribed lines at the front and rear of the tires and at an equal distance from the floor to set the toe-in as specified. Correct adjustment will require approximately ¼ turn of the adjusting sleeve of each tie rod. Tighten the adjusting sleeve clamp screws.

P-12. Front Wheel Camber

The purpose of camber Fig. 281 is to more nearly place the weight of the vehicle over the tire contact on the road to facilitate ease of steering.

The result of excessive camber is irregular wear of tires on outside shoulders and is usually caused by bent axle parts.

The result of negative or reverse camber, if excessive, will be hard steering and possibly a wandering condition. Tires will also wear on inside shoulders. Negative camber is usually caused by excessive wear or looseness of front wheel bearings, axle parts or the result of a sagging axle.

Unequal camber may cause any or a combination of the following conditions: unstable steering, wandering, kick-back or road shock, shimmy or excessive tire wear. The cause of unequal camber is usually a bent steering knuckle or axle end.

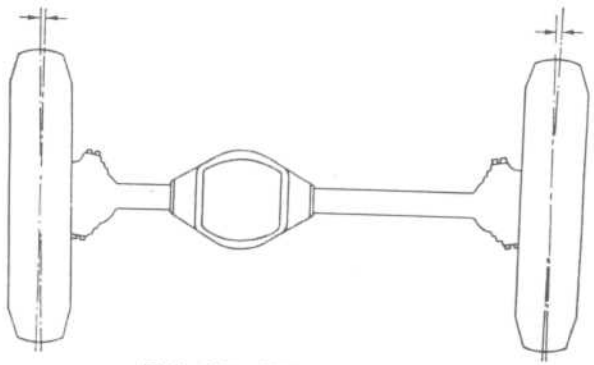


FIG. 281—WHEEL CAMBER

Correct wheel camber of all models excepting those equipped with planar type front suspension is set in the axle at the time of manufacture and cannot be altered by any adjustment. It is important that the camber be the same on both front wheels. Heating of any of these parts to facilitate straightening usually destroys the heat treatment given them at the factory. Cold bending may cause a fracture of the steel and is also unsafe. Replacement with new parts is recommended rather than any straightening of damaged parts.

On those models equipped with planar type front suspension the wheel camber is controlled by shim packs No. 37, Fig. 238, which are installed between the frame and the upper support arm frame brackets. Adjustment is through selection of the correct shim thickness. Shims .060″ and .120″ (1.524 mm. and 3.048 mm.) in thickness are available.

When adjustment is made the thickness of shim packs required for each wheel must be determined individually as one wheel of a vehicle may require more shims than the other, due to some variation in manufacture. Shim pack thickness between the frame and brackets on any one side of the vehicle must be of equal thickness. For additional information see Section N.

P-13. Axle Caster

The purpose of caster Fig. 282 is to provide steering stability which will keep the front wheels in the straight ahead position also assist in straightening up the wheels when coming out of a turn.

Caster of the front wheels is preset. If the angle of caster, when accurately measured, is found to be incorrect, correct it to the specification given at the end of this section by either installing new parts or installing caster shims between the axle pad and the springs.

If the camber and toe-in are correct and it is known that the axle is not twisted, a satisfactory check may be made by testing the vehicle on the road. Before road testing, make sure all tires are properly

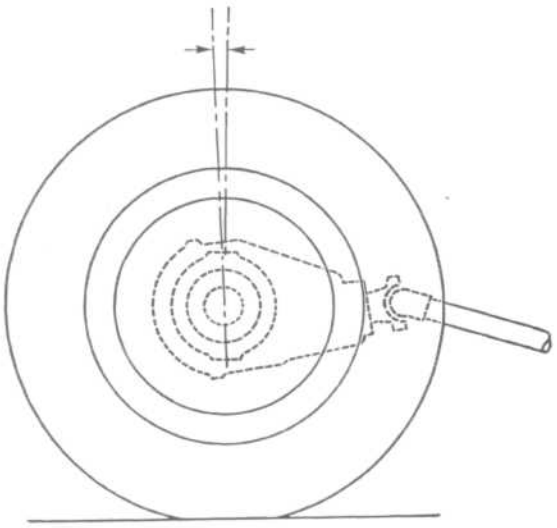


FIG. 282—AXLE CASTER

inflated, being particularly careful that both front tires are inflated to exactly the same pressure.

If vehicle turns easily to either side but is hard to straighten out, insufficient caster for easy handling of vehicle is indicated. If correction is necessary, it can usually be accomplished by installing shims between the springs and axle pads to secure the desired result.

P-14. Front Wheel Turning Angle

When the front wheels are turned, the inside wheel on the turn travels in a smaller circle than the outside wheel, therefore, it is necessary for the wheels to toe-out. This change in wheel alignment is obtained through the length and angularity of the steering knuckle arms in relation to the front axle. The left steering knuckle arm controls the relationship of the front wheels on a left turn and the right arm controls the relation on a right turn. If a forged type steering arm should be accidentally bent it can be straightened cold, if the bend is not excessive, otherwise the arm should be replaced.

See Par. N-13 for adjustment of the turning angle on 4-wheel-drive vehicles.

P-15. Front Wheel Shimmy

Wheel shimmy may be caused by various conditions in the wheels, axle or steering system, or a combination of these conditions. Outlined below will be found the usual corrections of this fault:

a. Equalize tire pressures and see that they are according to specifications.

b. Inspect pivot pin and wheel bearing looseness. Be sure that the inner wheel bearing race is not too loose on the spindle. Adjust wheel bearings and pivot pin bearings.

Pivot bearing adjustment is of special importance when adjusting 4-wheel drive steering systems. These bearings must be adjusted with the correct preload as outlined in the Front Axle Section and in the case of wheel shimmy the bearing races should be examined for damage due to brinelling (grooves worn in the race opposite each roller).

c. Check wheel run-out. This check should include radial run-out and for wheel looseness on the hub.

d. Test wheel balance — check for blowout patches, uniform tire tread, vulcanized tires, mud on inside of wheels, and tires creeping on the rims.

e. Try switching front wheels and tires to the rear criss-crossing them in this operation.

f. Check for front spring sag. Also check for broken spring leaves, broken center spring bolt, loose spring clips (or tight clips), over lubrication of spring leaves, spring shackle bracket loose on frame, and loose rear spring shackle. Be sure that the shock absorbers are operating properly to eliminate bobbing of the front end.

g. Check brakes to make sure that one does not drag.

h. Check the steering assembly and steering connecting rods. This includes the up and down play of the steering worm shaft, end play of the cross shaft, tightness of the steering gear in the frame, tightness of steering gear arm, adjustment of the steering connecting rod and condition of the steering tie rod ball joint ends.

i. Check front axle caster. This should be the same on both sides, otherwise a locking brake may be indicated causing a twisting action of the axle. Correct caster is shown in specifications at the end of this section.

j. Check the front wheel toe-in. See Specifications.

k. Check wheel toe-out on turns. This gives you an indication of the proper angularity of the steering knuckle arms and tells whether or not they have been bent and require replacing. These may be checked by comparing them with new parts. If an arm is bent, check for a bent tie rod.

l. Check wheel camber. This should be the same on both wheels as shown on the Specifications.

m. Check the king pin inclination. See Specifications.

n. Check the tracking of the front axle and frame alignment, which may be incorrect due to an accident.

SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Hard Steering	
Lack of Lubrication	Lubricate All Connections
Tie Rod Ends Worn	Replace
Connecting Rod Ball Joints Tight	Adjust
Cross Shaft Improperly Adjusted	Adjust
Steering Gear Parts Worn	Replace
Steering Loose	
Tie Rod Ends Worn	Replace
Connecting Rod Ball Sockets Worn	Replace
Steering Gear Parts Worn	Replace
Steering Gear Improperly Adjusted	Adjust
Road Shock	Steering Connecting Rod Too Tight; Axle Spring Clip Loose; Wheel Bearings Loose; Poor Shock Absorber Control.
Turning Radius	
Short One Side	Center Bolt in Spring Sheered Off, Axle Shifted, Steering Arm Bent, Steering Arm Not Properly Located on Steering Gear.

STEERING SPECIFICATIONS

	ALL MODELS
Steering Gear:	
Make	Ross
Type	Cam and Lever
Model	TL-12
Ratio (Variable)	19-16.7-19
Wheel	17" dia. [43,18 cm.]
Bearings:	
Cam-Upper	Ball
Cam-Lower	Ball
Lever Shaft	Bushing
Steering Column Upper	Ball
Lever Shaft:	
Clearance to Bushing	.0005" to .0025" [0,0127 a 0,0635 mm.]
End Play	.000"
Lash at Cam (Straight ahead)	Slight Drag

MODEL:	L6-226 4WD	L6-226 4x4	L6-226 4x2	F4-134 4WD	F4-134 4x4	F4-134 4x2
Steering Geometry:						
King Pin Inclination	7½°	7½°	7½°	7½°	7½°	7½°
Toe-in	3/64" to 3/32" [1,183 a 2,381 mm.]	3/64" to 3/32" [1,183 a 2,381 mm.]	3/64" to 3/32" [1,183 a 2,381 mm.]	3/64" to 3/32" [1,183 a 2,381 mm.]	3/64" to 3/32" [1,183 a 2,381 mm.]	3/64" to 3/32" [1,183 a 2,381 mm.]
Camber	1½°	1½°	1°	1½°	1½°	1°
Caster	3°	3°	3°	3°	3°	3°
Turning Radius	24' [7,3 m.]	24' [7,3 m.]	22' [6,7 m.]	25' [7,6 m.]	25' [7,6 m.]	22' [6,7 m.]

BRAKES

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Hand Brake	Q-6	Wheel Cylinder	Q-10
Adjustment	Q-7	Rattles in Brakes	Q-13
Hydraulic Brakes	Q-2	Relining Brakes	Q-8
Bleeding	Q-3	Shoe Adjustment	Q-5
Master Cylinder	Q-9	Squeaky Brakes	Q-12
Pedal Adjustment	Q-4		

Q-1. GENERAL

All models discussed here are equipped with the hydraulic type brakes. The hydraulic system on all models is similar. As a general example of this installation the Model F4-134 4WD system is illustrated in Fig. 283.

Q-2. Hydraulic Brakes

In order to thoroughly understand the operation of the hydraulic brake system, it is necessary to have a good knowledge of the various parts and their function, and to know what takes place throughout the system during the application and the release of the brakes.

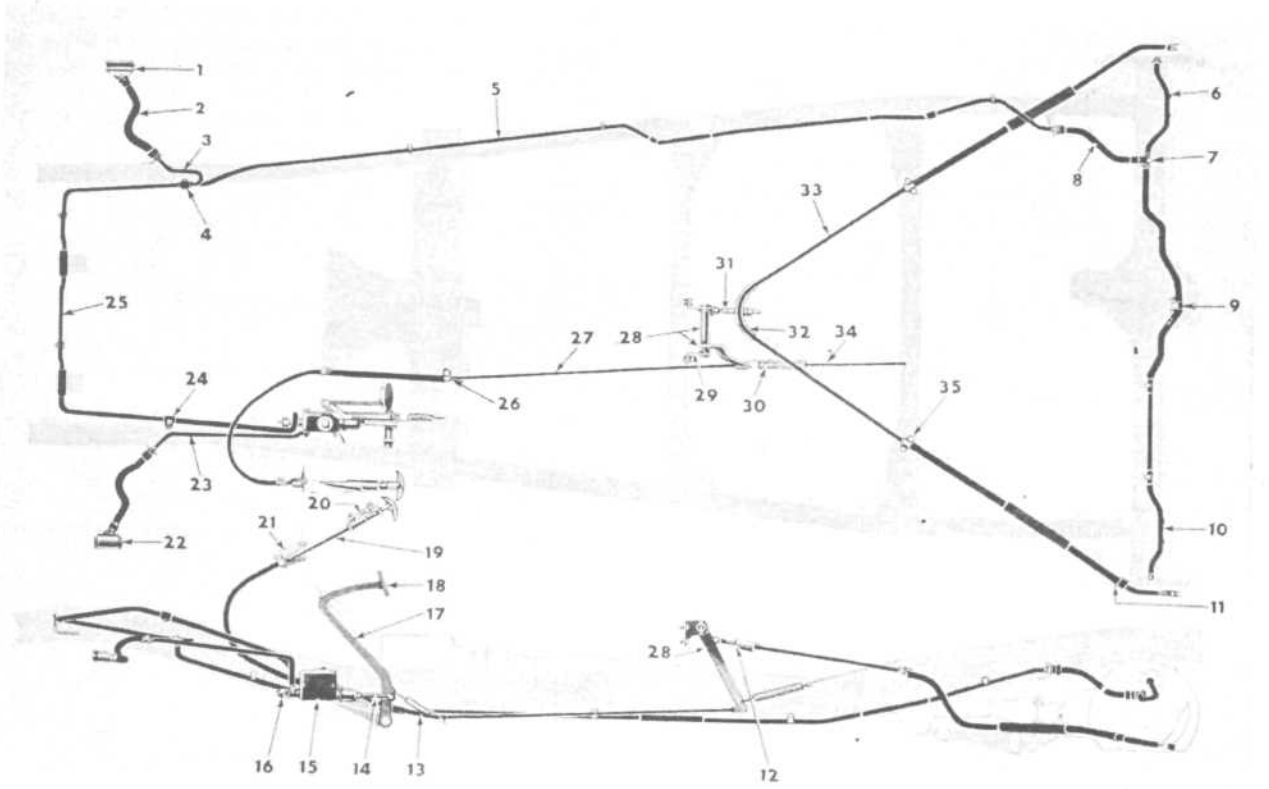


FIG. 283—BRAKE SYSTEM—MODEL F4-134 4WD

1—Right Front Brake Cylinder
2—Front Brake Hose
3—Right Front Brake Tube
4—Front Brake Tube Tee
5—Right Brake Tube
6—Right Rear Brake Tube
7—Rear Axle Tee
8—Brake Hose
9—Clip
10—Left Rear Brake Tube
11—Spring Yoke (473-4WD only
12—Adjusting Rod Block
13—Pedal Retracting Spring
14—Master Cylinder Eye Bolt
15—Master Cylinder
16—Stop Light Switch
17—Brake Pedal
18—Pedal Pad
19—Hand Brake Ratchet Tube
20—Tube Bracket
21—Conduit Bracket
22—Left Front Brake Cylinder
23—Left Front Brake Tube
24—Tube Clip
25—Brake Tube
26—Conduit Clamp
27—Hand Brake Cable
28—Hand Brake Lever
29—Left Lever Bracket
30—Retracting Spring
31—Adjusting Rod
32—Hand Brake Equalizer
33—Rear Cable
34—Retracting Spring Rod
35—Frame Clamp

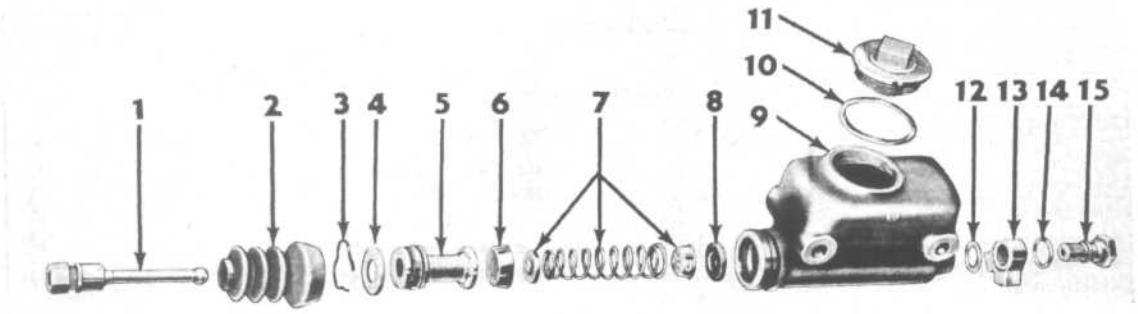


FIG. 284—MASTER BRAKE CYLINDER

1—Push Rod
2—Boot
3—Piston Stop Lock Wire
4—Stop Plate
5—Piston
6—Master Cylinder Cup
7—Valve Spring Assembly
8—Valve Seat
9—Supply Tank
10—Filler Cap Gasket
11—Filler Cap
12—Outlet Fitting Gasket
13—Outlet Fitting
14—Outlet Fitting Bolt Gasket
15—Outlet Fitting Bolt

The piston in the master cylinder, Fig. 284 and Fig. 285 receives mechanical pressure from the brake pedal and exerts pressure on the fluid in the lines, building up hydraulic pressure which moves the wheel cylinder pistons. The master cylinder primary cup No. 6 is held against the piston by the piston return spring which also holds the check valve against the seat.

The spring maintains a slight fluid pressure in the lines and in the wheel cylinders to prevent the possible entrance of air into the system. The secondary cup which is secured at the opposite end of the piston, prevents the leakage of fluid into the rubber boot. The holes in the piston head are for the purpose of allowing the fluid to flow from the space in back of the piston into the space between the primary cup and the check valve, keeping sufficient fluid in the lines at all times. The holes in the check valve case allow the fluid to flow through the case, around the lips of the rubber valve cup and out into the lines during the brake application. When the brakes are released, the valve is forced off the seat permitting the fluid to return to the master cylinder. The piston assembly is held in the opposite end of the housing by means of a lock wire (retainer spring). The rubber boot that fits around the push rod and over the end of the housing prevents dirt or any foreign matter from entering the master cylinder.

The wheel cylinder, Fig. 286, and Fig. 287, is a double piston cylinder, the purpose of the two pistons being to distribute the pressure evenly to each of the two brake shoes. Rubber piston cups on the pistons prevent the leakage of fluid. The rubber boots over the end of the cylinder prevent dust and dirt or foreign material from entering the cylinder. When pressure is applied to the brake pedal, the master cylinder forces fluid through the lines and into the wheel cylinders. The pressure forces the pistons in the wheel cylinders outward, expanding the brake shoes against the drums. As the pedal is further depressed, higher pressure is built up within the hydraulic system, causing the brake shoes to exert a greater force against the brake drums.

As the brake pedal is released, the hydraulic pressure is released and the brake shoe return spring draws the shoes together, pushing the wheel cylinder pistons inward and forcing the fluid out of the cylinders, back into the lines toward the master cylinder. The piston return spring in the master cylinder returns the piston to the piston stop faster than the brake fluid is forced back into the master cylinder, which creates a slight vacuum on the head of the piston. The vacuum causes a small amount of fluid to flow through the holes of the piston head, past the lip of the primary cup and into the forward part of the cylinder. This action keeps the cylinder filled with fluid at all times, ready for the next brake application. As fluid is drawn from the space behind the piston head it is replenished from the reservoir through the intake port. When the piston is in fully released position the primary cup clears the by-pass port, allowing the excess fluid to flow from the cylinder into the reservoir as the brake shoe retracting springs in all cylinders continue to force the fluid back into the master cylinder.

Q-3. Bleeding Brakes

The hydraulic brake system must be bled whenever a fluid line has been disconnected or air gets into the system. A leak in the system may sometimes be indicated by the presence of a spongy brake pedal. Air trapped in the system is compressible and does not permit the pressure applied to the brake pedal, to be transmitted solidly through to the brakes. The system must be absolutely free from air at all times. When bleeding the brakes it is advisable that the longest fluid line from the mas-

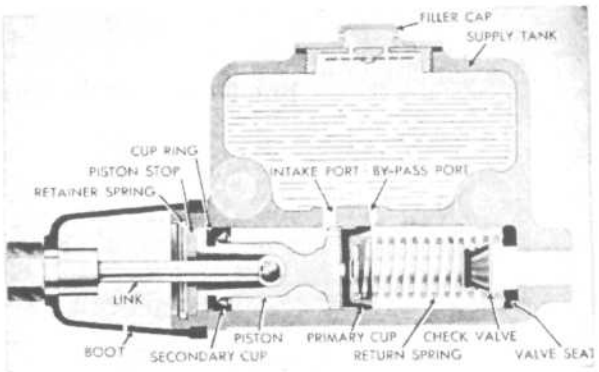


FIG. 285—BRAKE MASTER CYLINDER

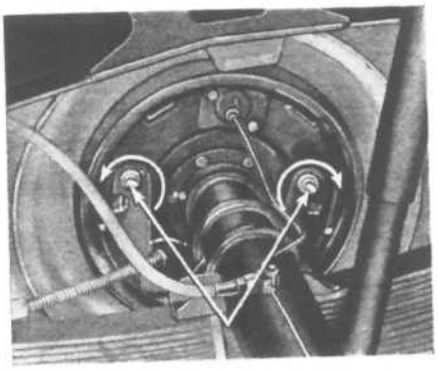


FIG. 289—BRAKE ADJUSTMENTS

Q-7. Hand Brake Adjustment

The foot brakes must be satisfactorily adjusted before attempting adjustment of the hand brake.

To adjust the hand brake raise both rear wheels free of the floor. Pull up three notches on the hand brake lever and tighten the adjustment until the rear brakes drag slightly. Release the hand brake lever and check the rear wheels for drag. The wheels must turn freely with the lever released.

All models are equipped with the brake cable equalizer and adjusting rod located directly back of the frame center cross member, No. 31, Fig. 283.

Q-8. Relining Foot Brakes

When necessary to reline the brakes, the vehicle should be raised so that all four wheels are free.

Remove the wheels and the hubs and drums which will give access to the brake shoes. Install wheel cylinder clamps or keepers to retain the wheel cylinder pistons in place and prevent leakage of brake fluid while replacing the shoes. Turn all eccentrics to the lowest side of the cam and then remove the brake shoe return springs.

Brake shoes may be distorted by improper lining installation and linings should be ground true after installation on the shoes. For this reason it is recommended that new or replacement shoe and lining assemblies be installed.

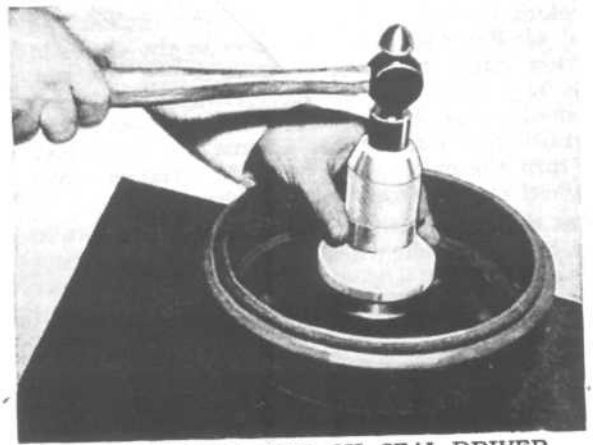


FIG. 290—WHEEL HUB OIL SEAL DRIVER

Inspect the oil seals in the wheel hubs. If the condition of any oil seal is doubtful, replace it. Install the oil seal with an oil seal driver as shown in Fig. 290.

Install the brake shoes on the brake backing plates and remove the wheel cylinder clamps.
Note: On some vehicles, the lining on the forward shoe is longer than the lining on the reverse shoe. Install the eccentrics and the brake shoe retaining springs.

Should a brake drum be rough and scored, it may be reconditioned by grinding or turning in a lathe. Do not remove more than .030" (.762 mm.) thickness of metal (.060" - 1.52 mm. - overall diameter). If a drum is reconditioned in this manner, either the correct oversize lining (.060" - 1.52 mm. - oversize shoes supplied by Factory) must be installed or a shim equal in thickness to the metal removed must be placed between the lining and shoe so that the arc of the lining will be the same as that of the drum.

Install the hubs and drums and make a major adjustment of the brakes.

If it is found when wheels are removed that there is brake fluid leakage at any of the wheel cylinders, it will be necessary to recondition that wheel cylinder and bleed the brake lines. This subject is covered under the heading, "Wheel Cylinders."

NOTE:
Whenever the brake lining is renewed in one front or one rear wheel be sure to perform the same operation in the opposite front or rear wheel, using the same brake lining as to color and part number, otherwise unequal brake action will result.

Q-9. Hydraulic Brake Master Cylinder

Should it be necessary to recondition the master cylinder, the method of removal is obvious.

After the master cylinder Fig. 284 has been removed it should be dismantled and thoroughly washed in alcohol. Never wash any part of the hydraulic braking system with gasoline or kerosene.

After the parts have all been thoroughly cleaned with alcohol, make a careful inspection, renewing those parts which show signs of being deteriorated. Inspect the cylinder bore and if found to be rough it should be honed out or a new cylinder installed. The clearance between the piston and the cylinder bore should be .001" to .005" (.025 to .127 mm.). Clean out the cylinder with alcohol and with a wire passed through the ports that open from the supply reservoir into the cylinder bore, make sure that these passages are free and clear of any foreign matter. It is our recommendation that a new piston, primary cup, valve and valve seat be installed when rebuilding the master cylinder.

Install the valve seat in the end of the cylinder with the flat surface toward the valve. Install the valve assembly. Install return spring and primary

ter cylinder be bled first. The proper sequence of bleeding is right rear; right front; left rear; left front. During the bleeding operation the master cylinder must be kept at least ¾ full of hydraulic brake fluid.

To bleed the brakes, first carefully clean all dirt from around the master cylinder filler plug. Remove the filler plug and fill the master cylinder to the lower edge of filler neck. Clean off all bleeder connections at all four wheel cylinders. Attach bleeder hose and fixture to right rear wheel cylinder bleeder screw and place end of tube in a glass jar, and submerged in brake fluid. Open the bleeder valve one-half to three-quarters of a turn. See Fig. 288.

Depress the foot pedal, allowing it to return very slowly. Continue this pumping action to force the fluid through the line and out of the bleeder hose

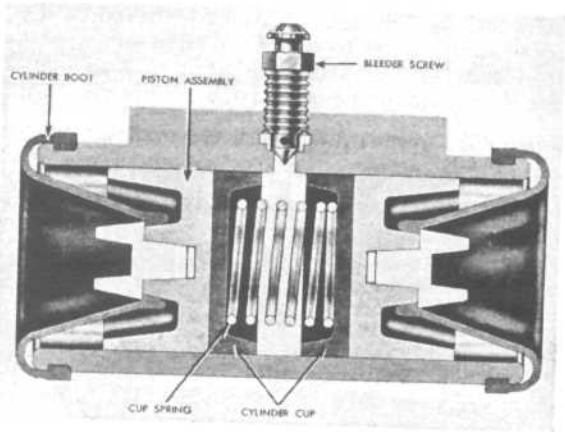


FIG. 286—WHEEL BRAKE CYLINDER

which carries with it any air in the system. When bubbles cease to appear at the end of the bleeder hose, close the bleeder valve and remove the hose.

After the bleeding operation at each wheel cylinder has been completed, fill the master cylinder reservoir and replace the filler plug.

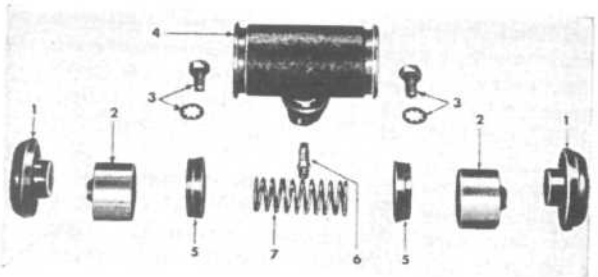


FIG. 287—WHEEL BRAKE CYLINDER

1. Boot
2. Piston
3. Mounting Screw
4. Cylinder
5. Cylinder Cup
6. Bleeder Screw
7. Cup Spring

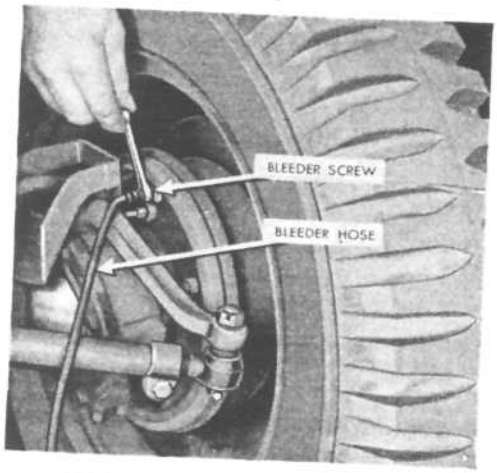


FIG. 288—BLEEDING BRAKES

Do not re-use the liquid which has been removed from the lines through the bleeding process because of air bubbles and dirt.

Q-4. Brake Pedal Adjustment

There should always be at least ½" (12.7 mm.) free pedal travel before the push rod engages the master cylinder piston.

This adjustment is accomplished by shortening or lengthening of the brake master cylinder eye bolt No. 14, Fig. 283. This is done so the primary cup will clear the by-pass port when the piston is in the off position, otherwise the compensating action of the master cylinder for expansion and contraction of the fluid in the system, due to temperature changes, will be destroyed and cause the brakes to drag.

Q-5. Brake Adjustment

The brakes used on these models are of the two shoe self-centralizing type without brake anchor adjustments.

To adjust this type of brake, first jack up all four wheels. Be sure that the brake pedal has approximately ½" (12.7 mm.) free travel without moving the master cylinder piston. Centralize the brake shoes in the drums by making a hard brake application and releasing the pedal. At each left front and left rear wheel turn the forward shoe adjusting cam clockwise until the shoe is tight against the drum, see Fig. 289. Turn the cam in the opposite direction until the wheel rotates freely without brake drag. At each right front and right rear wheel turn the forward shoe adjusting cam counter-clockwise until the shoe is tight against the drum and then turn the cam in the opposite direction until the wheel rotates freely without drag.

Repeat this procedure for the reverse or rear brake shoes, but on the left wheels turn the rear adjusting cams counter-clockwise to tighten and on the right wheels turn the rear adjusting cams clockwise to tighten.

Q-6. Hand Brakes

On all models the rear brake shoes are operated through cables and conduits to form the hand or parking brake.

cup. The flat side of the cup goes toward the piston. Install piston, stop plate, and lock wire (retainer spring). Install fitting connection with new gasket. Fill reservoir half full of brake fluid (see Par. B-27) and operate the piston with the piston rod until fluid is ejected at fitting. Install the master cylinder to the frame and fill to a level ½" [1,3 cm.] below the top of the fill hole. Make the necessary connections and adjust pedal clearance to ½" [1,3 cm.] free play.

Bleed the brake lines as instructed in Par. Q-3.

Recheck the entire hydraulic brake system to make sure there are no leaks.

Q-10. Wheel Cylinder

To remove a wheel cylinder jack up the vehicle and remove the wheel, hub and drum. Disconnect the brake line at the fitting on the brake backing plate. Remove the brake shoe return spring which allows the brake shoes at the toe, to fall clear of the brake cylinder. Remove two screws holding wheel cylinder to the backing plate.

Remove the rubber dust covers on ends of cylinder and then the piston and piston cups and the spring. See Fig. 287.

Wash the parts in clean alcohol. Examine the cylinder bore for roughness or scoring. Check fit of pistons to cylinder bore by using a .002" (.051 mm.) feeler gauge. When reassembling the cylinder, dip springs, pistons and piston cups in brake fluid. Install spring in center of the wheel cylinder. Install piston cups with the cupped surface towards the spring so that the flat surface will be against the piston. Install pistons and dust covers. Install wheel cylinder to the backing plate, connect brake line and install brake shoe return spring. Replace wheel, hub and drum, then bleed the lines as instructed under heading, "Bleeding Brakes". Adjust brakes if required.

Q-11. Care Of Brakes

No brake can be expected to work well when grease or oil is allowed to leak into the drum from the rear axle. Little breaking friction can be obtained between brakes and drums when the surface is covered with oil and grease.

Care should be exercised to see that excessive amounts of lubricants are not put into the front hubs or the rear axle bearings or differential. Keep the grease retainers in good condition.

Whenever wheels are removed, it is advisable to wash off the drums with a suitable solvent so that all grease and dirt are removed. Should there be a quantity of grease on the linings, this can also be washed off with solvent, however, should the linings be thoroughly saturated with grease, there is nothing that can be done except to replace the lining.

Q-12. Squeaky Brakes

In most cases, squeaks are entirely eliminated by correct adjustment of the brakes. Squeaks may be caused however, by glazed linings, lining wore thin to the point of exposed rivets or by vibration. A drum will not vibrate when the brake is securing uniform contact over the entire lining surface, except when due to improper conditions such as the linings becoming glazed. Glazed surface of the brake linings may be removed by a stiff wire brush.

Occasionally squeaks are caused by roughened surface of the drum, which can usually be remedied by rubbing down with emery cloth and by wiping the brakings surface clean. In extreme cases it may be necessary to reface the drum in a lathe. Should this be done, do not remove a metal thickness greater than .030" (.762 mm.)—.060" (1.52 mm.) overall diameter.

Q-13. Rattles in Brakes

See that the tension of the springs in the brakes and attached to the control system are sufficient to return brakes and brake mechanism to their normal position. Return springs are so placed that they keep all slack out of the control system by tension on all joints.

Brakes will not rattle inside the drum if the springs holding the shoes are kept at the proper tension.

SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Brakes Drag	
Brake Shoes Improperly Adjusted	Readjust
Piston Cups—Enlarged	Flush All Lines with Alcohol—Install New Cups in Wheel and Master Cylinders
Mineral Oil or Improper Brake Fluid in System	Flush All Lines with Alcohol—Install New Cups in Wheel and Master Cylinders
Improper Pedal Adjustment	Adjust Master Cylinder Rod
Clogged Master Cylinder Compensating Port	Clean Master Cylinder
One Brake Drags	
Brake Shoe Adjustment Incorrect	Adjust
Brake Hose Clogged	Replace
Return Spring Broken	Replace
Wheel Cylinder Piston or Cups Defective	Replace
Loose or Damaged Wheel Bearings	Adjust or Replace
Brake Grabs—Car Pulls to One Side	
Brake Anchor Pin Adjustment Incorrect	Adjust
Grease or Brake Fluid on Lining	Replace Lining
Dirt Between Lining and Drum	Clean With Wire Brush
Drum Scored or Rough	Turn Drum and Replace Lining—Shim Lining
Loose Wheel Bearings	Adjust
Axle Spring Clips Loose	Tighten
Brake Backing Plate Loose	Tighten
Brake Lining	Different Kinds on Opposite Wheels
Brake Shoe Reversed	Forward and Reverse Shoes Reversed in One Wheel
Tires Under-Inflated	Inflate
Tires Worn Unequally	Replace or Change Around to Opposite Wheels
Excessive Pedal Travel	
Normal Lining Wear	Adjust
Lining Worn Out	Replace
Leak in Brake Line	Locate and Repair
Scored Brake Drums	Replace or Regrind—Shim Lining
Incorrect Brake Lining	Replace
Air in Hydraulic System	Fill Master Cylinder and Bleed Lines
Spongy Brake Pedal	
Air in Lines	Bleed Lines
Brake Shoe Adjustment Incorrect	Adjust
Excessive Pedal Pressure	
Grease or Brake Fluid in Lining	Replace Lining
Shoes Improperly Adjusted	Major Adjustment
Warped Brake Shoes	Replace
Distorted Brake Drums	Replace or Regrind—Shim Lining
Squeaky Brakes	
Brake Shoes Warped or Drums Distorted	Replace
Lining Loose	Replace
Dirt Imbedded in Lining	Clean With Wire Brush or Replace
Improper Adjustment	Adjust

BRAKE SPECIFICATIONS

	ALL MODELS
Service Brakes:	
Type	4-Wheel Hydraulic
Size	11″ x 2″ [27,9 - 5,08 cm.]
Master Cylinder	
Size	1″ [2,54 cm.]
Mounted	Left Frame Side Rail
Wheel Cylinder:	
Size	Front 1 1/8″ [2,85 cm.] Rear 1″ [2,54 cm.]
Brake Shoe:	
Size	11″ x 2″ [27,9 - 5,08 cm.]
Lining Area	176 1/4 sq. in. [1150 cm²]
Length Lining — Forward Shoe	12 1/4″ [31,11 cm.]
Length Lining — Reverse Shoe	10 1/32″ [25,48 cm.]
Width	2″ [5,08 cm.]
Thickness	.212″ [5,38 mm.]
Pedal Return Spring	5 9/16″ [14,13 cm.]
Brakeshoe Return Spring	5 21/64″ [13,5 cm.]
Hand Brake:	
Control	Hand Lever and Cable
Operates on	Rear Service Brakes

WHEELS

Contents

SUBJECT	PAR.
Bearing Maintenance	R-7
Brake Drums	R-8
Front Wheel Bearings	R-2
Adjustment — 4-wheel-drive	R-3
Adjustment — 2-wheel-drive	R-4
Grease Protector	R-9
Rear Wheel Bearings	R-5
Adjustment	R-6
Tires	R-10

R-1. GENERAL

The front wheels of all models discussed here are carried on two opposed tapered bearings as shown in Fig. 291 & 292.

Each rear wheel is carried on a single tapered roller bearing mounted on the axle shaft as shown in Fig. 293 & 294.

To check the wheel bearings for adjustment, brakes must be free and in fully released position.

R-2. Front Wheel Bearings

To check the front wheel bearings raise the front end of the vehicle with a jack so that the tires clear the floor.

Grip the tire and test sidewise shake of the wheel. If bearings are correctly adjusted, shake of wheel will be just perceptible and wheel will turn freely with no drag.

If bearing adjustment is too tight, the rollers may break or become overheated. Loose bearings may cau.e excessive wear and possible noise.

If this test indicates adjustment is necessary, proceed as follows:

R-3. Front Wheel Bearing Adjustment

All 4-Wheel-Drive Models

With the vehicle on the jack, remove the hub cap, axle shaft nut, washer and driving flange. Use front axle shaft driving flange puller, Tool No. W-163, shown in Fig. 228 and a hub cap puller as shown in Fig. 227.

Bend the lip of nut lockwasher so that adjustment locknut and lockwasher may be moved. Rotate the wheel and tighten the adjusting nut until the wheel binds. Then back off nut about one-sixth turn or more if necessary making sure that the wheel rotates freely without sidewise shake. Replace the lockwasher and locknut and do not fail to bend over the lockwasher lip.

Check the adjustment and reassemble the driving flange. Make sure the gasket is properly installed between the hub and the flange.

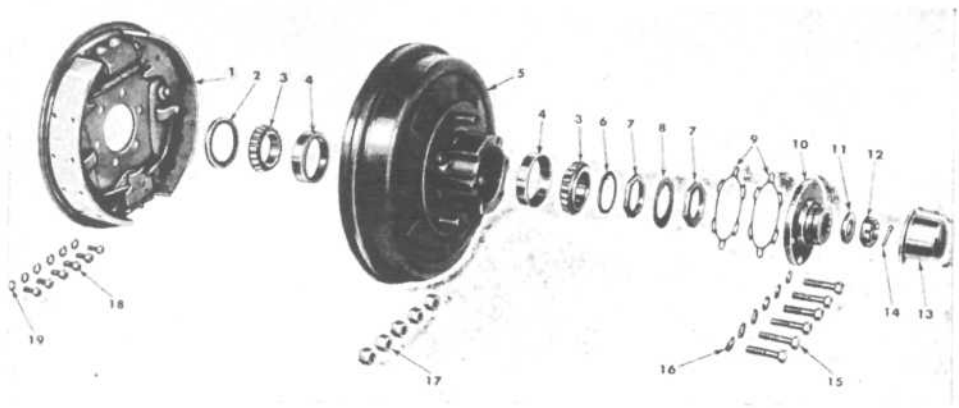


FIG. 291—FRONT WHEEL ATTACHING PARTS — 4-WHEEL-DRIVE VEHICLES

1—Brake Assembly
2—Oil Seal
3—Inner Bearing
4—Inner Bearing Cup
5—Hub and Brake Drum
6—Bearing Lockwasher
7—Lock Nut
8—Bearing Nut Locking Washer
9—Adjusting Shim
10—Driving Flange
11—Axle Shaft Nut Washer
12—Axle Shaft Nut
13—Hub Cap
14—Cotter Pin
15—Flange Bolt
16—Lockwasher
17—Wheel Nut
18—Backing Plate Bolt
19—Lockwasher

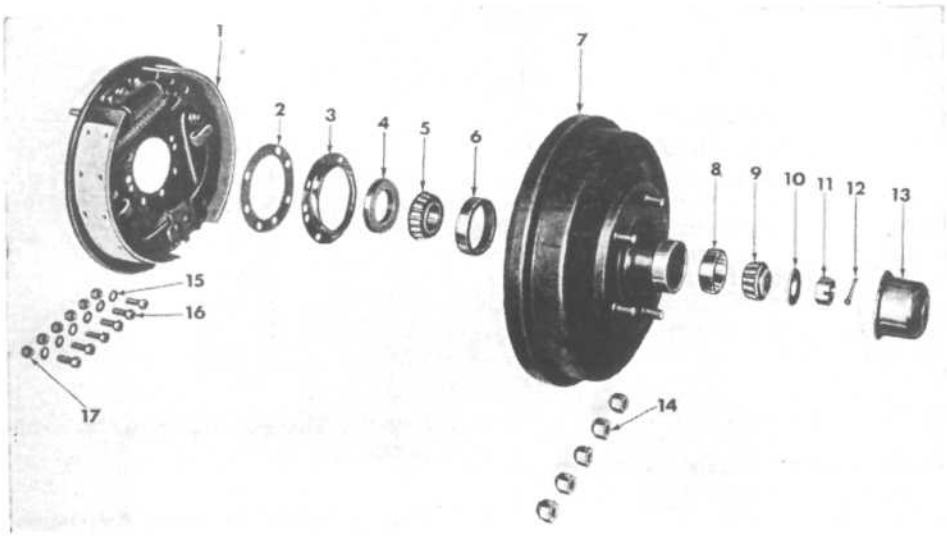


FIG. 292—FRONT WHEEL ATTACHING PARTS — 2-WHEEL-DRIVE VEHICLES

1. Brake Assembly
2. Grease Shield Gasket
3. Grease Shield
4. Hub Dust Washer
5. Inner Bearing
6. Inner Bearing Cup
7. Hub and Brake Drum
8. Outer Bearing Cup
9. Outer Bearing
10. Washer
11. Nut
12. Cotter Pin
13. Hub Cap
14. Wheel Nut
15. Brake to Knuckle Bolt
16. Lockwasher
17. Nut

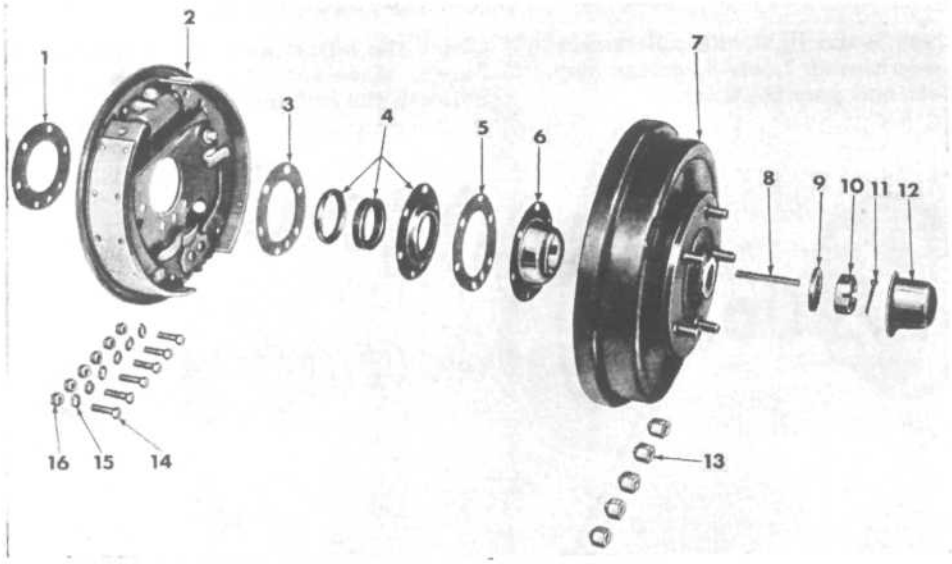


FIG. 293—REAR WHEEL ATTACHING PARTS

1. Retaining Flange
2. Brake Assembly
3. Adjusting Shim
4. Grease Retainer
5. Grease Shield Gasket
6. Grease Shield
7. Hub and Drum
8. Axle Shaft Key
9. Axle Shaft Washer
10. Axle Shaft Nut
11. Cotter Pin
12. Hub Cap
13. Wheel Nut
14. Axle Flange Bolt
15. Lockwasher
16. Nut

R-4. Front Wheel Bearing Adjustment

All 2-Wheel-Drive Models

With the vehicle still on the jack, remove the hub cap and the wheel retaining nut cotter pin. Rotate the wheel and tighten the wheel retaining nut until the wheel binds. Then back off nut about one-sixth turn or more if necessary making sure wheel rotates freely without sidewise shake. Replace the cotter pin and hub cap.

R-5. Rear Wheel Bearings

Raise wheel on which adjustment is to be made, by placing a jack under the axle housing. With hands, test sidewise shake of the wheel. If bearings are correctly adjusted, shake of wheel will be just perceptible and the wheel will turn freely with no drag. If adjustment is necessary proceed as follows.

R-6. Rear Wheel Bearing Adjustment

The bearing adjusting shims are placed between the brake backing plate and axle flange as shown in Fig. 294, No. 2. To make this adjustment remove the hub cap, the cotter pin, the axle shaft nut and use a wheel puller to remove the wheel hub. Remove the bolts holding the brake dust shield, grease and bearing retainer and the brake backing plate. Remove or install shims to adjust the bearings to provide .003″ to .007″ (.076–.177 mm.) end float of the axle shaft.

On all Spicer semi-floating type rear axles, the bearing shim packs are installed at both axle housing flanges.

On all Timken semi-floating type rear axles, the shims may be installed at one flange only or the clearance may be divided equally and shims installed at both flanges.

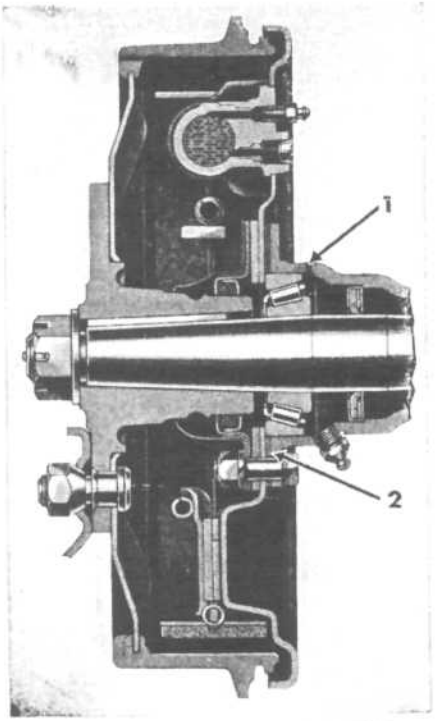


FIG. 294—REAR WHEEL HUB AND BEARING

R-7. Maintenance of Wheel Hub Bearings

Under normal operating conditions the hub bearings require lubrication only every 6000 miles (9600 km.). It is necessary to disassemble and remove the bearings from all front wheels to properly lubricate them. All models having semi-floating type rear axles are equipped with lubricators.

When hubs and bearings are removed for lubrication, they should be thoroughly washed in a suitable cleaning fluid. The bearings should be given more than a casual cleaning. Use a clean stiff brush to remove all particles of old lubricant from bearings and hubs. After the bearings are thoroughly cleaned inspect them for pitted races and rollers, also check the hub oil seals. Repack the bearing cones and rollers with grease and reassemble hub in the reverse order as that of dismantling. Test bearing adjustment as covered under "Bearing Adjustment".

When installing the hubs and drums, the hubs with the right hand threaded studs are placed on the right hand side of the vehicle. The left hand threaded studs are on the left hand side, viewing the vehicle from the rear.

R-8. Brake Drums

The brake drums are attached to the wheel hubs by five serrated bolts. These bolts are also used for mounting the wheels on the hub. To remove a brake drum, press or drive out the serrated bolts and remove the drum from the hub.

When placing the drum on the hub, make sure that the contacting surfaces are clean and flat. Line up the holes in the drum with those in the hub and put the drum over the shoulder on the hub. Insert five new serrated bolts through the drum and hub and drive the bolts into place solidly. Place a round piece of stock approximately the diameter of the head of the bolt, in a vise; next place the hub and drum assembly over it so that the bolt head rests on it. Then swage the bolt into the countersunk section of the hub with a punch.

The runout of the drum face should be within .003″ (.076 mm.). If the runout is found to be greater than .003″ (.076 mm.), it will be necessary to reset the bolts to correct the condition.

The left hand hub bolts are identified with an "L" stamped on the head of the bolt.

The left hand threaded nuts may be identified by a groove cut around the hexagon faces.

Hubs containing the left hand threaded hub bolts are installed on the left hand side of the vehicle.

R-9. Grease Protector

Late Model L6-226 4WD and F4-134 4WD vehicles.

An improved hub and brake drum assembly and companion grease protector were installed in production effective with these serial numbers:

L6-226 4WD	F4-134 4WD
55168-14472	55148-10975
55268-33884	55248-11555
55368-11281	55348-10060

Only the later grease protector (Fig. 295, No. 3) can be used with the later hub and brake drum assembly (1). Either grease protector can be used with the earlier hub and brake drum assembly (2).

R-10. Tires

One of the most important factors of safe vehicle operation is systematic and correct tire maintenance. Tires must sustain the weight of a loaded vehicle, withstand more than ordinary rough service, provide maximum safety over all types of terrain, and furnish the medium on which the vehicle can be maneuvered with ease.

Although there are other elements of tire service, inflation maintenance is the most important and in many instances the most neglected. The tire pressure should be constantly maintained for safe operation.

An under-inflated tire is dangerous as too much flexing causes breakage of the casing resulting in failure. Over-inflation in time may cause a blowout.

To remove a tire from a drop center rim, first deflate completely and then force the tire away from the rim throughout the entire circumference until the bead falls into the center of the wheel rim. With a heavy screw driver or tire removing tool, used opposite the valve, remove one side of the tire at a time and remove the inner tube.

Installation of the tire is made in the same manner by first dropping one side of the tire into the center of the rim and with a tire tool raise the bead over the wheel rim using care not to damage the inner tube.

When mounting the wheel, alternately tighten opposite stud nuts to prevent wheel runout. After the nuts have been tightened with the wheel jacked up, lower the jack so wheel rests on the floor and retighten the nuts.

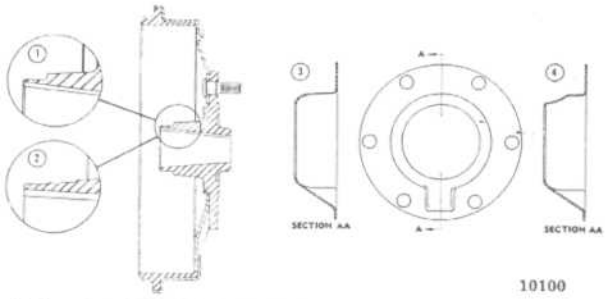


FIG. 295—GREASE PROTECTOR IDENTIFICATION

1—Late Hub and Drum Assembly
2—Early Hub and Drum Assembly
3—Late Grease Protector (912646)
4—Early Grease Protector (640888)

WHEEL AND TIRE SPECIFICATIONS

MODELS:	L6-226 4WD F4-134 4WD	L6-226 4x4 F4-134 4x4	L6-226 4x2 F4-134 4x2
Wheels:			
Make	Kelsey-Hayes	Kelsey-Hayes	Kelsey-Hayes
Rim	16 x 5.00	15 x 4.50	15 x 4.50
Tires	7.00 x 16	7.00 x 15	6.70 x 15
Pressure:			
Front	30 psi [2,11 kg-cm^2]	27 psi [1,89 kg-cm^2]	27 psi [1,89 kg-cm^2]
Rear	45 psi [3,16 kg-cm^2]	27 psi [1,89 kg-cm^2]	27 psi [1,89 kg-cm^2]
Bearings	Roller	Roller	Roller

FRAME

Contents

SUBJECT	PAR.
Alignment — Frame	S-2
— Front Axle	S-5
Dimensions — Frame	S-3
Straightening Frame	S-4

S-1. GENERAL

The frame is the structural center of the vehicle, for in addition to carrying the load, it provides and maintains correct relationship between other units to assure their normal functioning.

Of rugged design, the frame is constructed of heavy channel steel side rails and cross-members. Brackets and diagonal braces are used to maintain the proper longitudinal position of the side rails relative to each other, and at the same time provide additional resistance to torsional strains.

Vehicles which may have been in an accident of any nature, which may result in a swayed or sprung frame, should always be carefully checked for proper frame alignment, steering geometry, and axle alignment.

S-2. Checking Frame Alignment

The most efficient and satisfactory method of checking frame alignment is with a frame aligning fixture which is equipped with bending tools for straightening frame parts. In the absence of such a fixture, frame alignment may be determined by using the "X" or diagonal method of checking from given points on each side rail. Fig. 296 illustrates this method of checking the frame.

The most convenient way to make this check, particularly when the body is on the chassis, is by marking on the floor all points from which measurements should be taken.

Select a space on the floor which is comparatively level. If a cement floor is available clean it so that chalk marks will appear underneath the frame to be checked. If a wooden floor, it is advisable to lay a sheet of paper underneath the vehicle and tack in place, dropping a plumb-bob from each point indicated in Fig. 296, marking the floor directly underneath the point. Satisfactory checking depends upon the accuracy of the marks in relation to the frame.

To reach the points shown that have been marked, have vehicle carefully moved away from layout on the floor, and proceed as directed in the following paragraphs:

a. Check frame width at front and rear end, using corresponding marks on the floor. If widths correspond to specifications given on next page, draw center line the full length of the vehicle, half-way between marks indicating front and rear widths. If frame width is not correct and the center line cannot be laid out from checking points at the end of frame it can be drawn through intersections of any two pair of equal diagonals.

b. With the center line properly laid out, measure the distance from it to points opposite over the entire length of chassis. If frame is in proper alignment measurement should not vary.

c. To locate the point at which the frame is sprung, measure the diagonals marked "A-B", "B-C", "C-D". If the diagonals in each pair are within ⅛" (3.175 mm.), that part of the frame included between points of measurements may be considered as satisfactory alignment. These diagonals should also intersect at the center line. If the measurements do not agree within the above limits, it means that correction will have to be made between those points that are not equal.

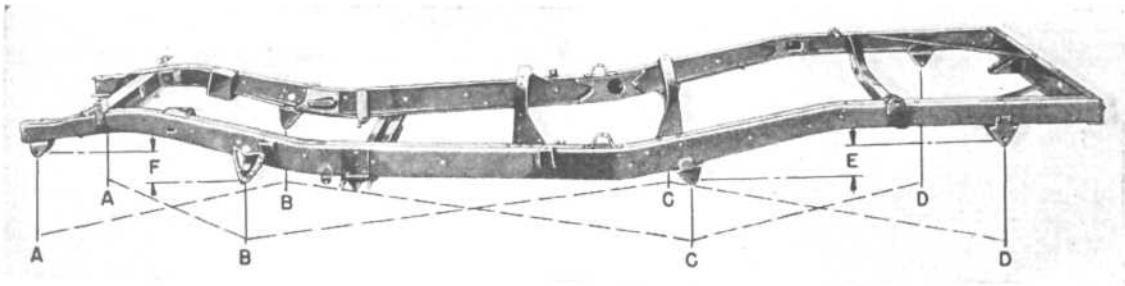


FIG. 296—TYPICAL FRAME SHOWING POINTS FOR MEASURING ALIGNMENT

S-3. Frame Dimensions

Points for measuring frame alignment are shown in Fig. 296. The correct measurements for each model are given in the table. Point A is at the front of the frame.

A-B and C-D are the distances between spring shackle bolt and spring pivot bolt frame centers measured on a line parallel with the frame centerline. E and F show the shackle bolt centers in relation (above or below) to the pivot bolt centers.

The Planar type of spring suspension used on early Model F4-134 4x2 vehicles makes it impossible to give checking dimensions for the front end of the frame. With the Planar type, the upper edges of the side rails are parallel at the front and at the center of the frame; also, the edges at the front are 4½" [114 mm.] higher than at the center.

S-4. Straightening Frame

In case the bending or twisting of the frame is not excessive, it may be straightened. This should be done cold, as excessive heat applied to the frame will weaken it. For this reason it is recommended that badly damaged frame parts be replaced.

S-5. Front Axle Alignment

After it has been determined that the frame is properly aligned, the front axle alignment with the frame can be checked. The front axle is square with the frame if the distance between the front and rear axle is the same on both sides. The distance from the spring upper bushings to the front axle on both sides should be equal.

Model	A-B	C-D	Width Front	Width Rear	"E"	"F"
F4-034 4x2 with Planar Front Suspension	.....	49 3/16" 1.249 m.	29½" .749 m.	44½" 1.130 m.	5½" above 130.2 mm.	.....
L6-226 4x4 L6-226 4x2 F4-134 4x4 F4-134 4x2	35 5/32" .893 m.	48¾" 1.238 m.	32" .813 m.	44½" 1.130 m.	3 11/32" above 84.8 mm.	5 19/32" above 1.421 mm.
L6-226 4WD F4-134 4WD	35 5/32" .893 m.	48 23/32" 1.238 m.	32" .813 m.	49½" 1.257 m.	5⅜" above 136.5 mm.	5 19/32" above 142.1 mm.

FRAME SPECIFICATIONS

Model:	F4-134 4x2 With Planar Front Suspension	L6-226 4x4 L6-226 4x2 F4-134 4x4 F4-134 4x2	L6-226 4WD F4-134 4WD
Frame:			
Material	SAE 1020	SAE 1020	SAE 1020
Depth Maximum	5" [12.70 cm.]	5½" [13.77 cm.]	5½" [13.77 cm.]
Thickness Maximum	.063" [.160 cm.]	.179" [.454 cm.]	.179" [.454 cm.]
Flange Width	3¾" [9.52 cm.]	2" [5.08 cm.]	2" [5.08 cm.]
Length	154¾" [393.06 cm.]	159 15/16" [406.24 cm.]	176 7/32" [447.6 cm.]
Width — Front	29½" [74.93 cm.]	32" [81.28 cm.]	32" [81.28 cm.]
Rear	44½" [113.03 cm.]	44½" [113.03 cm.]	49½" [125.73 cm.]
No. Cross Members	4	5	6
Weight	178.5 lbs. [80.96 kg.]	277 lbs. [125.64 kg.]	295 lbs. [133.81 kg.]
Wheelbase	104" [264.16 cm.]	104½" [265.43 cm.]	118" [299.72 cm.]
Tread — Front	55¼" [140.34 cm.]	57" [144.78 cm.]	57" [144.78 cm.]
Rear	57" [144.78 cm.]	57" [144.78 cm.]	63½" [160.66 cm.]

SPRINGS AND SHOCK ABSORBERS

Contents

SUBJECT	PAR.
Pivot Bolts	T-4
Shackles	T-4
U-Shackles	T-5
Shock Absorbers	T-7
Springs — Front	T-2
— Rear	T-3
— Remove and Replace	T-6

T-1. GENERAL

The springs are of alloy steel to stand the severe service to which they may be subjected.

They should be periodically examined for broken or shifted leaves, loose or missing rebound clips, angle of spring shackles and position of springs on the saddles. Springs with shifted leaves do not have their normal strength. Missing rebound clips may permit the spring leaves to fan out or break on rebound. Broken leaves may make the vehicle hard to handle or permit the axle to shift out of line. Weakened springs may break causing difficulty in steering.

Spring attaching "U" bolts must be tight. It is suggested that they be checked at each vehicle inspection. Tighten the 7/16" bolts to 45–55 ft. lbs. (6.2–7.6 kg.-m.) and the 1/2" bolts to 65–80 ft. lbs. (9.0–11.0 kg.-m.)

T-2. Front Springs

Semi-elliptic front springs are used on all the models discussed except those models equipped with planar type front suspension which are of the transverse type.

Spring dimensions of all models are found in the specifications at the end of this section.

Shackles are provided at the front end of the front springs on all models. The rear ends of the springs are supported by pivot bolts mounted in the frame brackets and supported by either rubber or bronze bushings as outlined under the heading "Spring Shackles and Pivot Bolts".

The springs are firmly attached to the front axle by "U"-bolts and the spring center bolts are inserted in the axle spring saddles to prevent shifting of the axle.

The front springs on Model F4-134 4x2 with Planar suspension and the rear springs on all 4x4 and 4x2 models are all of the "Dow" type and should never be lubricated.

This type spring has Neoprene rubber inserts mounted in forged cups at each end of the several leaves. Movement between the leaves is through flexing of the rubber inserts rather than sliding metal-to-metal contact. Lubricating the springs will destroy the effective use of the inserts. *Do not lubricate "Dow" type springs.*

It is recommended that all springs other than the "Dow" type be lubricated as sparingly as possible. Frequent lubrication will thin out the original graphite lubricant installed by the manufacturer which is necessary for effective spring action.

T-3. Rear Springs

The rear springs are of the semi-elliptic type, shackled at the rear end and pivoted on either bronze or rubber bushings at the front end.

Spring saddles are welded to the underside of the rear axle housing and the center spring bolt is utilized to prevent shifting of the axle. The springs are held in position by "U"-bolts around the axle.

The lubrication information given above for front springs applies as well to all rear springs.

T-4. Spring Shackles and Pivot Bolts

Spring shackles are either of the U-shackle type (Fig. 297) on earlier vehicles or the type shown in Fig. 298 on later vehicles. Threaded core bushings are used with the U-shackles. The side-plate shackles will have either silent-bloc (rubber) bushings or unthreaded bronze bushings. Use of bronze bushings with the side-plate shackles will be evident from the lubrication fitting; where no lubrication fitting is present, silent-bloc bushings are present and are not to be lubricated.

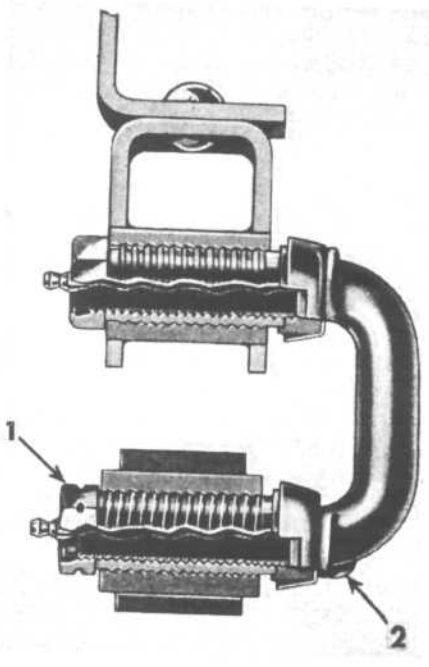


FIG. 297—FRONT SPRING SHACKLE (EARLY VEHICLES)

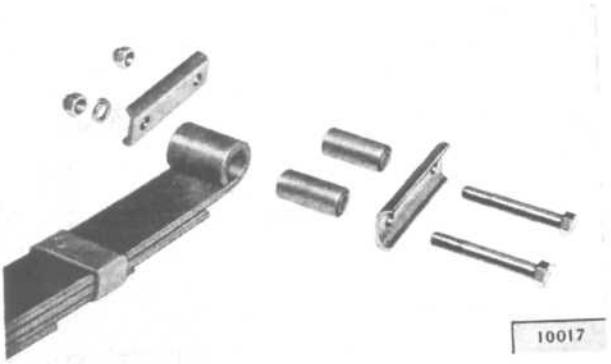


FIG. 298—FRONT SPRING SHACKLE

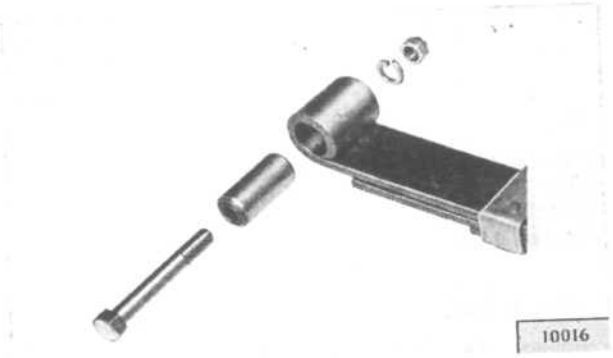


FIG. 299—SPRING PIVOT BOLT

Installation of the rubber type shackle and pivot bolt bushings is obvious, however, when making this installation tighten the shackle and pivot bolt retaining nuts only enough to hold the bushings in position until the vehicle is lowered from the jack. Allow the weight of the vehicle to seat the bushings to their operating position after which tighten the nuts to 27 – 30 ft. lbs. (3.73 – 4.15 kg.-m.) torque.

Bronze bushings require no reaming when replacement is made. Some early production shackles and pivot bolts were equipped with cotter pins to correctly position the nuts. After tightening these nuts, back them off two cotter pin slots before installing the cotter pins. To prevent shackle and pivot movement, the nuts must be tight but without evidence of binding. On later production vehicles, the nuts should be torqued to the specifications for vehicles equipped with rubber bushings as given above.

T-5. Threaded U-Shackles and Bushings

The threaded bushings of the "U"-type shackles are anchored solidly in the frame brackets and spring eyes and the oscillation is taken between the threads of the "U"-shackle and the inner threads of the bushings. Lubrication of the shackle bushings is important and should not be neglected or excessive wear of both the bushings and "U"-shackles will occur.

On later production vehicles, only right-hand threaded shackles and bushings were used.

The left hand threaded"U"-shackle may be identified by a small forged boss on the lower shank of the shackle as shown in Fig. 297, No. 2. The left hand threaded shackle is used at the left front spring with the left hand threaded end DOWN at the spring eye.

On early production vehicles, three bushings were used with right-hand threads and one with left-hand threads. The right-hand threaded bushings have plain hexagonal heads. The left-hand bushing has a groove around the head as indicated by No. 1 in Fig. 297.

The "U"-shackles are installed with the bushing hexagon heads at the outside of the frame.

When installing a new "U"-shackle or a shackle bushing, follow the procedure outlined below:

Install the shackle grease seal and retainer over the threaded end of the shackle up to the shoulder. Insert the shackle through the frame bracket and eye of the spring. Holding the "U"-shackle tightly against the frame, start the upper bushing on the shackle, care being taken that when it enters the thread in the frame that it does not cross-thread.

Screw bushing on the shackle about halfway, and then start the lower bushing, holding the shackle tightly against the spring eye and thread the bushing in approximately halfway, then alternating from top bushing to lower bushing turn them in until the head of the bushing is snug against the frame bracket and the bushing in the spring eye is 1/32" (.794 mm.) away from the spring measured from the inside of hexagon head to the spring.

Lubricate the bushing and then try the flex of the shackle, which must be free. If a shackle is tight it will cause spring breakage and it will be necessary to rethread the bushings on the shackle.

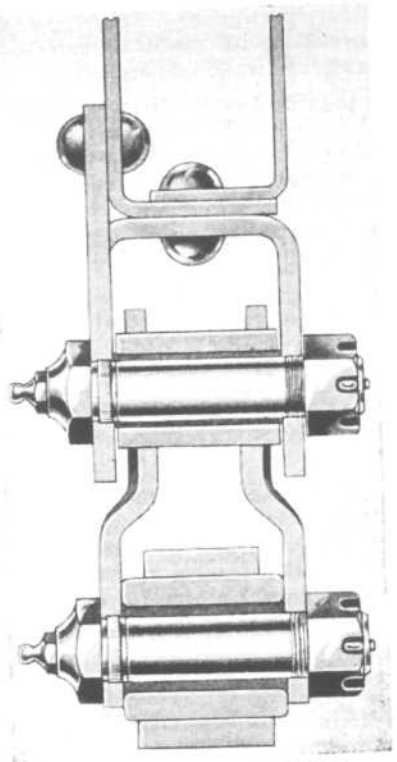


FIG. 300—REAR SHACKLE — 4-WHEEL-DRIVE VEHICLES

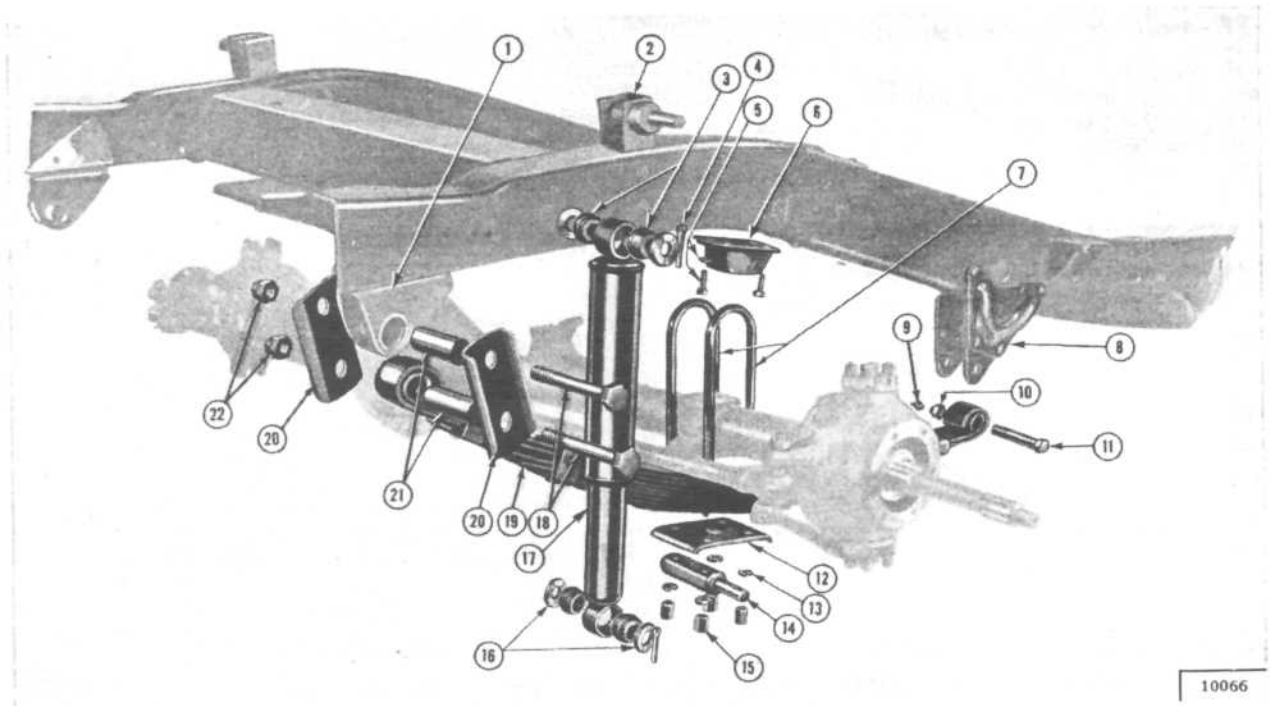


FIG. 301—TYPICAL FRONT SPRING

1—Bracket
2—Bracket and Shaft
3—Bushing
4—Cotter Pin
5—Bolt and Lockwasher
6—Axle Bumper
7—Clip
8—Bracket and Reinforcement
9—Lubrication Fitting
10—Nut
11—Bolt
12—Plate
13—Lockwasher
14—Bracket
15—Nut
16—Special Washer
17—Front Shock Absorber
18—Bolt
19—Front Spring
20—Spring Shackle Side Plate
21—Silent Bloc Bushing
22—Nut

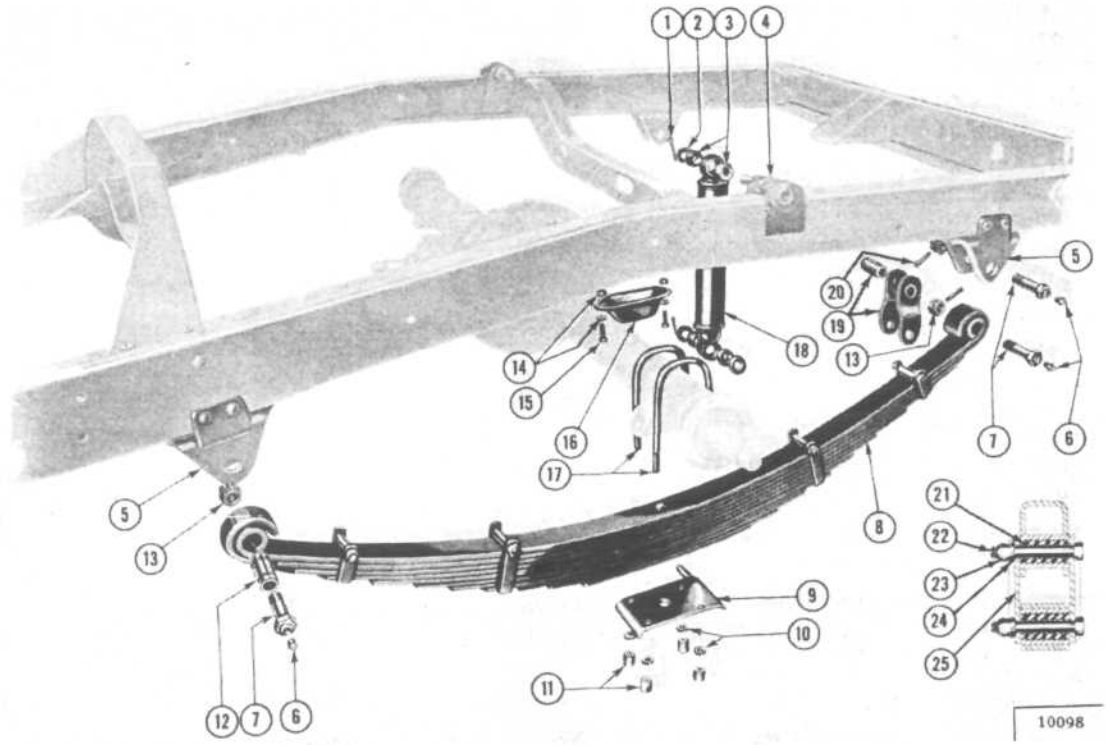


FIG. 302—TYPICAL REAR SPRING

1—Cotter Pin
2—Special Washer
3—Bushing
4—Bracket and Shaft
5—Rear Spring Hanger
6—Lubrication Fitting
7—Bolt
8—Rear Spring
9—Plate and Shaft
10—Lockwasher
11—Nut
12—Rear Spring Eye Bushing
13—Nut
14—Nut and Lockwasher
15—Bolt
16—Axle Bumper
17—Clip
18—Rear Shock Absorber
19—Rear Spring Shackle
20—Cotter Pin
21—Silent Bloc Bushing
22—Bolt
23—Nut
24—Lockwasher
25—Spring Shackle Side Plate

T-6. Remove and Replace Spring

To remove a spring raise the vehicle, then place a stand jack under the frame side rail, adjusted so that the load is relieved from the spring with the wheel resting on the floor. Remove the axle spring clip bolt nuts and lockwashers. Remove the spring plate and clip bolts. Lower jack at the side rail to free the spring from the axle.

Remove the pivot bolt nut and drive out the pivot bolt. Disconnect the shackle, or if a threaded "U"-type, remove the threaded bushing.

To install a spring, replace pivot bolt first and then reconnect the shackle. Raise the jack and place the spring center bolt in the axle saddle and install the axle spring clip bolts and nuts. Axle spring clip nut torque wrench reading, 50 – 55 ft. lbs. (6.91 – 7.60 kg.-m.); spring pivot bolt nut, 27 – 30 ft. lbs. (3.73 – 4.15 kg.-m.). Avoid over tightening. Be sure the spring is free to oscillate at both ends.

T-7. Shock Absorbers

The shock absorbers used on these models are of the hydraulic direct action type, designed to absorb both upward and downward motion. They are mounted on rubber bushings at both top and bottom and their removal and installation is obvious. They are non-refillable and non-adjustable, and if trouble develops in one, it must be discarded and replaced with a new one as no repairs can be made on the unit. If a shock absorber is removed from the vehicle and turned upside down it will lose its prime and become inoperative. To test a unit it must be held in an upright position and the plunger should be worked up and down its full length of travel four or five times to determine whether its action is positive or faulty.

NOTE: The shock absorber stem is smoothly machined to work through a tight seal in the upper end of the cylinder. *Do not* roughen the stem with pliers or similar tools during removal or installation as this will destroy the effectiveness of the seal.

SPRING AND SHOCK ABSORBER SPECIFICATIONS

Front Springs

MODEL:	L6-226 4WD — L6-226 4x4 F4-134 4WD — F4-134 4x4	L6-226 4x2 F4-134 4x2
Make	Mather	Mather
Type	Semi-Elliptic	Semi-Elliptic
Length — Center to Center of Eyes	36¼" [92,08 cm.]	36¼" [92,08 cm.]
Width	1¾" [4,44 cm.]	1¾" [4,44 cm.]
Number of Leaves	10	7
Rebound Clips	4	4
Spring Eye Bolt to Center Bolt	18⅛" [46,04 cm.]	18⅛" [46,04 cm.]
Camber	⅜" at 650 lb. [9,52 mm. - 295 kg.]	⅝" at 735 lb. [15,87 mm. - 333 kg.]

Rear Springs

MODEL:	L6-226 4WD F4-134 4WD	L6-226 4x4 — L6-226 4x2 F4-134 4x4 — F4-134 4x2
Make	Mather	Mather
Type	Semi-Elliptic	Semi-Elliptic
Length — Center to Center of Eyes	50" [127,0 cm.]	50" [127,0 cm.]
Width	2" [5,08 cm.]	1¾" [4,44 cm.]
Number of Leaves	10	8
Rebound Clips	4	2
Spring Bolt Eye to Center Bolt	25" [63,5 cm.]	25" [63,5 cm.]
Camber	1¾" at 1625 lb. [44,4 mm. - 737 kg.]	0" at 900 lb. [0,0 mm. - 408 kg.]

Shock Absorbers

MODEL:	L6-226 4x4 — L6-226 4x2 F4-134 4x4 — F4-134 4x2		L6-226 4WD F4-134 4WD	
	Front	Rear	Front	Rear
Make	Monroe	Monroe	Monroe	Monroe
Type	Hydraulic	Hydraulic	Hydraulic	Hydraulic
Action	Double	Double	Double	Double
Length Compressed	11 7/16" [29,05 cm.]	12 15/16" [32,86 cm.]	11 7/16" [29,05 cm.]	12½" [32,86 cm.]
Length Extended	18 7/16" [46,83 cm.]	21 7/16" [54,45 cm.]	18 7/16" [46,83 cm.]	20½" [54,45 cm.]
Mounting	Rubber	Rubber	Rubber	Rubber

BODY

Contents

SUBJECT	PAR.
Body Reinforcement	U-15
Cab Reinforcement	U-16
Care — Exterior Finish	U-2
— Chromium	U-3
— Interior	U-4
Cowl Ventilator	U-17
Door Adjustment	U-5, U-19
Door Striker Plate	U-6
Hood Adjustment	U-13
Hood Vibration	U-14
Glass Replacement — Door	U-9
— Sliding Window	U-12
— Window	U-10
— Windshield	U-11
Locks	U-8
Tail Gate Adjustment	U-7
Tool Box Door	U-19
Windshield Wiper	U-18

U-1. GENERAL

The bodies of all models discussed here are of all-steel construction. Of heavy gauge steel, all open edges of the panels are turned under, reinforced and flanged to give inherent strength. The panels are reinforced with "U" sections and welded. All component panels are seamed and welded together.

The bodies are insulated from the frame with insulator shims placed between the body and frame and held in position by the body bolts.

Regardless of the rigidity built into the body it must be periodically inspected for settling and alignment.

a. Check all body bolts to be sure they are tight.

b. Check floor board screws and tighten if necessary.

c. Inspect door hinges, locks, window regulators and tighten.

d. Check the door striker plates — adjust and tighten.

e. Check window glass for side play. Side play may be eliminated by placing cardboard shims back of the felt lined runs.

U-2. Care of Exterior Finish

Frequent washing with clear water and polishing with a soft cloth or chamois will preserve the original lustre of the finish. Always use cold water in washing a car. Never wash it in the direct rays of the hot sun and always wait until the sheet metal surfaces are cooled off before washing.

If the vehicle finish becomes extremely dirty, and especially when the dirt is allowed to remain for some time it may remain dull even after washing.

Dullness may also be caused by slight oxidation of the finish due to chemical action of the elements.

All that is needed to bring back the original lustre is a small amount of good polish. Rub the polish lightly until dry to eliminate a damp surface to collect dust. Oxidation of the finish will be reduced to a minimum by periodic application of a good quality wax.

U-3. Care of Chromium Finish

Wash chromium finish with clear water and a clean cloth. No polishing is required, however, the life of the finish will be extended by periodic application of a good quality wax.

Because of the severe use to which they are put, bumpers present a special problem in regards to keeping their polished surface bright. The finish is likely to become scuffed or worn through and small rust spots may appear. Should this occur clean off the rust with mild kitchen scouring compound on a cloth; then apply wax, transparent varnish or lacquer to retard further rust formation.

U-4. Care of the Interior

To remove spots and stains from upholstery or carpets the following suggestions may be helpful. Use a good shampoo type cleaner where possible instead of carbon tetrachloride on cloth upholstery.

When using cleaning fluids, follow the method that is commonly used when cleaning spots from clothing — that is, dampen a clean cloth with a little of the fluid and begin rubbing lightly around the outside of the spot, working gradually toward the center. This method keeps the spot from spreading and is less likely to leave a ring.

Blood Stains — Rub the stain with a clean cloth dampened with cold water.

Candy — If candy does not contain chocolate, the stain can be removed by rubbing with a cloth moistened with very hot water. Chocolate stains may be removed by rubbing with a cloth and lukewarm water, followed by sponging with carbon tetrachloride.

Chewing Gum — Moisten the gum with carbon tetrachloride and work the gum off the fabric with a dull knife while it is still moist.

Fruit Stains — Rub vigorously with a cloth dampened with very hot water. Let dry, then sponge with carbon tetrachloride.

Grease and Oil — Use cleaning fluid or carbon tetrachloride. If the fabric is saturated with oil, pour on the cleaning fluid and soak it up by pressing a white blotter on the spot before sponging in the usual manner with a cloth dampened in the fluid.

Ice Cream — Use the same method as for removal of fruit stains. If the stain is persistent, use a cloth moistened with warm soap suds, then cold water. After drying, sponge with carbon tetrachloride.
Lipstick — Pour on a little carbon tetrachloride and immediately press a clean blotter firmly on the spot. Repeat until the stain is removed.
Paints and Lacquers — Use a cloth saturated with turpentine, then sponge with a cloth and cold water.
Shoe Polish — Black or tan polish may be removed with a cloth saturated with carbon tetrachloride. White polish will usually come off with a stiff brush. If not, moisten with cold water, let it dry, and then use a brush.
Tar — Moisten the spot with carbon tetrachloride and remove as much tar as possible with a dull knife. Then sponge with cleaning fluid.
Water Spots — Sponge the entire panel with a clean cloth dampened with cold water then sponge the spot with a cloth moistened with carbon tetrachloride.
Imitation Leather Upholstery — May be cleaned by rubbing the surface with a clean cloth saturated in water, using a good quality soap. After thorough scrubbing, use water only and polish dry with a soft dry cloth.

U-5. Door Adjustment — All Models

Doors are adjusted by shifting the door end of hinges, Fig. 303, where attached to the door. Attachment is made by screws which thread into a floating plate at each hinge. Loosen the attaching screws to shift the door either vertically or horizontally. Do not attempt to spring the hinges to improve door fitting. The combination door support latch pin and dovetail is attached to the pillar by screws threaded into a floating plate. Adjustment may be made by loosening the screws to allow shifting of the assembly. Use care in positioning this assembly. If it is located too far in it will be necessary to slam the door and the remote control button will be hard to operate — if too far out the door will be loose horizontally.



FIG. 303—DOOR HINGE ADJUSTMENT

U-6. Door Striker Plate

To prevent the door opening in the safety latched position, the door striker wedge, Fig. 304, must be properly positioned in relation to the cam surface of the lock toggle. Improper safety latched position, as shown in Fig. 304, will permit the toggle to override the striker pin, causing the door to open. The striker must be positioned so that the door lock toggle will be held securely in engagement with the striker pin. The top or wedge end of the striker plate must be moved outward until the wedge firmly contacts the cam surface of the lock toggle, exerting sufficient pressure to prevent the toggle from overriding the striker pin. This may be accomplished by placing a suitable driver against the upper inside edge of the striker plate and with a hammer strike the driver to move the plate outward slightly. The safety latch operation must be checked intermittently with the repositioning of the striker until the correct position is obtained.

The striker plate to pillar attaching screws must be securely tightened after the striker plate has been properly positioned.

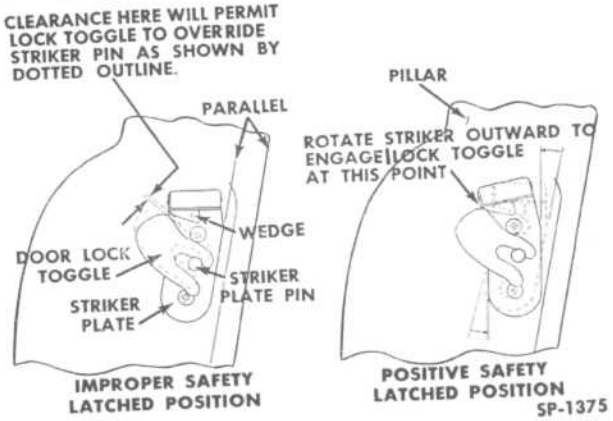


FIG. 304—LOCK TOGGLE AND STRIKER PLATE POSITION

U-7. Tail Gate Adjustment

All Utility Wagons

No adjustment is provided for the upper and lower piano type tail gate hinges. Both the upper and lower lock catches mounted on the body pillars are adjustable vertically. Loosen the mounting screws to adjust. The lower tail gate dovetails are adjusted in the same manner.

U-8. Door Locks

The remote control door locks are riveted at assembly and it is recommended that a new assembly be installed should trouble develop. To install a new lock first run the glass up to the closed position and remove the window regulator crank by pressing in the trim ring and removing the retaining pin. To remove the remote control handle, push in on the trim ring and remove the retaining pin.

Remove the arm rest and trim panel. Remove the inside door locking knob by unscrewing. Remove two screws from the edge of the door which attach the lower end of the glass runway channel. Place the lock in locked position by turning the forked latch to a vertical position. Remove three screws attaching the remote control to the door panel. Remove four screws attaching the lock to the edge of the door and remove the lock. Reassembly is the reverse of disassembly.

It is not necessary to remove the outside door lock handle to remove the lock assembly. To remove the handle, remove the retaining screw from the edge of the door. Run the glass up to the closed position. If the trim panel has not been removed, loosen the upper corner, directly back of the lock, to spring it back sufficiently to reach in and remove the retaining nut.

Should the outside door handle fail to release the door lock easily it is usually due to the trigger in the handle failing to release the lock until it is nearly flush with the handle due to wear or a bent releasing lever on the lock assembly. This condition may be usually corrected without replacement of parts as follows:

Remove the inside lining panel as outlined above.

Remove the outside door handle and close the door and lock it with inside lock. Measure through the door handle hole the distance from the face of the outside door panel to the face of the releasing lever on the lock assembly. Measure the distance on door handle from the edge of the handle casing to the tip of the boss on the trigger striker lever as shown in Fig. 305. Subtract the two measurements which will indicate the amount the lever boss must be built up to eliminate the lost motion in the trigger.

Add slightly more than this amount to the lever boss, indicated by the arrow in Fig. 305, by brazing and dress the brass down to the correct dimension with a file. Lubricate the handle parts and install the handle.

U-9. Door Glass Replacement

To remove the door glass first remove the door lock remote control escutcheon plate by pressing it in and rotating it ¼ turn counter-clockwise. If equipped with a remote control handle, remove as outlined in "Door Locks". Remove the regulator crank by pressing in the trim ring and removing the retaining pin. Remove the trim panel and also remove the garnish moulding from around the glass. Loosen the glass run channel and remove the regulator control arms from the channel, mounted on the bottom of the glass, by removing the two hair pin type locks which retain the control arm buttons. Remove the glass and runway as an assembly through the window opening.

U-10. Window Glass Replacement

Windshield, rear window and quarter window glass is replaced in the same manner on all models. The glass is mounted in a rubber channel or weather seal which is held in position by the rubber garnish moulding and a flange on the body. To remove the glass first remove the garnish moulding. The rubber

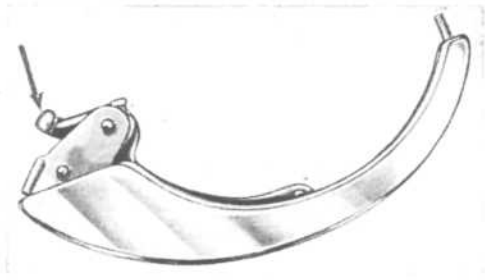


FIG. 305—DOOR HANDLE ADJUSTMENT

channel is cemented, for waterproofing, to the body flange and the cement must be loosened. This can usually be done by pressing with the fingers, however, in some cases it may be necessary to use a dull thin blade as a tool. When the cement is loosened the glass and rubber channel can be readily pushed through the opening for removal.

To install a glass, first remove the old cement from the rubber channel and body flange. Cement the body flange and glass. Place the rubber channel over the glass and wrap a piece 3/16" (4.76 mm.) rope around the channel. See Fig. 306. Place the glass and channel in the opening and as the assembly is pushed against the body flange pull both ends of the cord out from around the channel. As the cord is pulled the lip of the rubber channel will be pulled out and correctly positioned against the body and over the body flange. Fig. 307.

U-11. Windshield Glass Replacement

To make installation of a windshield glass, it is necessary to first remove the entire windshield assembly. To make a satisfactory installation, both glasses must be installed simultaneously.

First, remove the center cover plate from the center bar garnish moulding, the mirror bracket plate, the center bar, the outer cover panel and the two garnish mouldings.

Check the packing strip used for attachment of the upholstery to be sure there is no obstruction present which will prevent the free removal of the assembly. Drive in any upholstery tacks which may be protruding and be sure the packing strip is well back in the groove.

Have one man work from the front, using a screw driver to work the rubber mounting channel over the body retaining flange. Start at the top center and as the rubber is removed, push in on the assembly to prevent the rubber from working back over the flange. Have a second man support the assembly to prevent its falling in suddenly.

After the assembly has been removed, place it on a flat surface with a piece of 1" thick wood under each glass. Remove the glass which must be re-

placed by working the rubber channel over the edge of the glass. It may be necessary to use a screw driver to loosen the cement seal between the glass and rubber.

Next, install the glass in the rubber mounting channel. The two pieces of glass are interchangeable, however, note that the two corners which are

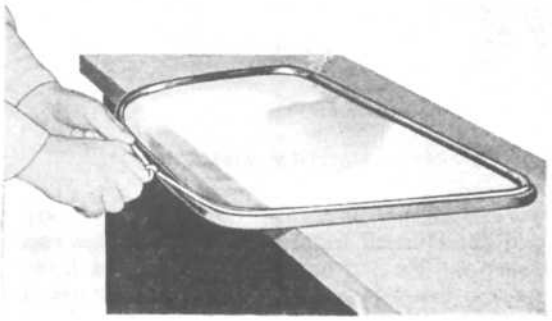


FIG. 306—WINDOW GLASS REPLACEMENT

nearly square are placed together with the rounded corners outside. Use a small paint brush to thoroughly coat the channel, which receives the glass, with cement. Place the rubber mounting channel over the glass and work the glass into the channel, being sure it is well-seated.

Next, reinstall the windshield assembly in the body, which requires two men. First, mix a strong solution of soap and water and paint the body and mounting flange at all points which contact the rubber. The soap acts as a lubricant to facilitate the installation. Wrap a piece of string at least 1/16" in diameter, but not more than 1/8", around the assembly and in the mounting flange

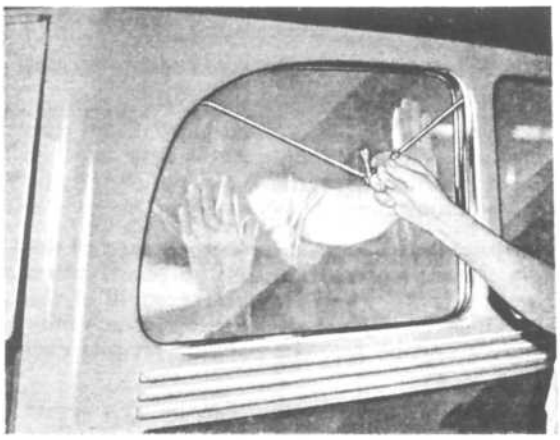


FIG. 307—WINDOW GLASS REPLACEMENT

groove as shown in Fig. 308. Approximately eight feet of string will be required. Have a man positioned inside the vehicle to place the assembly in the body opening, pressing it in until the rubber contacts the mounting flange. As the assembly is pressed in, have a man on the outside pull the string from the groove to feed the lip of the channel uniformly over the body flange around the windshield. See Fig. 309.

After positioning the windshield in the body, cement the rubber mounting channel to the body flange.



FIG. 308—WINDSHIELD GLASS INSTALLATION

U-12. Sliding Window

All Utility Wagons

To remove the sliding window, first remove the garnish moulding. Unclip the glass run channel at each end. Glass and channel are removed as an assembly by tilting in.

To remove the sliding window lock it is first necessary to remove the glass as outlined above. Remove the lock handle by removing the retaining pin using a pin punch. Remove the nut directly back of the handle. Remove the trim panel and remove the two screws attaching the lock spring to the body.

Fig. 310 illustrates the drain for the sliding window. Be sure the tube is cemented in position and inserted in the body drain hole.

U-13. Hood Adjustment

Hood hinge mounting holes on all models are slotted for hood adjustment.

The hood lock used on all models may be adjusted by threading the spring loaded catch, mounted on the hood, in or out. A screw driver slot is provided

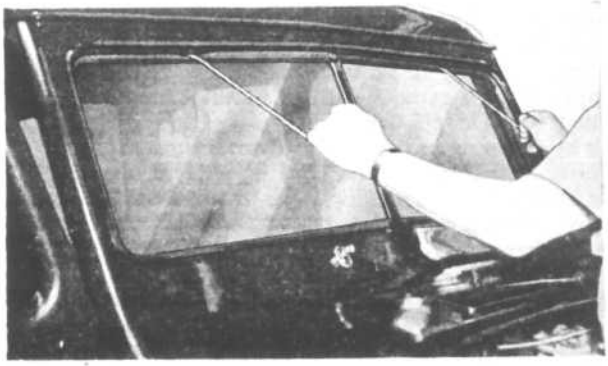


FIG. 309—WINDSHIELD GLASS INSTALLATION

for the adjustment. Use care that the catch is not screwed too far into the hood making it difficult to release.

U-14. Hood Vibration

Excessive hood vibration may develop on vehicles after long service and may be corrected as follows:

a. Check the hood lock for tight engagement of the locking bolt. Adjust if necessary.

b. Inspect the weatherstrips on the front and rear hood ledge for excessive wear or poor adhesion. Replace or recement if necessary.

c. Install new bumpers in place of the two original bumpers on the rear hood ledge at each end of the rear weatherstrip.

d. Apply chalk on top of the new bumpers and close the hood tightly. Open hood and check chalk marks or inner surface of hood. If bumpers are not providing good compression, add flat washers under the bumpers until positive pressure between hood and bumper is obtained.

e. Remove end clips from the weatherstrip on the front hood ledge. Cut 1½" [4 cm.] from each end of the weatherstrip. Make sure the remaining weatherstrip is securely cemented at the ends to the hood ledge.

f. Install two bumpers, one at each end of the front weatherstrip, using the holes left by removal of the end clips. Check for proper compression as outlined in paragraph d. above.

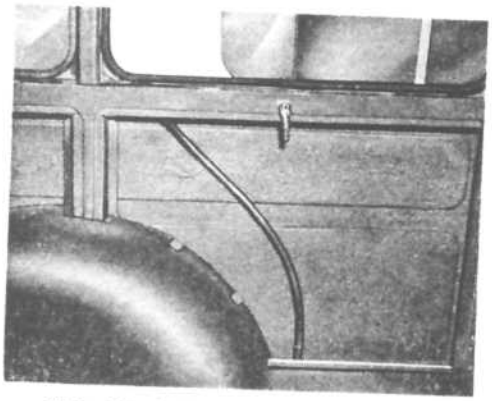


FIG. 310—SIDE WINDOW DRAIN

U-15. Body Reinforcement Kit

All 4-Wheel-Drive Models

If a 4-wheel drive truck or Utility Wagon is subjected to severe off-the-road usage it is recommended that the body reinforcement kit, Part No. 683962, be installed on the vehicle. This kit is available from the parts department and includes:

Dash panel reinforcement
Air deflector reinforcement
Radiator guard reinforcement
Rear fender braces
Front seat support pan reinforcement

Complete installation instructions are included in the kit.

U-16. Cab Reinforcement

All 4WD Trucks

Where 4WD trucks are subjected to strenuous operation over rough terrain, breakage of cab mounting brackets may occur. The procedure for fabricating and installing a cab mounting bracket reinforcement is given below.

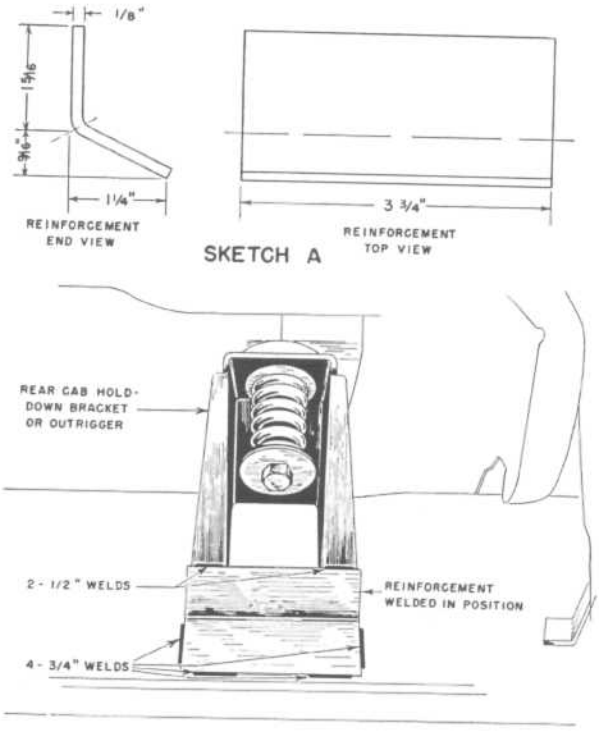


FIG. 311—CAB MOUNTING BRACKET REINFORCEMENT

The reinforcement should be fabricated of ⅛" x 2½" x 3¾" good quality steel stock, according to the dimensions shown in Sketch A of Fig. 311.

Support the cab with blocks between the cab and frame. The cab mounting bolt should be removed and the mounting bracket straightened to its proper position and spot welded in place. The reinforcement should then be welded to the mounting bracket and frame as shown in Sketch B of Fig. 311.

U-17. Cowl Ventilator

The cowl ventilator lid on all models is protected from leakage by sponge rubber gaskets. The gaskets are cemented in position and may be readily replaced.

The ventilator lid hinge mounting holes are slotted for adjustment.

U-18. Windshield Wiper

The windshield wiper motor is of the conventional vacuum type, mounted at the center of the dash directly back of the engine. The tandem wiper arms are actuated through cables which are equipped with suitable spring loaded tensioners and operate over "V"-type pulleys.

A tensioner may be readily released for cable replacement by loosening the nut which attaches it to the mounting bracket. See Fig. 312.

A ferrule is soldered at each end of the cable. The cable is installed by placing the ferrule in the recess provided in the motor arm, by passing the cable through the slot. When the cable is installed, correctly tighten it by adjusting the tensioner spring then retighten the locking nut.

Both the tensioners and the arm shaft pivots assemblies are made for the right and left sides of the vehicle and cannot be interchanged. Should they be removed they should be tagged to insure correct reassembly.

Twice each year or each 5000 miles (8000 km.) coat the cables with light grease and oil the pulley bearings with a few drops of light engine oil.

U-19. Tool Box Door

Utility Vehicles

If the tool box doors will not stay closed because the door is lower than the body panel opening, loosen the nuts on the hinges and use the slotted holes of the body panel provided for adjustment. If the door is positioned satisfactorily but fails to latch because of faulty operation of the lock cylinder, the lock cylinder should be replaced.

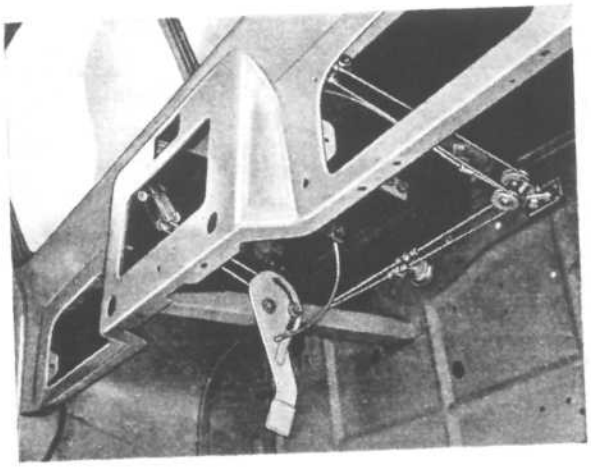


FIG. 312—WINDSHIELD WIPER CONTROL

MISCELLANEOUS

Contents

SUBJECT	PAR.
Extra Equipment	V-2
Power Take-Off	V-3
Governor	V-9
Miscellaneous Data	V-20
Special Tools	V-19
Torque Specifications	V-18

V-1. GENERAL

Miscellaneous information included in this section includes coverage of extra equipment, special tools, torque specifications, and charts and tables.

V-2. EXTRA EQUIPMENT

Much of the utility of the 4-wheel drive vehicles is due to the extra equipment which has been designed to adapt it for farming and industry. The maintenance and use of some of this equipment is outlined in this section.

V-3. Power Take-Off

Several methods of utilizing engine power, both with the vehicle standing or in motion, have been developed. General data, including horse power available, covering the power take-off assemblies, is given in Par. V-20.

The rear power take-off is covered in detail in the following paragraphs.

V-4. Power Take-Off with Shaft and Belt Pulley

The rear power take-off consists of four assemblies:

The shift unit mounted on the transfer case
The propeller shaft and universal joints
The shaft drive assembly
The pulley drive assembly

The shaft drive assembly is mounted at the rear of the vehicle and is designed to operate trailed equipment. The pulley drive assembly is driven by the shaft drive and is designed to operate stationary equipment by belt drive.

V-5. Front Unit or Shift Assembly

Drive for the power take-off is taken from the transfer case main drive gear through an internal type sliding gear, No. 42, Fig. 313. The sliding gear is mounted in the shift housing and the shift lever controls this gear to engage and disengage the drive. A conventional type poppet ball and spring prevents disengagement of the gear.

The shift assembly is lubricated from the transfer case and no attention is required other than regular lubrication of the transfer case.

Should it be necessary to remove the assembly for service, first remove the bolts in the propeller shaft companion flange at the power take-off front universal joint. Remove the shift lever by removing the four screws holding the lever cover, in position. Use care not to lose or damage the felt oil seal. Remove the five screws used to attach the assembly to the transfer case and remove the shift unit by pulling it to the rear.

Wash the assembly thoroughly in cleaning solution and place the unit in a bench vise if it is necessary to dismantle it.

Place a light bar through the shift lever opening to pry the shift rail and fork, No. 1, forward to clear the poppet ball and spring, using care not to lose the ball and spring, and remove the shifting sleeve, No. 42.

Remove nut, No. 4, and the companion flange, after which the shaft, No. 39, may be driven forward out of the housing. Be careful not to damage oil seal, No. 37, as the shaft is removed. Remove the spacer, No. 40, after which bearing No. 38 can be removed. Remove bearing, No. 38, from the housing.

Wash all parts in cleaning solution and inspect them for wear or damage. Reassembly is in the reverse order of dismantling. Do not overlook assembly of the poppet ball and spring when installing the shift rail.

V-6. Propeller Shaft and Universal Joint Assembly

The propeller shaft is tubular and has two universal joints, Fig. 313. The joints are enclosed by housings and boots, which contain the lubricant. As the torque capacity of the propeller shaft is far greater than that developed by the engine and as there is very little flexing of the joints, this unit will require no attention for the life of the vehicle under normal use other than an inspection at each 1000 miles (1600 km.), to guard against loose companion flange attaching screws or leakage of lubricant at the boots. Should the power take-off be used often for continuous operation, disassemble the joints and repack them with lubricant once each year. See "Propeller Shaft and Universal Joint" section.

NOTE: A Spicer type propeller shaft has been released as an optional component of the Power Take-Off assembly. This shaft has the cross type

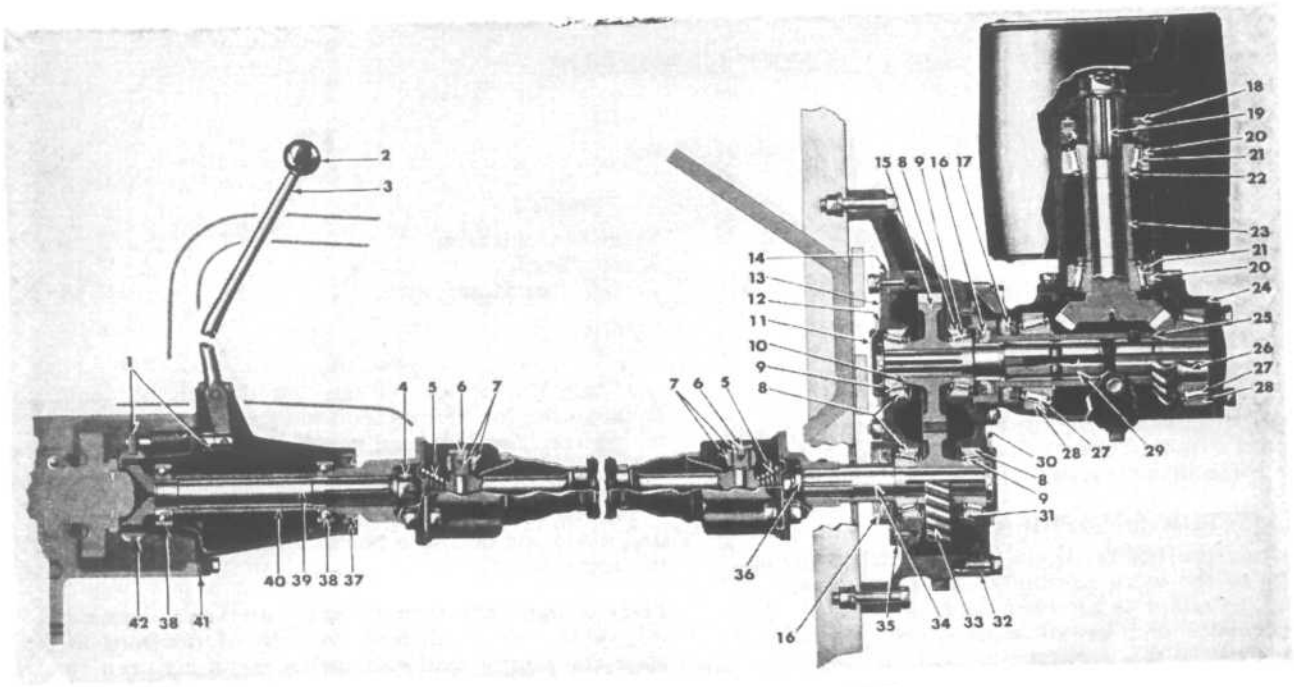


FIG. 313—POWER TAKE-OFF ASSEMBLY

1. Fork and Rod
2. Ball
3. Lever
4. Nut
5. Button and Spring
6. Spring
7. Trunnion and Ball
8. Cup
9. Bearing
10. Snap Ring
11. Plate
12. Gasket
13. Retainer
14. Gasket
15. Gear
16. Oil Seal
17. Oil Seal
18. Oil Sea
19. Gear and Shaft
20. Cup
21. Cone and Roller
22. Shims
23. Spacer
24. Shims
25. Shims
26. Pinion
27. Cone and Roller
28. Cup
29. Shaft
30. Gasket
31. Shims
32. Gasket
33. Gear
34. Shaft
35. Gasket
36. Washer
37. Oil Seal
38. Ball Bearing
39. Gear and Shaft
40. Spacer
41. Gasket
42. Sleeve

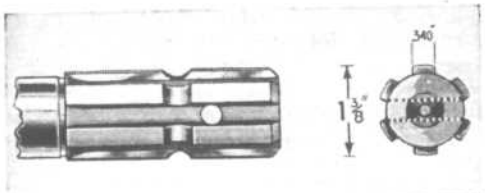


FIG. 314—POWER TAKE-OFF SPLINED SHAFT

universal joints and is attached with "U" bolts. A shear pin is embodied in the shaft as a safety feature. See Fig. 315 No. 1. It is IMPORTANT to note that the Spicer type universal joints have no slip splines to allow movement endwise and it is necessary to select and install spacing washers at No. 2, Fig. 315 to correctly position the center bearing assembly to prevent end bind in the universal joints.

Each joint on this type shaft is equipped with a lubricator and the shaft should be lubricated when installed and periodically thereafter, depending upon the amount of usage. Use a hand gun to avoid damaging the joint seals.

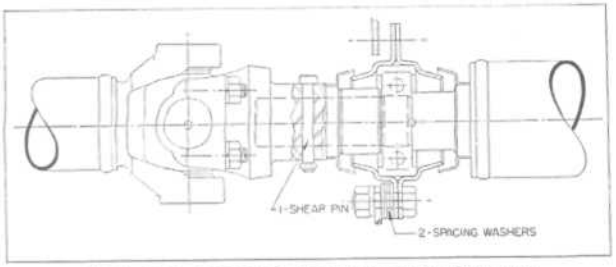


FIG. 315—SPICER PROPELLER SHAFT

V-7. Shaft Drive Assembly

The standard six splined, $1\frac{3}{8}$" (34.92 mm.) diameter output shaft, No. 29, Fig. 313 and also Fig. 314, of the rear power take-off assembly is driven through two helical cut gears mounted in a housing attached to the vehicle at the center of the frame rear cross member. Both the input and output shafts rotate on tapered roller bearings with the running clearance adjusted by shims.

The maximum torque of the engine is developed at a speed of 2000 r.p.m. At this speed the splined output shaft turns 536 r.p.m., which is the SAE standard for all farm tractors. This shaft speed is obtained, when the vehicle is in motion, by using low transmission gear and low transfer case gear in four-wheel drive. The 20-tooth gear, No. 33, must be installed on the input shaft and the 24-tooth gear, No. 15, on the output shaft, which is the standard assembly, to secure this speed. Should conditions require a decreased vehicle ground speed and maintenance of the output shaft speed, interchange these two gears. As an example, when towing power driven farm machines, it may be found that under extremely heavy crop conditions the machine being operated cannot handle the volume of crop which is cut at the standard ground speed of the vehicle. To handle the crop, it is necessary to reduce the ground speed and yet maintain the output shaft speed. This is accomplished by interchanging gears, No. 15 and No. 33, as shown in Fig. 313. These two gears form a drive ratio, within the power output unit, of either 20 to 24 (5 to 6) or 24 to 20 (6 to 5). To interchange the gears, first remove the power

take-off assembly from the vehicle and drain the lubricant from the housing. Remove bearing retaining plate, No. 11. Bend back the lips of the nut locking washer and remove the bearing retaining nut. The cover may then be removed with the bearing assembly. Use care not to lose the shims which are placed between the gear hub and the bearing cone. The gear may be slipped from the shaft through the cover opening.

The other gear may be removed in the same manner after removing the cover plate. Interchange the gears and reassemble in the reverse order with the long side of the gear hub toward the covering opening. Use care that the shims are replaced in the same position relative to the bearings from which they were removed. Do not overlook refilling the housing with lubricant.

Speed of the output shaft in relation to vehicle ground speed is important. To aid in the selection of engine speeds and gear ratio positions, refer to chart, Par. V-20, which shows both the shaft and vehicle speeds through the range of governor controlled engine speeds and in all transmission and transfer case gear positions.

When the power take-off is used, inspect it periodically to guard against possible leakage of the lubricant, which should be kept at the level of the filler plug hole in the left side of the housing. The attaching screws should be kept tight at all times and the breather free of dirt.

Should it be necessary to remove the unit for service, first remove the four screws attaching the rear universal joint to the companion flange. Remove the flange retaining screw and the flange. Remove the screws attaching the assembly to the vehicle and remove the unit.

Drain the oil and wash the unit with cleaning solution. Next remove the cover at bearing No. 9, and gasket. Bend the locking tangs away from the nut and remove the nut and locking washer on the input shaft, No. 34. Remove the five screws attaching the bearing retainer and remove the bearing and retainer assembly with the gasket, No. 32. Use care not to lose the shims installed between gear No. 33 and the bearing cone. The bearing cone may be readily removed from the retainer, after which remove the cup, then the snap ring. Next remove the three screws attaching the oil seal retainer and pilot assembly. Press the shaft through the housing, removing the bearing cone, the oil seal, and the oil seal retainer as an assembly. Gear No. 33 may be removed through the rear bearing retainer opening. The bearing cup may be pushed out after which the snap ring can be removed. The bearing cone and the oil seal may be removed from the shaft. Removal of the output shaft assembly is made in the same manner.

Adjustment of the tapered roller bearings on both shafts is accomplished by shim packs placed between the gear hubs and the bearing cones. The shims are interchangeable and care should be used not to mix the two packs, and that they be replaced in the same position from which they were removed. Should new parts be installed in the assembly, it may be necessary to change the thickness of the shim packs. The shims are supplied .003", .005", .010" and .030" (.076, .127, .254 and .762 mm.) in thickness. The correct combination of these shims must be installed to allow the bearings to turn freely, yet without end play of the shaft. As an approximate guide, if the thickness of the shim packs be unknown, install .031" (.787 mm.) shims on each shaft and add or remove, if necessary, to secure the correct adjustment.

Reassemble in the reverse order of dismantling. When assembly is completed, fill the housing to the filler plug level with hypoid gear oil. See Lubrication Chart.

V-8. Pulley Drive Assembly

The pulley drive assembly is mounted on the shaft drive assembly and is driven by the splined output shaft.

To dismantle the pulley drive assembly, remove it from the vehicle by removing the four attaching screws. Drain the oil from the housing and wash the assembly thoroughly with cleaning solution or solvent.

First remove the pulley retaining nut, Fig. 313, and remove the pulley. Remove six screws to disassemble the pulley shaft housing from the gear housing. Note that there is a shim pack between the two housings which must be kept separate.

Press the pulley shaft, No. 19, through the housing, removing the inner bearing cone, No. 21, spacer and shim pack, Nos. 22 and 23.

Remove the oil seal, No. 18, after which the outer bearing cone may be lifted from the housing. If necessary, pull the bearing cups, No. 20, from the housing.

To dismantle the gear housing assembly, first remove bearing retainer cover and shim pack, No. 24. Bearing assembly No. 27 and gear No. 26, will come out by using a brass drift to tap the shaft through the housing. Be careful not to lose the shims, No. 25, from between the gear and the sleeve on the stub shaft. Pull oil seal No. 17 and, if necessary, bearing cup No. 28.

Wash all of the parts in solvent and make careful examination to determine their condition. Replace parts found worn or damaged and reassemble in the reverse order, excepting the two oil seals which should not be installed until the shim adjustment is checked.

Shim packs of correct thickness should be installed to allow bearing to turn freely without end float and to provide .004" to .010" (.102 to .254) backlash of the gears. After the gear backlash is corrected with shim packs, No. 25 and that placed between the housings, the bearing adjustment is made with shim packs, No. 22 and No. 24. The standard thickness of gear adjusting shim packs, No. 25 and that placed between the housings, is .031" (.787 mm.). That of No. 22 is .050" (1.27 mm.) and No. 24 is .062" (1.57 mm.). Should the shims become lost or mixed, install the standard packs and then add or remove to secure proper adjustment. When the assembly is completed do not overlook

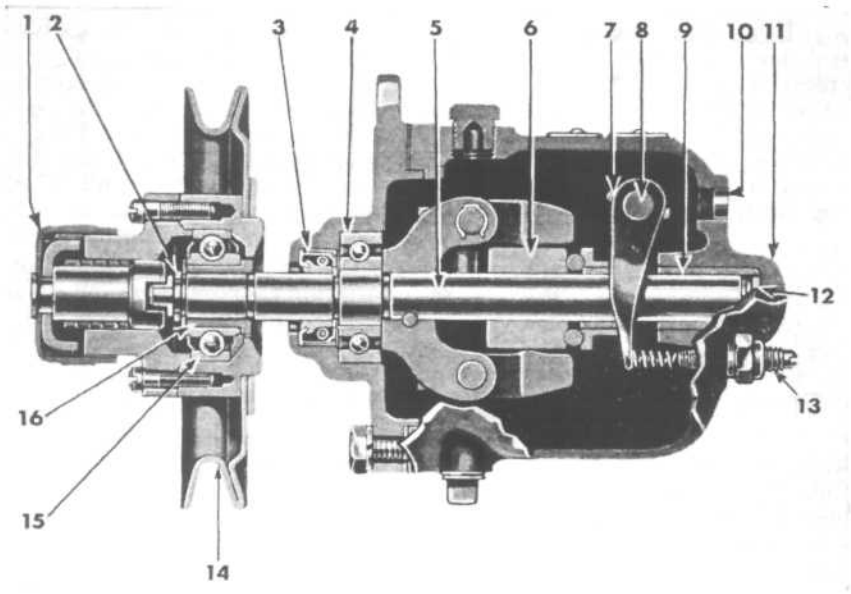


FIG. 316—KING-SEELEY GOVERNOR—4WD MODELS

filling the housing to filler plug level with hypoid gear oil. See Lubrication Chart.

V-9. Governor Assembly

Three different governors are used in production — the King-Seeley, the Monarch and the Novi. These governors are all of the centrifugal type and installation is similar as they are designed to mount on the same bracket and utilize the same dash control parts. There are some differences, however, in the carburetor throttle bell crank adjustment, throttle linkage and speed control adjustment which are pointed out below.

V-10. Carburetor Throttle Bell Crank

When a Novi governor is used, it is necessary that a carburetor equipped with a throttle bell crank as shown in Fig. 317 be used. King-Seeley or Monarch governors may be used when the carburetor is equipped with that shown in either Fig. 317 or Fig. 318. Carburetors equipped with the early type bell crank (Fig. 318) may be changed over to the later type (Fig. 317) by installing Part No. 116847 Throttle Shaft and No. 116849 Throttle Lever.

When bell crank shown in Fig. 317 is used, the screw attaching the bell crank to the throttle shaft must be installed correctly for the governor being used. For either King-Seeley or Monarch governor, the screw is placed in the top hole (No. 1) and the inner end extends above the throttle lever. When no governor is used the screw is placed in the center hole (No. 2) and through the throttle lever, locking the two parts together as a unit. When a Novi governor is used the screw is placed in the lower hole (No. 3) and the inner end extends below the throttle control lever.

When a carburetor having throttle bell crank as shown in Fig. 318, with which the Novi governor cannot be installed, is used screw No. 1 is removed and discarded when Monarch or King-Seeley governor equipped. This screw must be installed only when no governor is used.

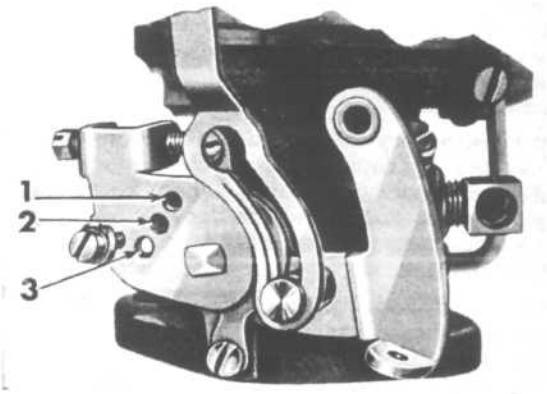


FIG. 317—THROTTLE BELL CRANK

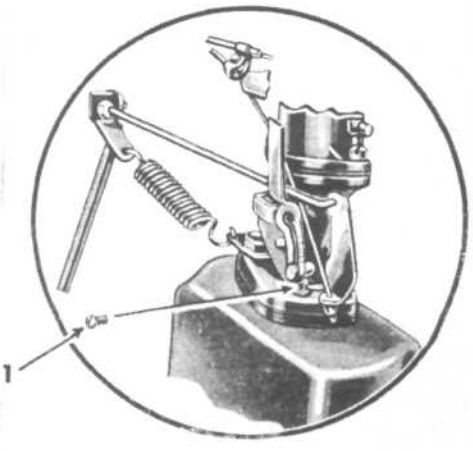


FIG. 318—THROTTLE BELL CRANK

V-11. Novi Governor Adjustment

a. Adjust the carburetor to obtain smooth engine idle at 600 rpm., then stop the engine.

b. Check throttle linkage to insure maximum throttle opening. Be certain that throttle and governor linkage is free as freedom is essential to satisfactory governor operation.

c. Place the carburetor throttle in the wide open position and pull the governor control handle out to the last notch. Adjust the link between governor and bell crank so that the linkage will hold the carburetor throttle in wide open position.

d. Close the governor control and start the engine. Again pull the control out to the last notch and adjust the length of the cable so that the engine will run at 2600 rpm. Close the control to recheck the linkage for free action and to make sure the engine will return to 600 rpm. idle speed.

e. Should it appear necessary to lengthen the governor control cable excessively to obtain an engine speed of 2600 rpm. the link between governor and bell crank may be lengthened slightly.

V-12. Novi Governor Operation

The Novi governor is directly belted to the engine as no clutch is provided to disconnect the drive.

To operate the vehicle WITHOUT governor control, push the governor hand control all the way IN against the instrument panel.

To operate the vehicle WITH governor control, pull the governor hand control handle out. The hand control has nine notched positions. Pulling the control out to the first notch sets the controlled engine speed at approximately 1000 r.p.m. and each successive notch increases the speed 200 r.p.m. until 2600 r.p.m. is reached in the ninth notch. The hand control may be released by turning the handle one-quarter turn in either direction.

When the engine is being operated under governor control (hand control out) the controlled engine speed may be exceeded at any time by depressing the foot accelerator in the conventional manner to secure a greater carburetor throttle opening than that determined by the governor hand control setting.

V-13. King-Seeley Governor Adjustment

First tune the engine to obtain smooth operation. Mechanical adjustment of speed control is obtained by adjusting the length of the hand control cable with a clevis.

First check the carburetor bell crank to be sure the screw shown in Fig. 318 has been removed or if as shown in Fig. 317 is correctly located. Check the carburetor throttle rod to make certain the throttle opens and closes fully. Disconnect the accelerator spring and eliminate any bind or stiffness in the throttle connections and carburetor linkage. Free operation of the throttle is necessary to avoid surging of the governor when the engine is placed under load. After checking, reconnect the accelerator spring.

Set the dash hand throttle in the fully open position and leave it there. All the adjustments are made with the throttle in this position.

Adjust the length of the spring loaded governor-to-throttle link No. 12 to allow exact assembly between the short or lower governor lever and the carburetor throttle lever without moving either lever and with the throttle fully open. Tighten the adjustment lock nut and install the link.

Engage the governor clutch by turning the control on the pulley hub until the driving pins engage the deeper recesses. Place the governor hand control in the closed or IN position and check to be sure the hand throttle on the dash is fully out. Start the engine and allow it to run until operating temperature is reached.

The governed engine speed is controlled by the position of the upper or long governor lever. Adjust the yoke on the hand control cable and attach it to the governor arm when the arm is positioned to give an engine speed of 1000 rpm. In the absence of electrical tachometer equipment, the engine speed may be determined by the speedometer. Safely jack up the rear wheels and be sure the front wheel drive is not engaged. When driving the rear wheels in high or direct transmission gear, the speedometer will read 15 mph [24 kph.] at an engine speed of 1000 rpm.

In some cases it may be necessary to adjust the surge screw at the rear of the governor to eliminate surge. Should this be necessary, loosen the lock nut and turn the slotted screw in until the engine stops surging when the governor hand control is suddenly operated from low to high speeds, then tighten the lock nut. Use care in making this adjustment not to turn the screw in too far or governor speed control will be lost.

V-14. King-Seeley Governor Operation

When speed control is not desired the governor may be disengaged with the twin-pin type clutch mounted on the driven pulley hub. Never attempt to engage this clutch with the engine running. To operate it pull the cap out toward the radiator and rotate it ¼ turn in either direction until you feel the two driving lugs drop into the recesses provided. The governor is engaged when the lugs are in the deeper recesses, and, locked in the disengaged position when in the shallow recesses.

The controlled engine speed may be varied with the governor hand control. With this control in against the dash, the controlled engine speed is 1000 r.p.m. The speed is increased 200 r.p.m. per notch, as the hand control is pulled out. The top speed is 2600 r.p.m. in the ninth notch. The hand control is released by turning the handle ¼ turn in either direction.

When the governor is to be used, stop the engine, engage the governor clutch and pull the hand throttle control fully out to allow the governor to take over engine speed control. When the governor clutch is disengaged, release the hand throttle by turning the handle one-quarter turn in either direction.

V-15. Monarch Governor Adjustment

The adjustment of the Monarch governor is the same as that listed above for the King-Seeley with the exception of the adjustment of the spring loaded governor-to-throttle link No. 12. Adjust this link to have approximately 1/16" (1.588 mm.) slack or lost motion. No surge adjustment is provided and this lost motion is allowed to cushion any slight irregularities in governor control.

V-16. Monarch Governor Operation

The operation of the Monarch governor is the same as that of the King-Seeley excepting the clutch control. Clutch control is through a spring loaded lever mounted on the top of the unit. To engage the drive, unlatch the lever and allow the spring to carry the engaging assembly forward. Do not engage this clutch with the engine running.

V-17. Governor Maintenance (All Types)

The belt tension may be adjusted by raising or lowering the governor in the slotted holes in the mounting bracket. Keep the pulleys and belt free of dirt and oil. Belt slippage will affect governor operation and a tight belt may cause rapid wear of the governor shaft and bearings. Adjust it to allow 1" (25.4 mm.) depression midway between the pulleys with thumb pressure.

There is little wear of the internal parts for they operate in oil. The governor housings are equipped with both fill and drain plugs and also (with the exception of some Novi type governors), with level indicating plugs. Check the oil level at each vehicle lubrication and change the oil each time the engine oil is changed using the same grade oil used in the engine. IMPORTANT — Do not fill the governor housing above the level plug. Overfilling will prevent governor control and possibly cause damage to governor internal parts.

Guard against overfilling the Novi units, which are not equipped with level indicating plugs. The capacity of these governors is two fluid ounces (59.15 cc.). The Novi filler plug is also a vent which should be cleaned thoroughly at each oil change to be sure that the vent operates.

V-18. TORQUE SPECIFICATIONS

	L6-226		F4-134	
	Pounds-Feet	Kg-m.	Pounds-Feet	Kg-m.
Camshaft Gear to Camshaft	35-40	[4,8 a 5,5]	30-40	[4,1 a 5,5]
Camshaft Thrust Plate Bolt	12-15	[1,7 a 2,1]	20-26	[2,8 a 3,6]
Clutch Control Ball Stud — 5/16" [0,8 mm.]	-	.....	35-45	[4,8 a 6,2]
Clutch Control Ball Stud — 9/16" [1,4 mm.]	-	.....	70-85	[9,7 a 11,8]
Clutch Housing to Cylinder Block Screw	40-50	[5,5 a 6,9]	-	.....
Connecting Rod Cap Bolt Nut — 3/8" [1 mm.]	40-45	[5,5 a 6,2]	35-45	[4,8 a 6,2]
Connecting Rod Cap Bolt Nut — 7/16" [1,1 mm.]	-	.....	50-55	[6,9 a 7,6]
Crankshaft Counterweight Bolt	-	.....	60-70	[8,3 a 9,7]
Cylinder Head to Block Bolts	35-45	[4,8 a 6,2]	60-70	[8,3 a 9,7]
Engine Mounting (Center Bolt)	-	.....	45-55	[6,2 a 7,6]
Exhaust Manifold to Cylinder Block	30-35	[4,1 a 4,8]	29-35	[4,0 a 4,8]
Front and Rear Filler Block Bolt	12-15	[1,7 a 2,1]	-	.....
Front End Plate Screw — 5/16" [0,8 mm.]	12-15	[1,7 a 2,1]	-	.....
Front End Plate Screw — 7/16" [1,1 mm.]	40-50	[5,5 a 6,9]	-	.....
Flywheel to Crankshaft Bolt	35-40	[4,8 a 5,5]	35-41	[4,8 a 5,7]
Generator Bracket to Cylinder Block	20-25	[2,8 a 3,4]	25-35	[3,4 a 4,8]
Intake Manifold to Cylinder Block	30-35	[4,1 a 4,8]	29-35	[3,4 a 4,8]
Main Bearing Caps	85-95	[11,8 a 13,1]	65-75	[9,0 a 10,4]
Oil Filter to Cylinder Head Nut	20-25	[2,8 a 3,4]	-	.....
Oil Pan Screws to Cylinder Block	12-15	[1,7 a 2,1]	9-14	[1,2 a 1,9]
Oil Pump Body to Intermediate Bearing Cap	30-35	[4,1 a 4,8]	-	.....
Oil Pump Cover to Body Bolt	7-10	[1,0 a 1,4]	-	.....
Piston Pin Lock Bolt	-	.....	35-41	[4,8 a 5,7]
Rocker Arm Bracket to Head Nut	-	.....	30-36	[4,1 a 5,0]
Spark Plugs to Cylinder Head	20-30	[2,8 a 4,1]	25-33	[3,4 a 4,6]
Starting Motor Mounting Bolt	25-30	[3,4 a 4,1]	20-25	[2,8 a 3,4]
Timing Chain Cover Bolts	12-15	[1,7 a 2,1]	-	.....
Valve Tappet Cover Nuts	7-10	[1,0 a 1,4]	-	.....
Vibration Damper to Crankshaft	100-130	[13,8 a 18,0]	-	.....
Vibration Damper to Pulley Hub	12-15	[1,7 a 2,1]	-	.....
Water Outlet Elbow to Cylinder Head	12-15	[1,7 a 2,1]	20-25	[2,8 a 3,4]
Water Pump to Cylinder Block	15-20	[2,1 a 2,8]	12-17	[1,7 a 2,3]

Note: Turn the connecting rod cap nut locks (inverted type, pressed steel) finger tight and then tighten 1/3 turn more with wrench

CHASSIS	Pounds-Feet	Kg-m.
Brake Backing Plate Bolts	25-35	[3,4 a 4,8]
Differential Carrier	38-42	[5,2 a 5,8]
Engine Front Insulator to Frame	10-15	[1,4 a 2,1]
Engine Rear Insulator to Cross Member Bolt	20-30	[2,8 a 4,1]
Engine Rear Mounting Bracket to Transmission Bolt	20-30	[2,8 a 4,1]
Pressure Plate to Flywheel Bolts	12-17	[1,7 a 2,3]
Propeller Shaft and Universal Joint Flange Bolt	20-30	[2,8 a 4,1]
Propeller Shaft and Universal Joint U-Bolt	15-20	[2,1 a 2,8]
Rear Axle Shaft Nut — Minimum	150	[20,8]
Spring Mounting — Front and Rear U-Bolt — 7/16" [1,1 mm.]	45-55	[6,2 a 7,6]
Spring Mounting — Front Suspension U-Bolt	65-80	[9,0 a 11,0]
Spring Mounting — Rear U-Bolt — 1/2" [1,3 mm.]	65-80	[9,0 a 11,0]
Spring Pivot Bolts	25-30	[3,4 a 4,1]
Steering Arm to Gear Nut	150-175	[20,8 a 24,2]
Steering Arm to Steering Knuckle	55-65	[7,6 a 9,0]
Steering Bell Crank Bolt Nut	70-90	[9,7 a 12,4]
Steering Knuckle Seal Retainer Bolts	15-20	[2,1 a 2,8]
Steering Knuckle Support to Knuckle Arm to Wheel Spindle Bolt	45-55	[6,2 a 7,6]
Steering Mounting to Frame — 3/8" [1,0 mm.]	30-40	[4,1 a 5,5]
Steering Mounting to Frame — 7/16" [1,1 mm.]	45-55	[6,2 a 7,6]
Steering Tie Rod Clamp Bolts — 5/16" [0,8 mm.]	10-15	[1,4 a 2,1]
Steering Tie Rod Clamp Bolts — 7/16" [1,1 mm.]	35-45	[4,8 a 6,2]
Transmission Mainshaft Nut	80-110	[11,0 a 15,2]
Wheel to Hub Bolts	60-75	[8,3 a 10,4]

TRANSMISSION TO Transfer Case : 25-35 ft lbs

Transmission to Clutch : 45-65 ft lbs

V-19. SPECIAL TOOLS

Below are listed the tools applicable to models covered in this manual. These special tools are essential not only for the time they will save but also because many operations described cannot be performed without them.

Address any correspondence concerning special tools, their application or availability, to Willys Sales Corporation, Service Department, Toledo 1, Ohio.

Engine Group

KF-27	Driver — Valve Guide.
KF-28	Sleeve — Oil Seal Installing.
C-83	Reamer — Valve Guide, .375" [0,953 mm.].
DD-82-2	Reamer — Piston Pin, .859" [2,182 mm.].
W-172	Puller — Crankshaft Gear, Camshaft Sprocket, U-Joint Flange and Parking Brake Drum.
W-175	Puller — Crankshaft Fan Pulley.
W-231	Kit — Flywheel Dowel Bolt Installing.
W-238	Kit — (pr.) Intake and Exhaust Valve Guide Drivers.
C-249	Reamer, Valve Guide, .343" Exp. [0,871 mm.].
C-3422	Compressor — Valve Spring.

Clutch Group

KF-5	Remover — Clutch Pilot Bushing.
KF-6	Burnisher — Clutch Pilot Bushing.
C-360	Arbor — Clutch Plate Aligning.
C-585-C	Fixture — Clutch Rebuilding and Adjusting.

Transmission Group

KF-128	Driver — Trans. Main Drive Pinion Ball Brg. and Rear Axle Pinion Shaft Brg.
W-133	Driver — Speedometer Drive Pinion Bushing.
W-166	Arbor and Sleeve — Cluster Gear Needle Bearing Assembly.
W-193	Arbor — Transmission Cluster Gear Assembly.
W-194	Plate — Transmission Mainshaft Retaining.
W-210	Wrench — Overdrive Governor Removing and Installing.
C-3105	Driver — Transmission Rear Oil Seal.

Transfer Case Group

W-130	Thimble and Driver — Transfer Case Shifter Rod Oil Seal.
W-131	Thimble and Driver — Pinion Shaft Rear Bearing Cone.
W-139	Driver — Transfer Case Output Shaft Front Bearing Cone Removing.
W-141	Ring — Transfer Case Output Shaft Front Bearing Cone Removing.
W-143	Driver — Transfer Case Output Shaft Front and Rear Oil Seal Installer.
W-176	Puller — Transfer Case Shift Rod Oil Seal.
W-192	Pilot Pin — Transfer Case Intermediate Gear Thrust Washer

Universal Joints Group

W-148	Clamp and Adapter — U-Joint.
W-162	Tool — U-Joint Flange Installer.
W-220	Jig and Bushing — Power Take-Off U-Joint Pin Remover and Installer.
C-452	Puller — U-Joint Flange.
C-3281	Wrench — U-Joint Flange Holding.

Rear Axle Group

W-99-A	Set — Pinion and Ring Gear Setting Gauge.
W-104-A	Puller — Axle Shaft, Pinion Shaft and Differential Case Tapered Bearing Cone (Includes: Plates 13, 18, 20, 21, 28 and 32).
W-126	Driver — Pinion Front Bearing Cup.
W-128	Installer — Differential Carrier End Oil Seal.
W-129	Spreader — Axle Housing.
W-142	Driver — Differential Case Bearing Cone.
W-147	Driver — Pinion Shaft Oil Seal.
W-186	Driver — Rear Axle Shaft Oil Seal.
W-188	Driver — Differential Case Bearing Cone.
W-201	Wrenches — (pr.) Pinion Bearing Adjusting.
W-202	Driver — Pinion Bearing Race.
W-203	Remover and Installer — Rear Axle Bearing Assembly.
W-204	Driver — Rear Axle Differential Case Side Bearing Cup Installing.
W-205	Driver — Pinion Rear Bearing Installing.
W-207	Driver — Pinion Pilot Bearing Installing.
W-251	Puller — Transfer Case Output Shaft Front and Rear Oil Seal Removing; also Pinion Shaft Oil Seal.
C-319	Puller — Rear Wheel Hub.
C-637	Puller — Axle Shaft and Oil Seal.

Front Suspension Group

W-138	Driver and Adapter — King Pin Bearing Cap Remover and Installer.
W-144	Wrench — Wheel Bearing Adjusting.
W-163	Puller — Front Axle Drive Flange.
C-690	Scale — King Pin Bearing Preload Checking.

Steering Group

C-3646	Puller — Steering Shaft Arm.

Cooling System Group

W-115	Puller — Water Pump Fan Hub (F-Head).

Shock Absorber Group

W-198	Installer — Shock Absorber Rubber Grommet.

Brake Group

W-213	Wrench — Brake Adjusting.

V-20. MISCELLANEOUS DATA

MODEL L6-226 4WD

POWER TAKE-OFF SHAFT AND VEHICLE GROUND SPEEDS ALL GEAR SHIFT POSITIONS MILES PER HOUR

Governor Control Position	Transfer In	POWER-TAKE-OFF 1 TO 1 GEAR RATIO						Engine Speed
		Transmission Gear In						
		Low		Intermediate		High		
		Take-Off Shaft R.P.M.	Vehicle Speed M.P.H.	Take-Off Shaft R.P.M.	Vehicle Speed M.P.H.	Take-Off Shaft R.P.M.	Vehicle Speed M.P.H.	
1	Low	357	2.61	644	4.70	1000	7.30	1000
	High	357	6.42	644	11.57	1000	17.95	
2	Low	428	3.13	773	5.64	1200	8.76	1200
	High	428	7.70	773	13.89	1200	21.54	
3	Low	500	3.65	902	6.58	1400	10.22	1400
	High	500	8.98	902	16.20	1400	25.13	
4	Low	571	4.18	1030	7.53	1600	11.67	1600
	High	571	10.26	1030	18.52	1600	28.72	
5	Low	643	4.70	1159	8.47	1800	13.13	1800
	High	643	11.55	1159	20.83	1800	32.31	
6	Low	714	5.22	1288	9.41	2000	14.59	2000
	High	714	12.83	1288	23.14	2000	35.90	
7	Low	785	5.74	1417	10.35	2200	16.05	2200
	High	785	14.11	1417	25.46	2200	39.49	
8	Low	857	6.26	1546	11.29	2400	17.51	2400
	High	857	15.40	1546	27.77	2400	43.08	
9	Low	928	6.79	1674	12.23	2600	18.97	2600
	High	928	16.68	1674	30.09	2600	46.69	

MODEL F4-134 4-WD

POWER TAKE-OFF SHAFT AND VEHICLE GROUND SPEEDS ALL GEAR SHIFT POSITIONS MILES PER HOUR

Governor Control Position	Transfer In	POWER-TAKE-OFF 1 TO 1 GEAR RATIO						Engine Speed
		Transmission Gear In						
		Low		Intermediate		High		
		Take-Off Shaft R.P.M.	Vehicle Speed M.P.H.	Take-Off Shaft R.P.M.	Vehicle Speed M.P.H.	Take-Off Shaft R.P.M.	Vehicle Speed M.P.H.	
1	Low	357	2.37	644	4.27	1000	6.62	1000
	High	357	5.82	644	10.50	1000	16.28	
2	Low	428	2.84	773	5.12	1200	7.94	1200
	High	428	6.98	773	12.59	1200	19.53	
3	Low	500	3.31	902	5.98	1400	9.26	1400
	High	500	8.15	902	14.69	1400	22.79	
4	Low	571	3.79	1030	6.83	1600	10.59	1600
	High	571	9.31	1030	16.79	1600	26.04	
5	Low	643	4.26	1159	7.68	1800	11.91	1800
	High	643	10.47	1159	18.89	1800	29.30	
6	Low	714	4.73	1288	8.54	2000	13.24	2000
	High	714	11.64	1288	20.99	2000	32.55	
7	Low	785	5.20	1417	9.39	2200	14.56	2200
	High	785	12.80	1417	23.09	2200	35.81	
8	Low	857	5.68	1546	10.24	2400	15.88	2400
	High	857	13.96	1546	25.19	2400	39.06	
9	Low	928	6.15	1674	11.10	2600	17.21	2600
	High	928	15.13	1674	27.29	2600	42.32	

PULLEY SPEEDS (R.P.M.) - 8" (20.3CM.) PULLEY POWER TAKE-OFF GEAR RATIOS

Governor Control Positions	5-6 RATIO TRANSMISSION			6-5 RATIO TRANSMISSION			1-1 RATIO TRANSMISSION			Engine Speeds
	Low	Inter.	High	Low	Inter.	High	Low	Inter.	High	
1	255	460	714	367	663	1028	306	552	857	1000
2	306	552	857	440	795	1234	367	662	1028	1200
3	357	645	1000	514	928	1440	428	774	1200	1400
4	408	737	1143	587	1061	1645	490	884	1372	1600
5	459	829	1285	660	1193	1851	551	995	1542	1800
6	510	921	1428	734	1326	2057	612	1105	1714	2000
7	561	1031	1571	807	1458	2262	673	1237	1885	2200
8	612	1105	1714	881	1591	2468	734	1326	2057	2400
9	663	1197	1857	954	1723	2674	796	1436	2228	2600

V-21. Spline Shaft Horsepower

The chart below shows the draw bar horsepower at the governor controlled engine speeds and the horsepower at the spline shaft with the vehicle stationary. Also is shown the horsepower available at the spline shaft with the vehicle at the maximum approved weight (3500 lbs.) (1590 kg.) moving at the speed shown and exerting a draw bar pull of zero pounds through 1200 pounds (544 kg.) (maximum recommended) in steps of 300 pounds (136 kg.).

Governed Engine R.P.M.	Vehicle Speed M.P.H.*	Draw Bar H.P.**	H.P. AT P.T.O. SPLINE SHAFT					
			Vehicle Stationary	3500 Lb. Vehicle Moving with				
				No Lbs. Draw Bar Pull	300 Lbs. Draw Bar Pull	600 Lbs. Draw Bar Pull	700 Lbs. Draw Bar Pull	1200 Lbs. Draw Bar Pull
1000	2.2	7.18	16.3	13.7	11.9	10.2	8.4	6.6
1200	2.7	8.62	20.3	17.2	15.0	13.0	10.8	8.6
1400	3.1	10.06	24.5	20.8	18.3	15.9	13.3	10.8
1600	3.6	11.49	28.5	24.3	21.5	18.8	15.8	12.9
1800	4.0	12.93	33.0	28.6	25.3	22.2	19.0	15.8
2000	4.5	14.38	33.0	33.0	30.0	26.4	22.9	19.3
2200	4.9	15.80	33.0	33.0	32.5	28.5	24.7	20.7
2400	5.4	17.24	33.0	33.0	33.0	29.8	25.4	21.2
2600	5.8	18.68	33.0	33.0	33.0	31.2	26.6	22.0

*Vehicle speed in low transmission and transfer case ratios.

**Based on maximum recommended draw bar pull for continuous service — 1200 Lbs.

METRIC

Governed Engine R.P.M.	Vehicle Speed K.P.H.*	Draw Bar H.P.** (Metric)	METRIC H.P. AT P.T.O. SPLINE SHAFT					
			Vehicle Stationary	1590 Kg. Vehicle Moving with				
				No Kg. Draw Bar Pull	135 Kg. Draw Bar Pull	270 Kg. Draw Bar Pull	405 Kg. Draw Bar Pull	540 Kg. Draw Bar Pull
1000	3.5	7.28	16.5	13.9	12.1	10.3	8.5	6.7
1200	4.4	8.74	20.6	17.4	15.2	13.2	10.9	8.7
1400	5.0	10.20	24.8	21.1	18.6	16.1	13.5	10.9
1600	5.8	11.65	28.9	24.6	21.8	19.1	16.0	13.1
1800	6.4	13.11	33.5	27.2	25.7	22.5	19.3	16.0
2000	7.2	14.58	33.5	33.5	30.4	26.8	23.2	19.6
2200	8.9	16.02	33.5	33.5	33.0	28.9	25.0	21.0
2400	8.7	17.48	33.5	33.5	33.5	30.2	25.8	21.5
2600	9.3	18.94	33.5	33.5	33.5	31.6	27.0	22.3

*Vehicle speed in low transmission and transfer case ratios.

**Based on maximum recommended draw bar pull for continuous service — 540 Kg.

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