

SERVICE MANUAL



FOR
UNIVERSAL
Jeep
VEHICLES

SERVICE MANUAL

Jeep UNIVERSAL

4-WHEEL DRIVE

CJ-2A CJ-3B

CJ-3A CJ-5

CJ-6

Jeep DISPATCHER

2-WHEEL DRIVE

DJ-3A

ORIGINAL REPRODUCTIONS
P. O. BOX 74
UPLAND, CALIFORNIA 91786

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1965 KAISER JEEP CORPORATION
NOW JEEP CORPORATION

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GENERAL DATA

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A-1. GENERAL

This manual is provided for the guidance of all automotive service men, vehicle owners, and service salesmen who repair, maintain, or adjust the 'Jeep' Universal and 'Jeep' Dispatcher. The information herein was prepared from the service man's viewpoint to give him the 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.

Specifications and components covered were for standard production models of 'Jeep' Vehicles current at the time the manual was approved for printing. Kaiser 'Jeep' Corporation reserves the right to discontinue models at any time or change specifications or design of any of its models without notice and without incurring any obligation.

A-2. Vehicle Description

This manual covers all standard production 'Jeep' Universal and 'Jeep' Dispatcher models currently being produced at the time this manual was approved for publication. Significant changes made in each model since it was first produced are included in the manual.

A description of each model follows. General specifications for each model are listed in Par. A-17. Detailed specifications covering major vehicle units are listed at the end of each section of the manual.

CJ-2A — This is a 4-wheel-drive 'Jeep' Universal. It has a four-cylinder, L-head engine. This model is no longer in current production.

CJ-3A — This is a 4-wheel-drive 'Jeep' Universal. It has a four-cylinder, F-head engine. This model is no longer in current production.

CJ-3B — This is a 4-wheel-drive 'Jeep' Universal. It has a four-cylinder, F-head engine.

CJ-5 — This is a 4-wheel-drive 'Jeep' Universal. It has a four-cylinder, F-head engine.

CJ-6 — This is a 4-wheel-drive 'Jeep' Universal. It has a four-cylinder, F-head engine.

DJ-3A — This is a 2-wheel-drive 'Jeep' Dispatcher. It has a four-cylinder, L-head engine. It comes as either an open body model or has a "Surrey" top.

A-3. Vehicle Identification

Each 'Jeep' vehicle model series has one or more serial number prefixes to identify it. Complete identification of a specific vehicle requires the prefix plus the serial number. Serial numbers are consecutive for each prefix grouping. Prefix information following will identify the 'Jeep' model by serial number prefix.

'Jeep' Model	Prefix	Serial Number
CJ-2A	no prefix	5- or 6-digit S/N
CJ-3A	no prefix	5-digit S/N
	451-GB1	5-digit S/N
	452-GB1	5-digit S/N
	453-GB1	5-digit S/N
CJ-3B	453-GB2	5-digit S/N
	454-GB2	5-digit S/N
	57348	5-digit S/N
CJ-5	57548	5- or 6-digit S/N
CJ-6	57748	5-digit S/N
DJ-3A	56337	5-digit S/N

Any prefix not given here for one of the listed models indicates a special vehicle whose differences from standard are not covered in this manual.

A-4. IDENTIFICATION NUMBER LOCATION

All 'Jeep' vehicles and some of their major components have identifying numbers. Paragraphs following will describe the location of identifying numbers.

A-5. Vehicle Serial Number

The vehicle serial number is stamped on a metal plate located on the dash under the hood. It is on the left side of the vehicle for models CJ-5 and

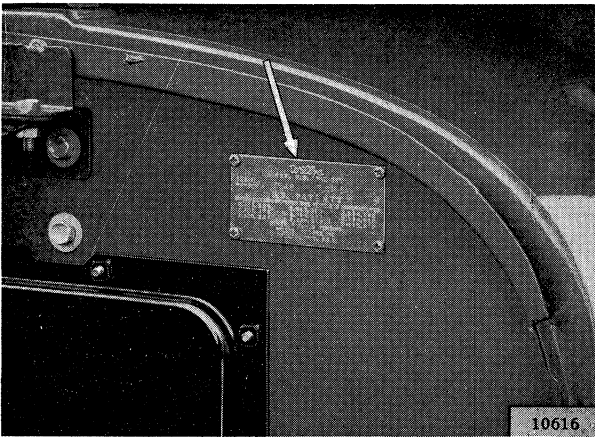


FIG. 1—CJ-5, CJ-6 VEHICLE SERIAL NUMBER LOCATION

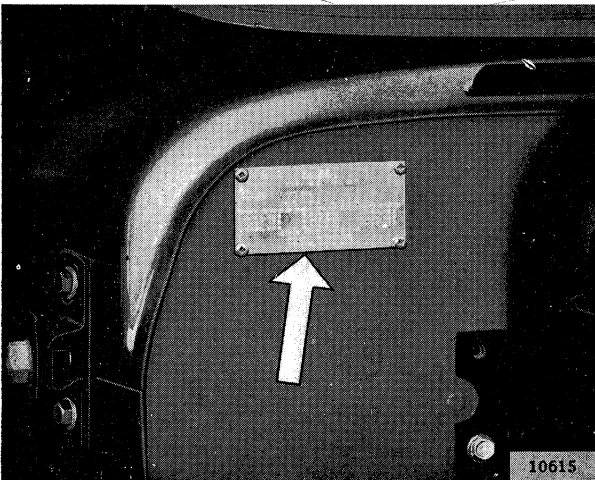


FIG. 2—CJ-2A, CJ-3A, CJ-3B, DJ-3A VEHICLE SERIAL NUMBER LOCATION

CJ-6 as shown in Fig. 1. It is on the right side of the vehicle for models CJ-2A, CJ-3A, CJ-3B, and DJ-3A as shown in Fig. 2. Refer to Par. A-3 for specific information on codes.

A-6. Engine Serial Number

The engine identification number consists of a prefix followed by a five-digit or six-digit serial number. The prefix identifies the particular engine. F4-134 and L4-134 engine serial numbers are stamped on the water pump boss at the front of the engine, as shown in Fig. 3.

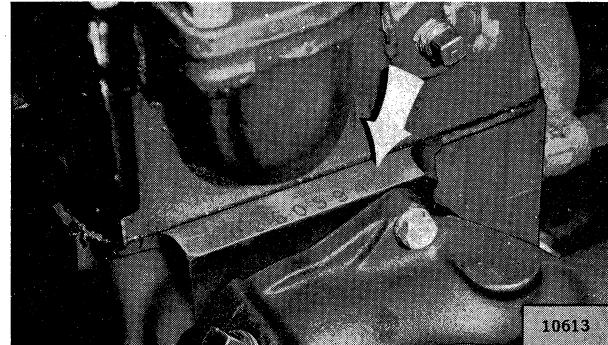


FIG. 3—ENGINE SERIAL NUMBER LOCATION

A-7. Paint-and-Trim Option Plate

A Paint-and-Trim Option Plate is installed on late production 'Jeep' vehicles. The paint code on the plate identifies the paint colors. The trim code on the plate identifies the color of all trim parts in the interior of the vehicle.

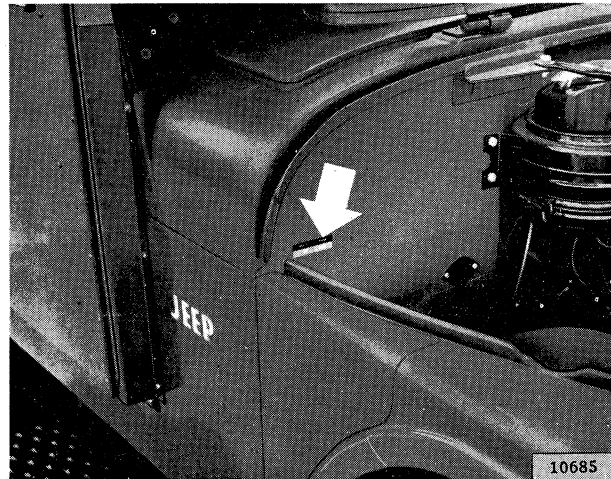


FIG. 4—PAINT AND TRIM OPTION PLATE LOCATION

To identify paint or trim on vehicles manufactured before the Paint-and-Trim Option Plate was installed, see your 'Jeep' dealer.

'Jeep' Universals and Dispatchers have the plate located on the right hand side of the dash under the hood, as shown in Fig. 4.

A-8. Axles

All live axles on 'Jeep' vehicles are identified by a model number cast into the axle differential housing near or on one of the reinforcing webs, as shown in Fig. 5. The differential gear ratio may be determined from the axle ratio tag installed under one of the gear cover screw heads. The tag lists the number of teeth on the gear and also on the pinion. Some tags also list the gear ratio.

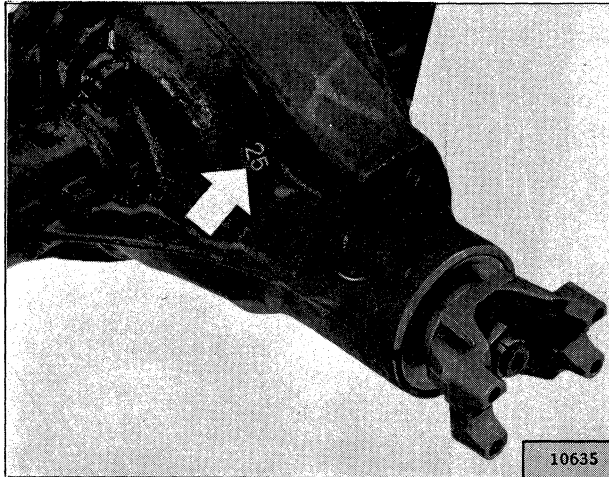


FIG. 5—AXLE MODEL NUMBER LOCATION

A-9. Carburetor

Carburetors are identified by the manufacturer's model number stamped or cast into the carburetor body, as shown in Fig. 6.

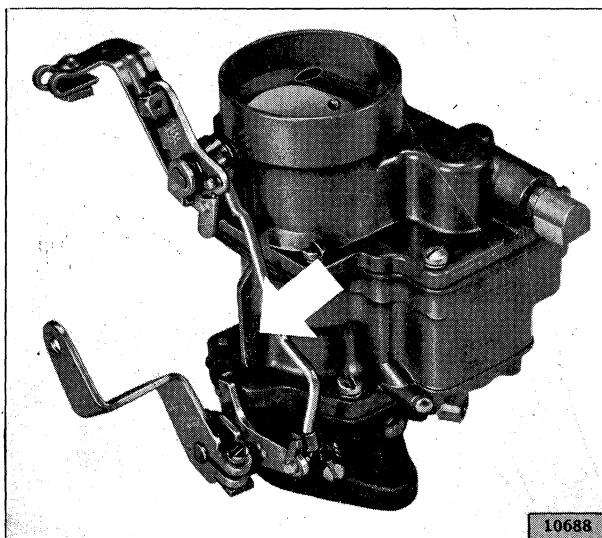


FIG. 6—CARBURETOR MODEL NUMBER LOCATION

A-10. Fuel Pump

Fuel pumps are identified by the manufacturer's model number. The model number is stamped on the edge of the pump mounting flange. The manufacturer's name is cast into the pump body. See Fig. 7.

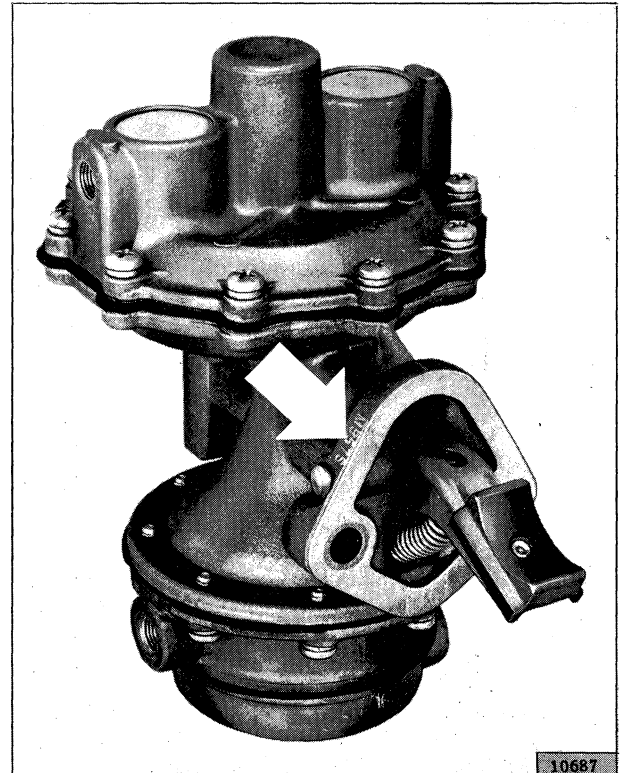


FIG. 7—FUEL PUMP MODEL NUMBER LOCATION

A-11. Generator

Generators are identified by the manufacturer's model number stamped on a metal plate attached to the generator housing, as shown in Fig. 8.

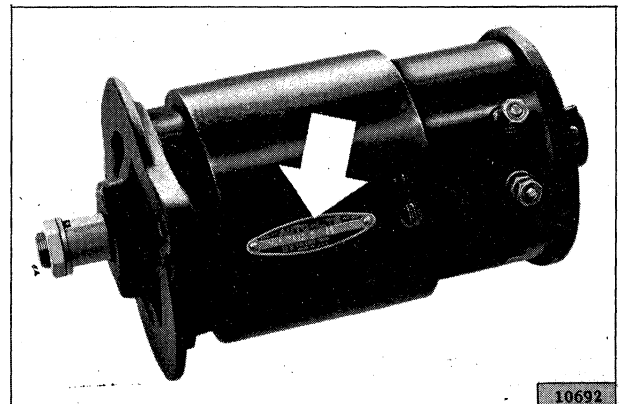


FIG. 8—GENERATOR MODEL NUMBER LOCATION

A-12. Ignition Coil

Ignition coils are identified by the manufacturer's model number stamped on the coil housing below the top flange, as shown in Fig. 9.

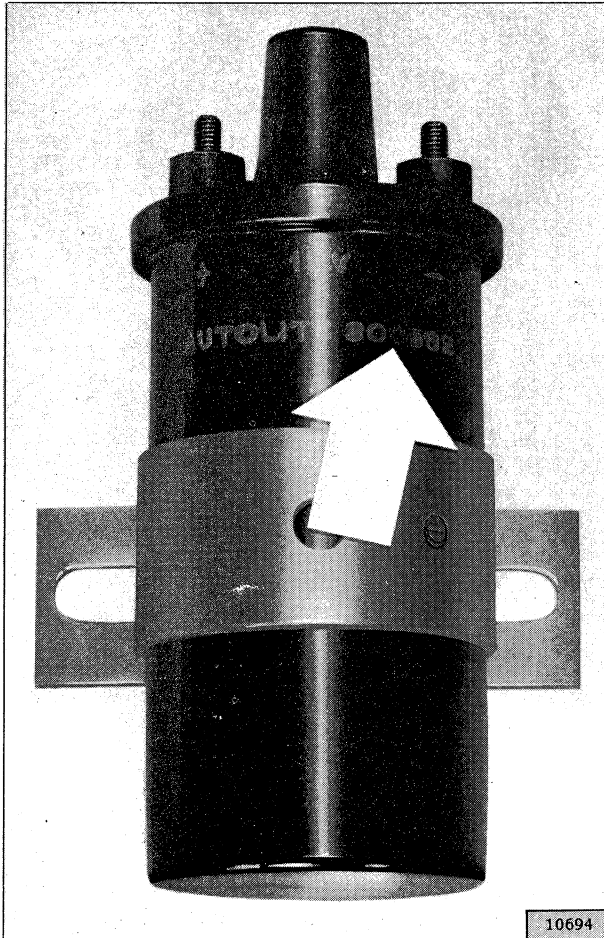


FIG. 9—IGNITION COIL
MODEL NUMBER LOCATION

A-13. Distributor

Ignition distributors are identified by the manufacturer's model number stamped on a plate attached to the distributor housing, as shown in Fig. 10.

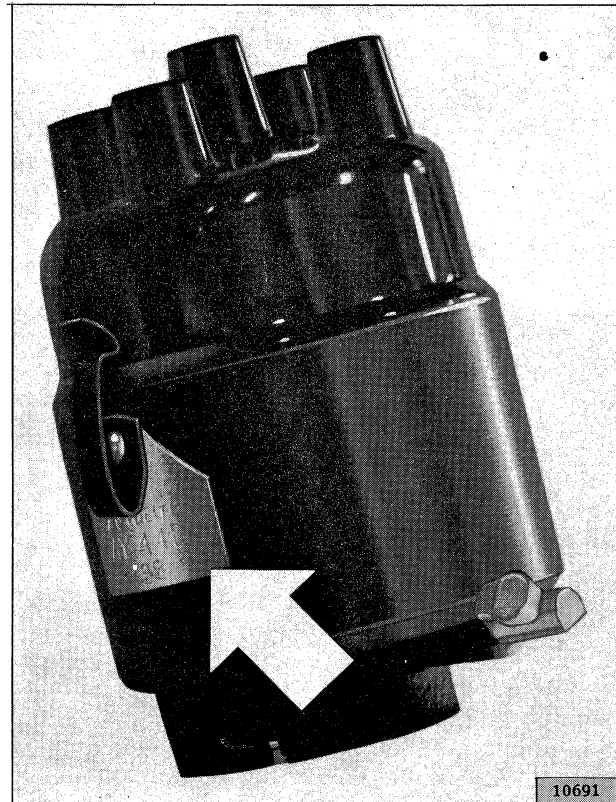


FIG. 10—DISTRIBUTOR
MODEL NUMBER LOCATION

A-14. Radiator

Radiators are identified by markings on the top tank, usually on the top or rear face, as shown in

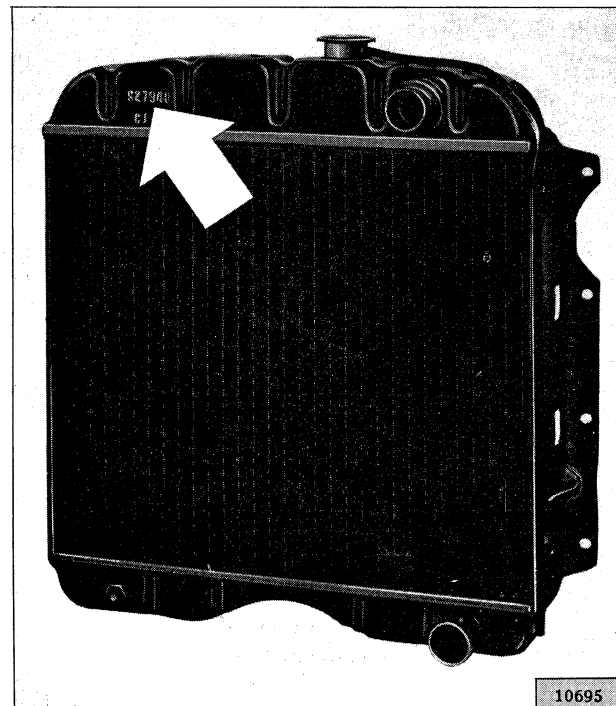


FIG. 11—RADIATOR MODEL NUMBER LOCATION

Fig. 11. Individual markings vary with each radiator manufacturer.

A-15. Starting Motor

Starting motors are identified by a manufacturer's model number stamped on a metal tag attached to the motor housing, as shown in Fig. 12.

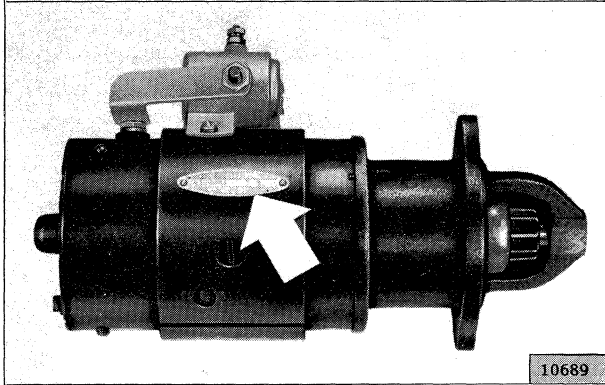


FIG. 12—STARTING MOTOR
MODEL NUMBER LOCATION

A-16. Voltage Regulator

Voltage regulators are identified by a manufacturer's model number stamped on the regulator base flange, as shown in Fig. 13.

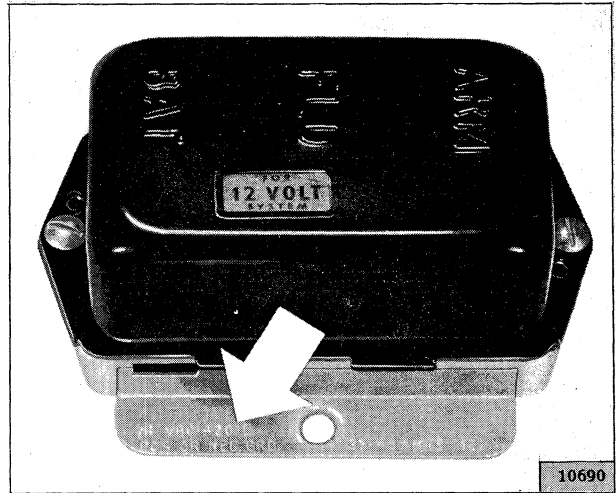


FIG. 13—VOLTAGE REGULATOR
MODEL NUMBER LOCATION

A-17. GENERAL SPECIFICATIONS

MODEL:	CJ-2A	CJ-3A	DJ-3A
Engine:	L-Head	L-Head	L-Head
Number of cylinders	4	4	4
Bore	3 $\frac{1}{8}$ " [79,37 mm.]	3 $\frac{1}{8}$ " [79,37 mm.]	3 $\frac{1}{8}$ " [79,37 mm.]
Stroke	4 $\frac{3}{8}$ " [111,12 mm.]	4 $\frac{3}{8}$ " [111,12 mm.]	4 $\frac{3}{8}$ " [111,12 mm.]
Displacement	134.2 cu. in. [2,20 ltr.]	134.2 cu. in. [2,20 ltr.]	134.2 cu. in. [2,20 ltr.]
Compression Ratio	6.48:1	6.48:1	7.00:1
Compression Pressure	100 psi [7 kg-cm ²]	100 psi [7 kg-cm ²]	100 psi [7 kg-cm ²]
Horsepower (max. brake)	60 at 4000 rpm.	60 at 4000 rpm.	60 at 4000 rpm.
Horsepower (SAE)	15.63	15.63	15.63
Torque (max. at 2000 rpm.)	105 lb-ft [14,5 kg-m.]	105 lb-ft [14,5 kg-m.]	105 lb-ft [14,5 kg-m.]
Wheelbase	80" [203 cm.]	80" [203 cm.]	80" [203 cm.]
Tread (front and rear)	48 $\frac{1}{4}$ " [122,5 cm.]	48 $\frac{1}{4}$ " [122,5 cm.]	48 $\frac{1}{4}$ " [122,5 cm.]
Height (over all):			
Open body	69" [175 cm.]	66 $\frac{3}{4}$ " [170 cm.]	59 $\frac{7}{8}$ " [150 cm.]
Soft top			62 $\frac{15}{16}$ " [160 cm.]
Hard top			71 $\frac{1}{4}$ " [181 cm.]
Length (over all):			
Open body	130 $\frac{1}{8}$ " [3,3 m.]	129 $\frac{3}{4}$ " [3,29 m.]	125 $\frac{7}{16}$ " [3,18 m.]
Soft top			130" [3,3 m.]
Hard top			129" [3,28 cm.]
Width (over all):			
Open body	59" [149,8 cm.]	68 $\frac{25}{32}$ " [174,7 cm.]	57 $\frac{1}{8}$ " [145,3 cm.]
Soft top			57 $\frac{1}{8}$ " [145,3 cm.]
Hard top			72 $\frac{3}{4}$ " [184,8 cm.]
Ground Clearance	8 $\frac{3}{4}$ " [22,2 cm.]	8 $\frac{3}{4}$ " [22,2 cm.]	7" [17,8 cm.]
Weights (approximate):			
Shipping			
Open body	2120 lb. [961,6 kg.]	2110 lb. [957,1 kg.]	1709 lb. [775,2 kg.]
Soft top			1769 lb. [802,4 kg.]
Hard top			2004 lb. [909 kg.]
Curb			
Open body	2215 lb. [1004,7 kg.]	2205 lb. [1000,2 kg.]	1815 lb. [823,4 kg.]
Soft top			1875 lb. [850,5 kg.]
Hard top			2110 lb. [957 kg.]
Gross			
Open body	3500 lb. [1587,5 kg.]	3500 lb. [1587,5 kg.]	2600 lb. [1179,3 kg.]
Soft top			2600 lb. [1179,3 kg.]
Hard top			3200 lb. [1451,4 kg.]
Capacities:			
Fuel tank	10 $\frac{1}{2}$ gal. [40 ltr.]	10 $\frac{1}{2}$ gal. [40 ltr.]	12 gal. [45 ltr.]
Cooling System:			
Without heater	11 qt. [10,4 ltr.]	11 qt. [10,4 ltr.]	11 qt. [10,4 ltr.]
With heater	12 qt. [11,4 ltr.]	12 qt. [11,4 ltr.]	12 qt. [11,4 ltr.]

MODEL:	CJ-3B	CJ-5	CJ-6
Engine:	F-Head	F-Head	F-Head
Number of cylinders	4	4	4
Bore	3 $\frac{1}{8}$ " [79,37 mm.]	3 $\frac{1}{8}$ " [79,37 mm.]	3 $\frac{1}{8}$ " [79,37 mm.]
Stroke	4 $\frac{3}{8}$ " [111,12 mm.]	4 $\frac{3}{8}$ " [111,12 mm.]	4 $\frac{3}{8}$ " [111,12 mm.]
Displacement	134.2 cu. in. [2,20 ltr.]	134.2 cu. in. [2,20 ltr.]	134.2 cu. in. [2,20 ltr.]
Compression Ratio:			
Standard	6.9:1	6.9:1	6.9:1
High Altitude (opt.)	7.4:1	7.4:1	7.4:1
Compression Pressure	120 to 130 psi. [8,4 a 9,2 kg-cm ²]	120 to 130 psi. [8,4 a 9,2 kg-cm ²]	120 to 130 psi. [8,4 a 9,2 kg-cm ²]
Horsepower (max. brake)	72 at 4000 rpm.	72 at 4000 rpm.	75 at 4000 rpm.
Horsepower (SAE)	15.63	15.63	15.63
Torque (max. at 2000 rpm.)	114 lb-ft [15,7 kg-m.]	114 lb-ft [15,7 kg-m.]	114 lb-ft [15,7 kg-m.]
Wheelbase	80" [203 cm.]	81" [206 cm.]	101" [257 cm.]
Tread (front and rear)	48 $\frac{7}{16}$ " [123 cm.]	48 $\frac{7}{16}$ " [123 cm.]	48 $\frac{7}{16}$ " [123 cm.]
Height (over all)	66 $\frac{1}{4}$ " [169 cm.]	67" [170 cm.]	67" [170 cm.]
Length (over all)	129 $\frac{29}{32}$ " [3,30 m.]	135 $\frac{9}{16}$ " [3,44 m.]	155 $\frac{9}{16}$ " [3,95 m.]
Width (over all)	68 $\frac{7}{8}$ " [175 cm.]	71 $\frac{3}{4}$ " [128 cm.]	71 $\frac{3}{4}$ " [128 cm.]
Ground Clearance	8" [20,3 cm.]	8" [20,3 cm.]	8" [20,3 cm.]
Weights (approximate):			
Shipping	2132 lb. [967,1 kg.]	2163 lb. [981,1 kg.]	2225 lb. [1009,2 kg.]
Curb	2243 lb. [1017,4 kg.]	2274 lb. [1031,5 kg.]	2336 lb. [1059,6 kg.]
Gross	3500 lb. [1587,5 kg.]	3750 lb. [1701,0 kg.]	3900 lb. [1769,0 kg.]
Capacities:			
Fuel tank	10 $\frac{1}{2}$ gal. [38,75 ltr.]	10 $\frac{1}{2}$ gal. [38,75 ltr.]	10 $\frac{1}{2}$ gal. [38,75 ltr.]
Cooling System:			
Without heater	11 qt. [10,4 ltr.]	11 qt. [10,4 ltr.]	11 qt. [10,4 ltr.]
With heater	12 qt. [11,4 ltr.]	12 qt. [11,4 ltr.]	12 qt. [11,4 ltr.]

LUBRICATION

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Air Cleaner	B-23, B-43	King Pin Bearings	B-11
Body	B-29	Lubrication Fittings	B-8, B-41
Brake Master Cylinder	B-31	Oil Filter	B-22, B-42
Choke Control	B-27	Oil Pressure	B-4
Clutch Linkage	B-28	Power Take-Off	B-47
Clutch Release Bearing	B-35	Propeller Shaft U-Joints	B-10
Differential:		Radiator	B-32
Conventional	B-18, B-46	Shock Absorbers	B-38
Powr-Lok	B-19	Speedometer Cable	B-25
Distributor	B-20	Spring Shackles and Pivot Bolts	B-9
Engine Crankcase	B-2, B-7, B-40	Springs	B-37
Field and Industrial Use	B-39	Starting Motor	B-36
Flexible Controls	B-27	Steering Gear	B-12
Front Axle U-Joint	B-11, B-44	Throttle Control	B-27
Generator	B-21	Transfer Case	B-15, B-45
Governor	B-49	Transmission	B-15, B-45
Hand Brake Control	B-27	U-Joints, Front Axle	B-11, B-44
Heat Control Valve	B-25	U-Joints, Propeller Shaft	B-10
Hydraulic Lift	B-50	Water Pump Bearing	B-35
Initial Lubrication	B-6	Wheel Bearings	B-13

B-1. GENERAL

It is highly important that the correct amounts of the proper lubricants be used at regular intervals. The specifications given in the charts and detailed description of this section should be closely followed. Special lubricating instructions for field and industrial use are given as the last part of this section.

B-2. Engine Oil Classifications

The American Petroleum Institute has a system of classifying engine oils according to type of service. These designations are:

ML — Light and favorable service conditions.

MM — Moderate to severe service conditions.

MS — Most severe service conditions.

Common short trip, stop-and-go driving is the most severe and becomes intensified even more in cold weather. In contrast, constant-speed driving on highways is the least severe.

Depending upon conditions of operation, either **MM** or **MS** grade is recommended for Jeep vehicles. It is also necessary to specify the SAE number in addition to the above classification.

B-3. Lubricant Base

Sodium base lubricants are used at the factory for initial fill of the wheel bearings, front axle shaft universal joints, and propeller shaft universal joints. Because mixing of sodium base and lithium base lubricants results in a thinned-out mixture that can bleed through seals, always use sodium base

wheel bearing and universal joint lubricants on 'Jeep' vehicles. Should oil leaks occur at these bearings, thoroughly remove the old lubricant before new lubricant is added.

B-4. Oil Pressure Gauge or Indicator

On Models CJ-2A, CJ-3A, and early CJ-3B an oil pressure gauge is mounted on the instrument panel. This gauge indicates the oil pressure within the engine lubricating system.

On Models CJ-5, CJ-6, DJ-3A and later production vehicles of Model CJ-3B a red telltale lamp, which operates when the ignition switch is turned on, 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.

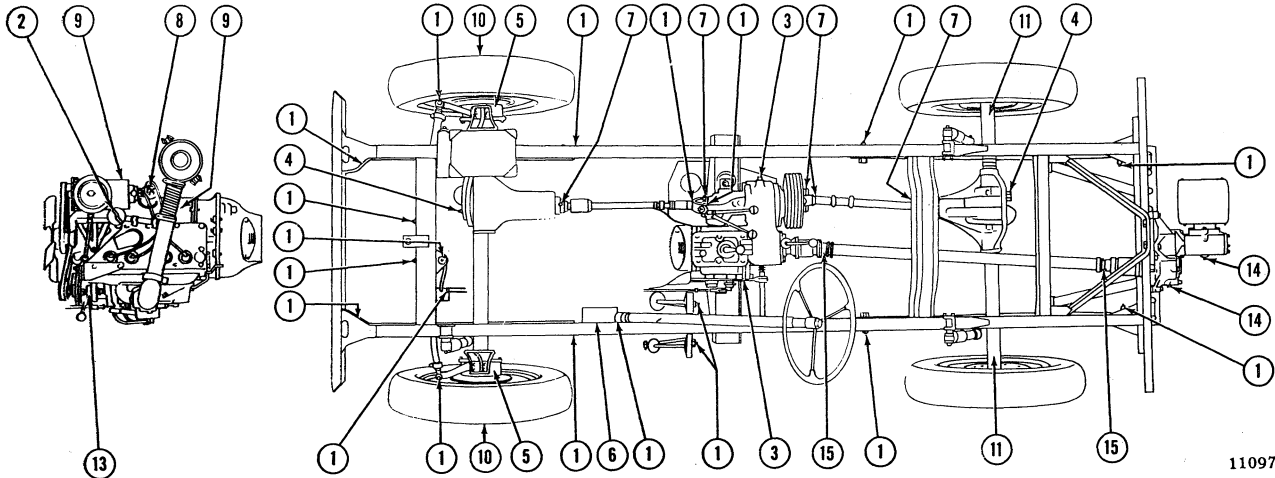
Failure of the gauge or indicator to register normal oil pressure may indicate insufficient supply of oil in the engine crankcase, low or no oil pump pressure, or a fault in the gauge or indicator electrical circuit. The engine must be stopped immediately to prevent possible damage to engine bearings and the fault corrected before restarting the engine.

B-5. 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 recirculation of any sediment or water that might accumulate in the oil pan. Typical

Text continued on page 13.

**LUBRICATION SPECIFICATIONS
MODELS CJ-2A AND CJ-3A**



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FIG. 14—LUBRICATION CHART—MODELS CJ-2A AND CJ-3A

Chart No.	ITEM TO BE LUBRICATED	FREQUENCY*	QUANTITY			LUBRICANT		
			U.S.	Imperial	Metric	TYPE	GRADE	
							Summer	Winter
1.	Chassis Bearings	Each 1000 miles [1.600 km.]	As required			Chassis Lubricant	No. 1	No. 0
2.	Engine	Change each 2000 miles [3.200 km.]	4 qts.	3 1/2 qts	3.785 ltrs.	Engine Oil	See Note	
3.	Transmission and Transfer Case	{ Check each 1000 miles [1.600 km.] Change each 10,000 miles [16.000 km.]	3 1/2 pts.	3 pts.	1.65 ltrs.	GL4	SAE 90	SAE 80
4.	Differentials:							
	Front	{ Check each 1000 miles [1.600 km.] Change each 10,000 miles [16.000 km.]	2 1/2 pts.	2 pts.	1.18 ltrs.	MIL-L-2105B	SAE 80	SAE 80
	Rear	{ Check each 1000 miles [1.600 km.] Change each 10,000 miles [16.000 km.]	2 3/4 pts.	2 1/4 pts.	1.3 ltrs.	MIL-L-2105B	SAE 80	SAE 80
5.	Universal Joints							
	Front Axle	{ Check each 1000 miles [1.600 km.] Change each 12,000 miles [19.200 km.]	As required			Universal Joint Lubricant†	No. 1	No. 0
6.	Steering Gear	Check each 1000 miles [1.600 km.]	As required			MIL-L-2105B	SAE 80	SAE 80
7.	Universal Joints							
	Propeller Shaft	Each 1000 miles [1.600 km.]	As required			Universal Joint Lubricant†	No. 1	No. 0
8.	Distributor:							
	Oiler	Each 1000 miles [1.600 km.]	Several drops			Engine Oil	Same as engine	
	Wick	Each 1000 miles [1.600 km.]	One drop			Engine Oil	Same as engine	
	Pivot	Each 1000 miles [1.600 km.]	One drop			Engine Oil	Same as engine	
	Cam	Each 1000 miles [1.600 km.]	Sparingly			Grease	Soft	
9.	Generator and Starting Motor**	Each 1000 miles [1.600 km.]	2-4 drops			Engine Oil	Same as engine	
10.	Front Wheels	Disassemble to lubricate each 6000 miles [9.600 km.]	As required			Wheel Bearing Lubricant†	No. 2	No. 2
11.	Rear Wheels**	Sparingly each 1000 miles [1.600 km.]	As required			Wheel Bearing Lubricant†	No. 2	No. 2
13.	Governor	Check each 1000 miles [1.600 km.]	As required			Engine Oil	Same as engine	
14.	Power Take-Off	Check each 1000 miles [1.600 km.]	As required			GL4	SAE 80	SAE 80
15.	Universal Joints							
	Power Take-Off	Extensive use: Repack once a year.	As required			Chassis Lubricant	No. 1	No. 0
	Air Cleaner	Each 2000 miles [3.200 km.]	1 1/4 pts.	1 pt.	.591 ltrs.	Engine Oil	Same as engine	

Not lower than 32°F. [0°C.]
use SAE 30 or 10W-30

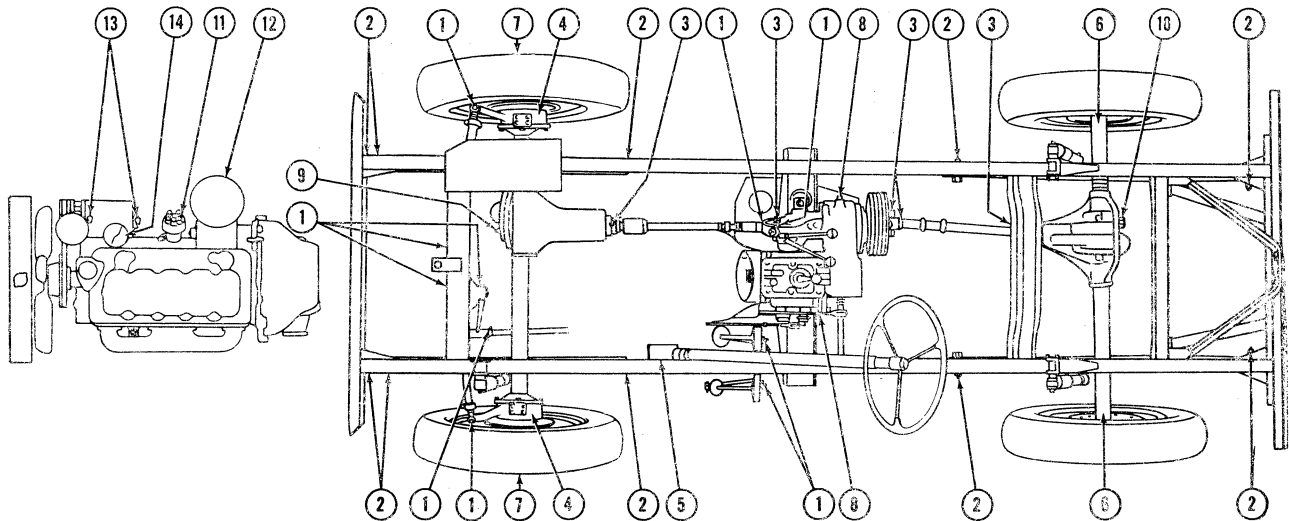
As low as 10°F. [-12°C.]
use SAE 20, 20W, 10W-30, or 10W-20

As low as -10°F. [-23°C.]
use SAE 10W, 10W-30, or 10W-20

Below -10°F. [-23°C.]
use SAE 5W or 5W-20

*This chart applies for usual road work. For additional lubrication requirements when used for field or industrial work, see Par. B-39.
**Starting motor bearings on Model CJ-3A vehicles after Serial No. 30972 were lubricated at assembly to last between normal rebuild periods.
***Rear wheels must be removed from Model CJ-2A vehicles before Serial No. 13413 to lubricate wheel bearings.
†Sodium base lubricants recommended; do not mix sodium base and lithium base lubricants.

LUBRICATION SPECIFICATIONS MODELS CJ-3B, CJ-5 AND CJ-6



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FIG. 15—LUBRICATION CHART—MODELS CJ-3B, CJ-5, CJ-6

CHART NO.	ITEM TO BE LUBRICATED	FREQUENCY 1000 miles=1.600 km.	QUANTITY			LUBRICANT		
			U. S.	Imperial	Metric	TYPE	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
3.	Universal Joints	Each 1000 miles	As required			Universal Joint Lubricant†	No. 1	No. 0
4.	Propeller Shaft..... Front Axle Shaft.....	{ Check each 1000 miles Change each 12,000 miles [19.200 Km.]	As required			Universal Joint Lubricant†	No. 1	No. 0
5.	Steering Gear Housing....	Check each 1000 miles	As required			MIL-L-2105B	SAE 80	SAE 80
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.	3-Speed Transmission and Transfer Case.....	{ Check each 1000 miles Change each 10,000 miles	6 ½ pts.	5 ½ pts.	3 ltrs.	GL4	SAE 90	SAE 80
9.	4-Speed Transmission Transfer Case.....	{ Check each 1000 miles Change each 10,000 miles	6 ¾ pts. 3 ½ pts.	5 ¾ pts. 3 pts.	3,2 ltrs. 1,7 ltrs.	GL4 GL4	SAE 90 SAE 90	SAE 80 SAE 80
10.	Differentials Front..... Rear.....	{ Check each 1000 miles Change each 10,000 miles	2 ½ pts. 2 ½ pts.	2 pts. 2 pts.	1,2 ltrs. 1,2 ltrs.	MIL-L-2105B* MIL-L-2105B*	SAE 80 SAE 80	SAE 80 SAE 80
	Speedometer Cable.....	Disassemble to lubricate each 12,000 miles [19.200 km.]	As required			Graphite Grease	Light	
	Distributor Oiler..... Wick..... Pivot..... Cam.....	Each 1000 miles Each 1000 miles Each 1000 miles Each 1000 miles	Several drops One drop One drop 2 c. c.			Engine Oil Engine Oil Engine Oil Cam Lubricant	Same as engine Same as engine Same as engine	
	Air Cleaner.....	Each 2000 miles	1 ¼ pts.	1 pt.	591,4 cm ³	Engine Oil	Same as engine	
	Generator.....	Each 1000 miles	2-4 drops			Engine Oil	Same as engine	
	Engine.....	Change each 2000 miles	4 qts.**	3 ½ qts.	3,8 ltrs.			
		Not lower than 32°F. (0°C.) use SAE 30 or 10W-30	Not lower than 10°F. (-12°C) use SAE 20, 20W, 10W-30, or 10W-20			As low as -10°F. (-23°C.) use SAE 10W, 10W-30, or 10W-20		
						Below -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 [one ltr.]

†4-Speed transmission and transfer case (optional on CJ-5 and CJ-6) require separate lubrication of each unit.

‡Sodium base lubricants recommended; do not mix sodium base and lithium base lubricants.

**LUBRICATION SPECIFICATIONS
MODEL DJ-3A "DISPATCHER"**

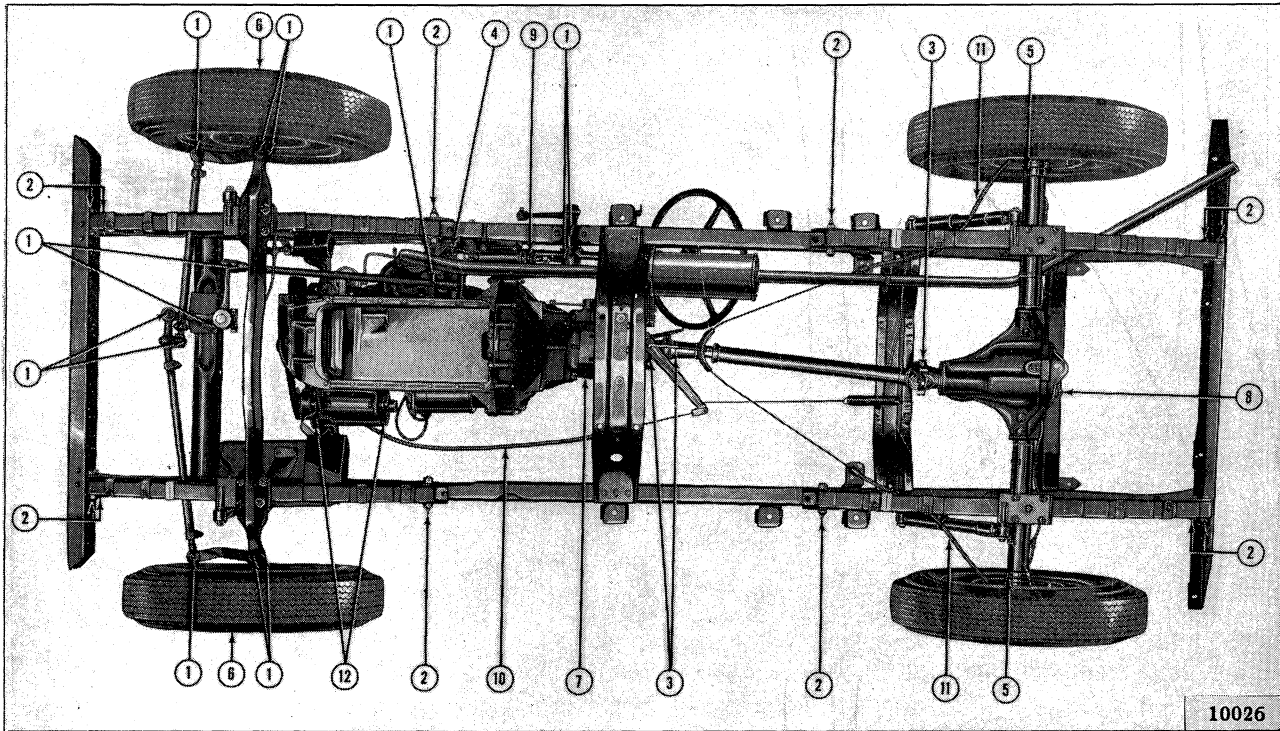


FIG. 16—LUBRICATION CHART—MODEL DJ-3A

CHART NO.	ITEM TO BE LUBRICATED	FREQUENCY 1000 miles = 1.600 km.	QUANTITY			LUBRICANT		
			U. S. Imperial Metric			TYPE	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
3.	Universal Joints	Each 1000 miles	As required			Universal Joint Lubricant †	No. 1	No. 0
4.	Steering Gear Housing	Check each 1000 miles	As required			MIL-L-2105B	SAE 80	SAE 80
5.	Rear Wheel Bearings	Sparingly each 1000 miles	As required			Wheel Bearing Lubricant †	No. 2	No. 2
6.	Front Wheel Bearings	Disassemble to lubricate each 10,000 miles	As required			Wheel Bearing Lubricant †	No. 2	No. 2
7.	3-Speed Transmission	Check each 1000 miles Change each 10,000 miles	1 ½ pts.	1 ¼ pts.	0,7 ltrs.	GL4	SAE 90	SAE 80
8.	Differential	Check each 1000 miles Change each 10,000 miles	2 pts.	1 ¾ pts.	0,9 ltrs.	MIL-L-2105B*	SAE 80	SAE 80
9.	Remote Control Shift	Each 1000 miles	As required			Chassis Grease	No. 1	No. 0
10.	Hand Brake Control Handle Cable	Each 10,000 miles	As required			Graphite Grease	Medium	Medium
11.	Hand Brake Control Cable Rear	Each 10,000 miles	As required			Graphite Grease	Medium	Medium
12.	Generator	Each 1000 miles	2 to 4 drops			Engine Oil	Same as engine	
	Speedometer Cable	Disassemble to lubricate each 12,000 miles [19-200 km.]	As required			Graphite Grease	Light	
	Distributor:							
	Oilier	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	
	Air Cleaner (Oil bath)	Each 2000 miles	1 ¼ pts.	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.			

Not lower than 32°F. (0°C.)
use SAE 30 or 10W-30

As low as 10°F. (-12°C.)
use SAE 20, 20W, 10W-30, or 10W-20

As low as -10°F. (-23°C.)
use SAE 10W, 10W-30, or 10W-20

Below -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 (one ltr.).

†Sodium base lubricant recommended; do not mix sodium base and lithium base lubricants.

engine lubrication is shown in Fig. 17. Maximum oil pressure in the system is limited by an oil pressure relief valve located on the oil pump. See Par. D-63 and E-64.

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 normal service, or more often under any of the following exceptions. Change engine oil more frequently depending on type and quality of oil used, severity of operating conditions, and if vehicle is driven short distances in cold weather or allowed to idle excessively. Always drain while crankcase oil is hot as suspended dirt and contaminants will more likely be

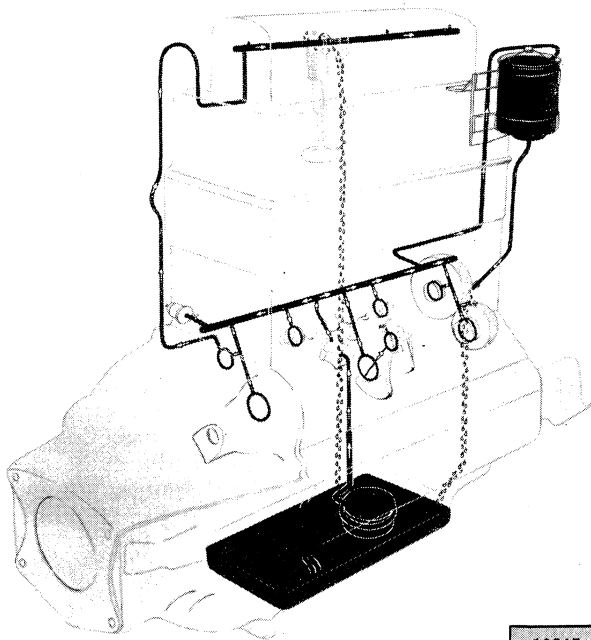


FIG. 17—ENGINE LUBRICATION

held in suspension and, therefore, drain out more completely.

- a. Position drain receptacle under plug.
- b. Remove drain plug using correct size wrench. Be careful of hot oil.
- c. Clean drain plug. Inspect and replace gasket if deteriorated.
- d. When oil has drained, replace and tighten drain plug.
- e. Check for presence of excess water in the oil that might indicate an internal leak from the cooling system.

B-8. Lubrication Fittings

Each 1000 miles [1,600 km.] clean each lubrication fitting indicated by No. 1 on Lubrication Charts. Use a pressure gun to lubricate. Be sure that grease channels are open to provide complete lubrication of bearing surfaces. In some cases it may be necessary to replace the lubrication fitting. In extreme cases it may be necessary to disassemble and clear plugged channels. The following points have lubrication fittings.

- a. Remote control gearshift base (Models DJ-3A and some models CJ-2A only).
- b. Tie rod: 4 fittings
- c. Drag link (steering connecting rod): 2 fittings
- d. Clutch pedal
- e. Brake pedal
- f. Steering bellcrank
- g. King pin: 4 fittings (Model DJ-3A only)
- h. Transfer case shift lever shaft (All models except DJ-3A)
- i. Spring shackles and pivot bolts: See Par. B-9
- j. Propeller shaft universal joints: See Par. B-10
- k. Rear wheel bearings: See Par. B-14

B-9. Spring Shackles and Spring Pivot Bolts

- Models CJ-3B, CJ-5, CJ-6, DJ-3A

All spring shackles and spring pivot bolts are shown as item 2 on the Lubrication Charts for these models, 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

The propeller shaft universal joints and slip joints are equipped with lubrication fittings. These should be lubricated with a good quality universal joint or chassis grease each 1000 miles [1,600 km.] using a hand compressor.

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 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 filler 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.], (10,000 miles [16,000 km.] for the Dispatcher), remove the front wheels and repack the bearings with wheel bearing grease. Work the grease into the cage holding the rollers.

Follow this same procedure for wheel bearings for 23-2 (full-floating) rear axle installed on early CJ-2A Models.

B-14. Rear Wheel Bearings

The rear wheel bearings are equipped with lubrication fittings with a vent opening through the housings above each fitting. Lubricate each 1000 miles [1,600 km.]. 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.

For Model CJ-2A with 23-2 (full-floating) rear axle follow the procedure of Par. B-11 for removing and repacking the rear wheel bearings.

B-15. 3-Speed Transmission and Transfer Case

• Models CJ-2A, CJ-3A, CJ-3B, CJ-5, CJ-6
Maintain lubricant at fill plug level in both transmission and transfer case. Check level each 1000 miles [1,600 km.] and add lubricant when necessary. Drain and refill both housings each 10,000 miles [16,000 km.].

Service each assembly individually even though drilled passages are provided in the housings for oil circulation and unit lubrication on all models except CJ-2A before Serial No. 24196.

Hard shifting of the gears in cold weather is a positive indication that the lubricant is too heavy a grade or the quality allows it to congeal at the prevailing temperature. If the oil is too heavy for easy shifting it will not properly lubricate the closely fitted parts. Change the lubricant to a lighter grade.

B-16. 3-Speed Transmission

• Model DJ-3A
Maintain lubricant at fill plug level. Check level each 1000 miles [1,600 km.] and add lubricant when necessary. Drain and refill housing each 10,000 miles [16,000 km.].

B-17. Optional 4-Speed Transmission and Transfer Case

• Models CJ-5 and CJ-6

The four-speed transmission and transfer case require separate lubrication for each unit as they have no cross-over oil passage. At each transmission service check, the fill plugs of **both** four-speed transmission and transfer case should be pulled and the lubricant refilled to level if necessary.

B-18. 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 filler plug openings. Drain and refill the housings every 10,000 miles [16,000 km.].

Do not mix different types of lubricants. Use a light engine or flushing oil to clean out the housings. Do not use water, steam, kerosene or gasoline for flushing.

B-19. Powr-Lok Differential

Some vehicles are equipped with locking differential (optional equipment). For identification of this unit, see Par. N-15. Ordinary lubricants **must not** be used in the locking differential. 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-20. 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 cam lubricant to the breaker arm cam and place a drop of oil on the breaker arm pivot.

B-21. 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-21A. Starting Motor

• Models CJ-2A (all) and CJ-3A to S/N 30972.
Lubricate the starter with three to five drops of engine oil every 1000 miles [1,600 km.] at an oiler located on the front (commutator) end.
For other models, see Par. B-36.

B-22. Oil Filter

After the initial change specified in Par. B-5, 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 [1 ltr.] to the engine oil change requirement.

B-23. Oil Bath Air Cleaner

• Models CJ-3B, CJ-5, CJ-6

• Optional on Model DJ-3A

These vehicles are equipped with an oil bath type

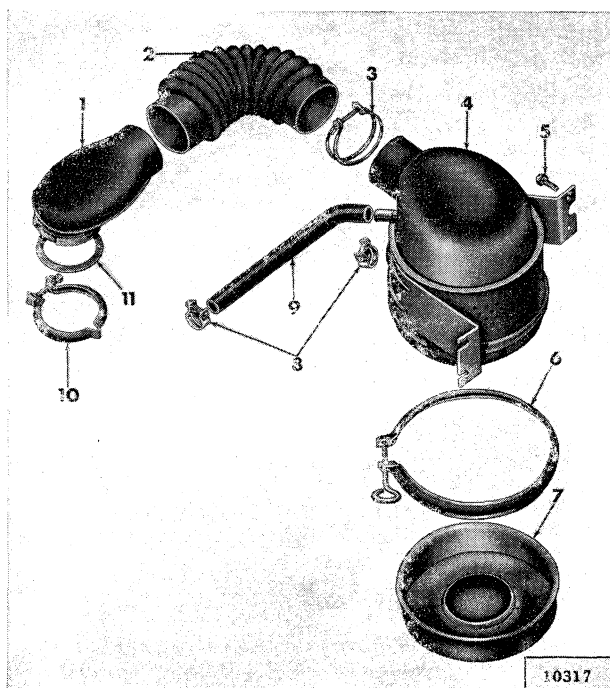


FIG. 18—OIL BATH AIR CLEANER

- | | |
|------------------------|-----------|
| 1—Horn | 7—Oil Cup |
| 2—Flexible Connector | 8—Clamp |
| 3—Hose Clamp | 9—Hose |
| 4—Body | 10—Clamp |
| 5—Screw and Lockwasher | 11—Gasket |
| 6—Clamp | |

air cleaner, Fig. 18. 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.

Care of the air cleaner is extremely vital to the life of the engine. Pay particular attention to the amount of dust and dirt in the air taken into the engine through the air cleaner. When dirt is not noticeable in the air, service the air cleaner each 2000 miles [3,200 km.]. Whenever the air is noticeably dusty (for example when the vehicle is driven on secondary roads or through fields) then service the air cleaner more frequently. Under extreme continually dusty and dirty conditions where the vehicle operates in clouds of dust and dirt, service the air cleaner daily.

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.

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

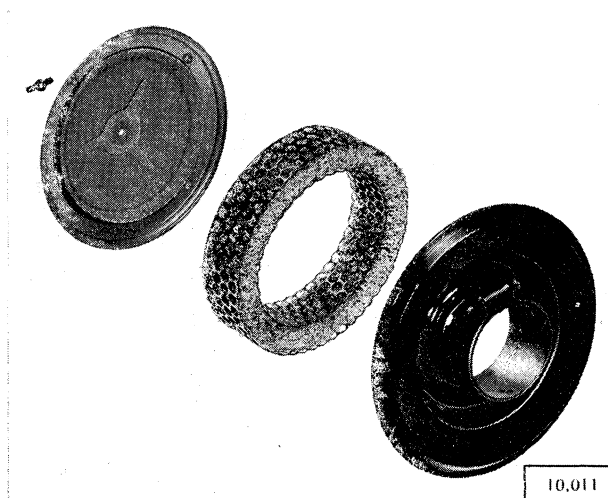


FIG. 19—WIRE GAUZE AIR CLEANER

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-24. Wire Gauze Air Cleaner

• Model DJ-3A

The air cleaner furnished as standard equipment on Model DJ-3A is the wire gauze type shown in Fig. 19. Dust particles in the air entering the air cleaner are deposited on the oil wetted wire gauze. This accumulated dust on the wire gauze mesh can choke off the air supply to the carburetor if the element is not cleaned at regular intervals. It is important, therefore, that the air cleaner be serviced every 2000 miles [3,200 km.].

To service the unit, first remove the wing nut and cover from the air cleaner. Then lift out the wire gauze element and wash out the accumulated dust by plunging the element up and down in a container filled with clean solvent. Allow the element to air dry; use of compressed air for drying the element is not recommended. Inspect the element and the felt seal in the cover. After the element is dry, dip it in engine oil of the same grade used for the oil change. Allow the excess oil to drain. Wipe the inside of the housing and cover clean. Install the element and cover. Tighten the wing nut securely.

B-25. Exhaust Manifold Heat Control Valve

• Models CJ-2A, CJ-3A, DJ-3A

These models are equipped with a 4-cylinder L-head engine which incorporates an exhaust manifold heat control valve. Lubricate the valve shaft and bushings at each 1000-mile lubrication. Place a few drops of penetrating oil at each end of the shaft where it passes through the manifold. Then move the valve up and down a few times to work the oil into the bushing.

B-26. Speedometer Cable

Remove the speedometer cable from the tube every 12,000 miles [19,200 km.]. Clean it thoroughly and coat it with a good quality light graphite grease.

B-27. Flexible Controls — Choke, Throttle, Hand Brake

Each 12,000 miles [19,200 km.] or once a year 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-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 lubricate these points will result in premature wear; the links will wear and the holes in the mating parts will become elongated.

B-29. 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 tail gate and hood hinges. The hood catch, hand brake ratchet, cowl ventilator control, and hood prop should be oiled for easy operation.

B-30. ADDITIONAL PERIODIC SERVICES**B-31. 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 $\frac{1}{2}$ " [1,3 cm.] below the top of the fill hole. Use only heavy-duty brake fluid conforming to specification SAE-70-R3. 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-32. Radiator

The exterior of the radiator core should be cleaned and the radiator inspected for leaks each 1000 miles [1,600 km.] of normal service of the vehicle. If the vehicle is subjected to considerable off-the-road operation, this interval should be each 1000 miles or 30 days, whichever interval occurs first. Refer to Par. H-6.

B-33. Cooling System

The cooling system should be flushed twice a year and checked for leaks, preferably in the spring and fall at the time of changing the antifreeze. Refer to Par. H-1.

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

- Models CJ-3A S/N 30972 and on, CJ-3B, CJ-5, CJ-6, DJ-3A

The starting motor bearings are lubricated at assembly to last between normal rebuild periods. For other models, see Par. B-21A.

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.

B-38. Shock Absorbers

Hydraulic direct-action shock absorbers are permanently sealed and require no periodic lubrication service. Also the shock absorber mounting bushings are not to be lubricated.

B-39. LUBRICATION REQUIREMENTS FOR FIELD AND INDUSTRIAL USE

Adequate lubrication becomes increasingly important when vehicles are used in field or industrial work and in many types of off-highway operation, for 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-40. Engine Oil

Use only a nationally advertised brand of MS type oil.

No definite change interval can be recommended due to 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. Do not fail to watch the condition of the oil closely and should it become contaminated, change it immediately.

B-41. 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 usually extremely dusty conditions of field work 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-42. Oil Filter

Dismantle and clean the filter and replace the element at the end of the first 100 hours of service.

Usually element replacement at each 150 hours of additional service will 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-43. Air Cleaner

The care of the air cleaner is extremely important at all times but especially so when the vehicle is used for industrial or field work.

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-44. Front Axle Shaft Universal Joints

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 field or industrial use remove the universal joints twice yearly, thoroughly clean both the housings and joints with a suitable solvent and refill the housings to the filler plug opening levels with the correct lubricant as shown in the appropriate Lubrication Specification Chart.

B-45. 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 heavy duty farm or industrial work, drain both housings every 300 hours of operation and refill to the filler plug opening levels.

B-46. Front and Rear Axle 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 Power-Lok differentials).

B-47. 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 filler opening levels. Should the units be used often drain and refill the housings each 300 hours of operation.

B-48. 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-49. Centrifugal Governor

Check the oil level in the governor housing 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 level indicating plug opening. Keep the vent in the filler plug open at all times.

B-50. Hydraulic Lift Lubrication

For lubrication requirements for the Monroe Hydraulic Lift, refer to Sec. U.

ENGINE TUNE-UP

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Air Cleaner.....	C-12	Fuel Supply.....	C-13
Battery.....	C-2	Heat Control Valve.....	C-6
Carburetor.....	C-16	Ignition.....	C-10, C-11
Compression.....	C-7	Service Diagnosis.....	C-19
Crankcase Ventilation.....	C-5	Spark Plugs.....	C-3
Cylinder Head.....	C-4	Tune-Up Specifications.....	C-20
Distributor.....	C-9	Vacuum.....	C-15
Fuel Pump.....	C-14	Valve Adjustment.....	C-8

C-1. GENERAL

An engine tune-up should be performed each 6,000 miles [9,600 km.], or at the end of each 250 hours of off-the-road use, to restore performance and power lost through wear and deterioration resulting from vehicle use. The tune-up should follow the sequence given below. Correction of items affecting the fuel system should not be attempted until all items affecting compression and ignition have been satisfactorily checked and any problems corrected.

C-2 Clean and Check Battery

Inspect battery and cables. If the battery is not satisfactory, install a fully-charged battery to allow completion of the tune-up.

a. Check the specific gravity of the electrolyte in each cell of the battery. A hydrometer reading of 1.260 indicates that the battery is fully charged. If the reading is 1.225 or below, the battery needs recharging. If one or more cells is 25 "points" (.025) or more lower than the other cells, this indicates that the cell is shorted, the cell is about to fail, or there is a crack in the battery partition in the case. Unless the battery is repaired or replaced, battery trouble will soon be experienced.

b. Check the electrolyte level in each cell, add distilled water to maintain the solution $\frac{3}{8}$ " [9.5 mm.] above the plates. Avoid overfilling. Replace the filler caps and tighten securely. It is important to keep the electrolyte level above the plates at all times because plates that are exposed for any length of time will be seriously damaged.

c. Check the wing nuts on the hold-down frame for tightness. Tighten them only with finger pressure, never with pliers or a wrench. Excessive pressure could damage the battery case.

d. Clean the battery terminals and cable connectors. Prepare a strong solution of baking soda and water and brush it around the terminals to remove any corrosion that is present. The cell caps must be tight and their vents sealed to prevent cleaning solution entering the cells. After cleaning, coat the terminals with heavy grease.

e. Inspect the battery cables and replace if badly

corroded or frayed. Check tightness of terminal screws to ensure good electrical connections. Check the tightness of the negative ground cable connection at the frame to ensure a good ground connection.

f. Load test the battery. Connect a voltmeter across the battery. Run the starting motor for 15 seconds. If the voltage does not drop below 5 volts on a 6-volt battery, or 10 volts on a 12-volt battery, the battery is satisfactory. If the voltage falls below the figures given, yet the specific gravity is above 1.225, the condition of the battery is questionable.

g. Be sure the engine ground strap connection, Fig. 20, is tight at both connections. If these connections are loose or dirty, hard starting or failure to start may result.

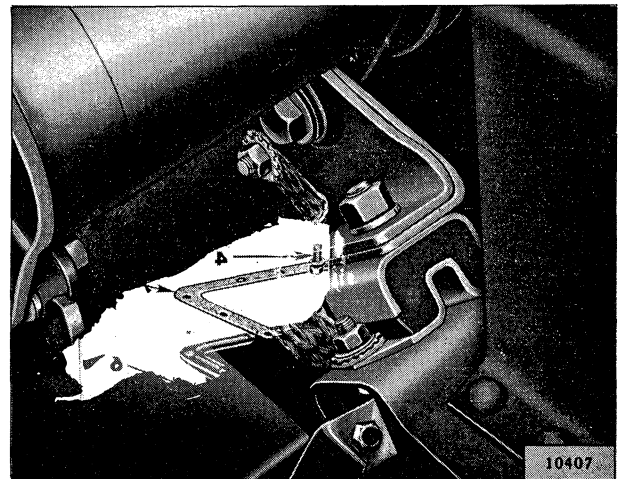


FIG. 20—ENGINE GROUND STRAP

C-3. Clean and Adjust Spark Plugs

Clean, inspect, and gap spark plugs. Do not install spark plugs until completion of compression tests.

a. Using a spark plug wrench, loosen each spark plug one or two turns to break loose any carbon deposits on the plug base.

b. Blow out all carbon and dirt from each spark

plug hole with compressed air. If compressed air is not available, start the engine and accelerate to 1000 rpm. to blow out the carbon and dirt. Stop the engine.

c. Remove the plugs carefully with a spark plug wrench.

d. Inspect the plugs for serviceability. Especially check for burned and eroded electrodes, blistering of porcelain at the firing tip, cracked porcelain, or black deposits and fouling. These conditions indicate that the plugs have not been operating at the correct temperature. See Par. I-14. Replace bad or worn plugs in sets.

e. Measure the electrode gap of each plug with a wire gauge as shown in Fig. 21. Adjust each electrode gap to the specific gap by bending the outer electrode mounted in the plug shell.

f. Reinstall plugs. Torque with a wrench to proper setting.

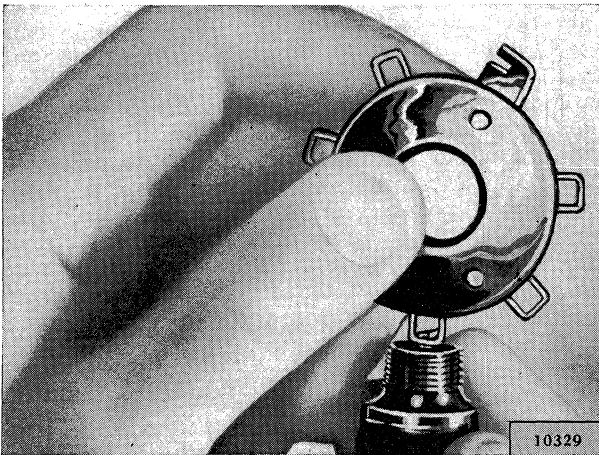
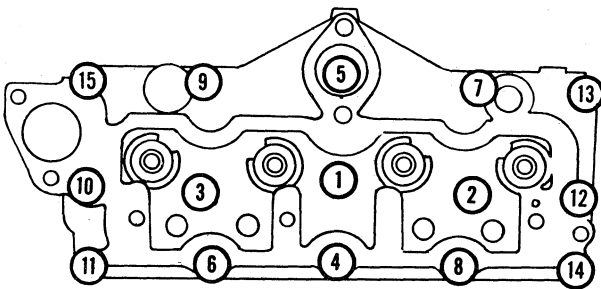


FIG. 21—SETTING SPARK PLUG GAP

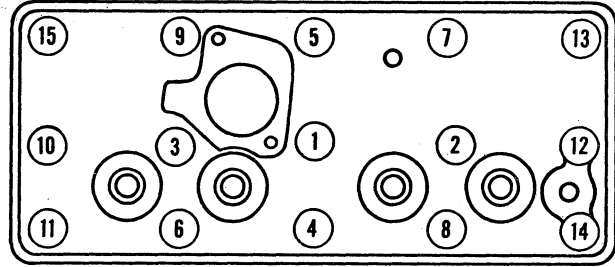
C-4. Torque Cylinder Head and Manifold

Torque the cylinder head bolts with a torque wrench to 60 to 70 lb-ft. [8,3 a 9,7 kg-m.]. Follow the sequence shown in Fig. 22 or Fig. 23. On F4-134 engines, do not overlook tightening the cylinder head bolt, No. 5, in the intake manifold directly under the carburetor opening. Torque all manifold attaching nuts evenly to 30 to 35 lb-ft. [4,1 a 4,8 kg-m.].



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FIG. 22—F4-134 ENGINE CYLINDER HEAD BOLT TIGHTENING SEQUENCE



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FIG. 23—L4-134 ENGINE CYLINDER HEAD BOLT TIGHTENING SEQUENCE

C-5. Clean Crankcase Ventilator

On engines equipped with a closed crankcase ventilating system, remove the control valve and tubes and clean them thoroughly. Inspect the oil filler tube cap gasket and replace if defective.

C-6. Service Manifold Heat Control Valve

On L4-134 engines equipped with a manifold heat control valve, test the valve for free operation. Place a few drops of penetrating oil at each end of the shaft where it passes through the manifold. Then move the valve up and down a few times to work the oil into the bushing.

C-7. Check Compression

Take compression readings with a compression gauge, as shown in Fig. 24, at each cylinder while cranking the engine with the starter motor. Allow only four compression strokes at each cylinder and record only the first and fourth readings. Interpret the readings as follows:

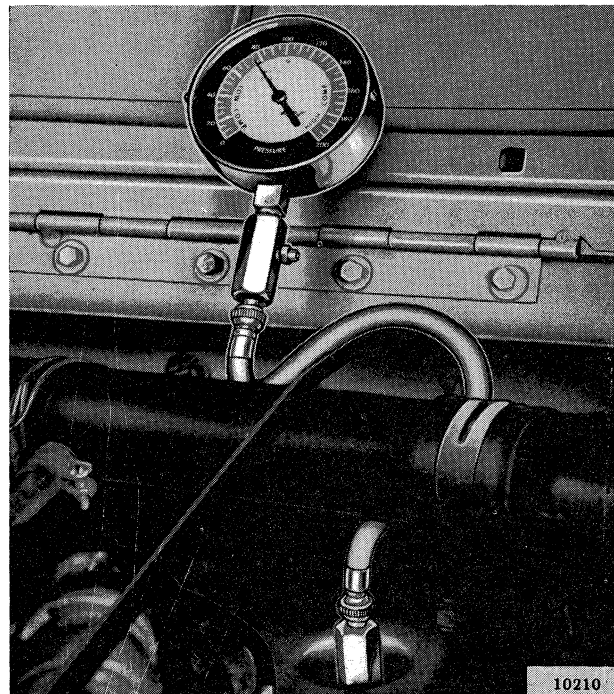


FIG. 24—COMPRESSION AND VACUUM GAUGE

a. When pressure quickly comes up to specified pressure and is uniform between all cylinders within 10 psi. [0,7 kg-cm²] it indicates that the engine is operating normally with satisfactory seating of rings, valves, valve timing, etc.

b. When pressure is low on the first stroke and builds up to less than specified pressure it indicates compression leakage usually attributable to rings or valves. To determine which is responsible, pour ½ oz. [15 cm³] of tune-up oil into each cylinder. Allow a few minutes for the oil to leak down past the rings and then again test compression. If compression pressures improve over the first test, the trouble is probably worn piston rings and bores. If compression pressures do not improve, the trouble is probably caused by improper valve seating. If this condition is noticed on only two cylinders that are adjacent, it indicates that there is a possible gasket leak between these cylinders. If inspection of the spark plugs from these cylinders disclosed fouling or surface cracking of electrodes, gasket leakage is probable.

c. When pressure is higher than normal it indicates that carbon deposits in the combustion chamber have reduced the side 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 to correct this trouble.

d. Reinstall the spark plugs. Torque with a wrench to proper setting. Advise the vehicle owner if compression is not satisfactory.

C-8. Check Valve Tappet Clearance

Adjust all valves with the engine cold.

a. For the four-cylinder L-head engine adjust both intake and exhaust valves to .016" [0,406 mm.]. There is one exception. Rotor-type exhaust valves were never installed on this engine in production. The necessary parts for this installation, however, are supplied in a kit so some L-head engines may be so equipped. Where rotor-type exhaust valves are installed, follow the specifications given in step b for F-head engines.

b. For the four-cylinder F-head engine adjust the intake valves to .018" [0,46 mm.] clearance and the exhaust valves to .016" [0,406 mm.] clearance.

C-9. Check Distributor

Refer to Fig. 25

a. The distributor cap should be inspected for cracks, carbon runners and evidence of arcing. If any of these conditions exists, the cap should be replaced. Clean any corroded high tension terminals.

b. 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.

c. 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 capacity should check from .21 to .25 microfarads. In the absence of a tester check by substituting a new condenser.

d. Examine the distributor points. If they show wear, poor mating, transferred metal, or pitting, then new ones should be installed. Clean the points with a suitable solvent and a stiff bristled brush.

e. Check the alignment of the point for a full, square contact. If not correctly aligned, bend the stationary contact bracket slightly to provide alignment.

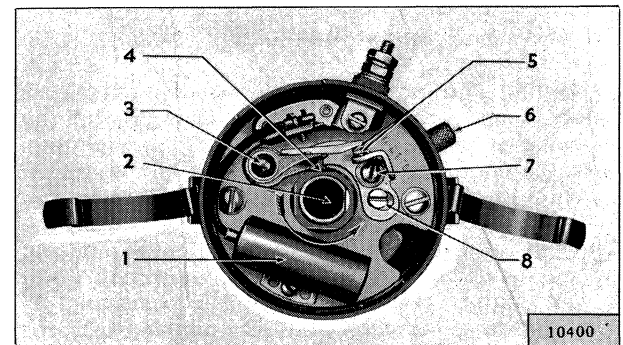


FIG. 25—DISTRIBUTOR

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

f. The contact gap should be set at .020" [0,508 mm.], measured with a wire gauge. Adjustment of the gap is accomplished by loosening the lock screw and turning adjusting eccentric screw until correct gap is secured. Be sure that the fiber block on the breaker arm is resting on the highest point on the cam while the adjustment is being made. Recheck the gap after locking the adjustment.

g. Apply a thin film of cam lubricant to the cam to lessen fiber block wear.

h. Check point contact spring pressure, which should be between 17 and 20 ounces [0,487 a 0,56 kg.]. Check with a spring scale hooked on the breaker arm at the contact and pull at right angle to the breaker arm. Make the reading just as the points separate. Adjust the point pressure by loosening the stud holding the end of the spring and slide the end of the spring in or out as necessary. Retighten the stud and recheck the pressure. Too low a pressure will cause engine missing at high speeds. Too high a pressure will cause rapid wear of the cam, block, and points.

C-10. Check Ignition Timing

If a neon timing light is available, use it to check ignition timing following the instructions of the timing light manufacturer.

In the absence of a timing light, remove No. 1

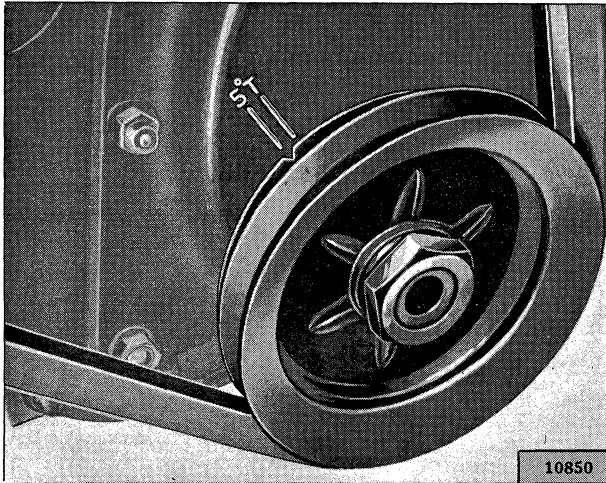


FIG. 26—TIMING MARKS (Early Engines)

spark plug and turn the engine over until No. 1 piston is on compression stroke as indicated by air being forced from No. 1 spark plug opening. Turn the engine slowly until the 5° BTC mark on the timing gear cover is in alignment with the notch on the crankshaft pulley. Fig. 26 shows the timing pointer arrangement used on early engines; Fig. 27 shows the timing pointer arrangement used on late engines. When the piston is positioned 5° BTC, 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. See Fig. 25. Timing may be altered by loosening the distributor mounting clamp and turning the distributor. Turn the distributor clockwise to advance the timing and counterclockwise to retard the timing. Do not overtighten the mounting clamp screw.

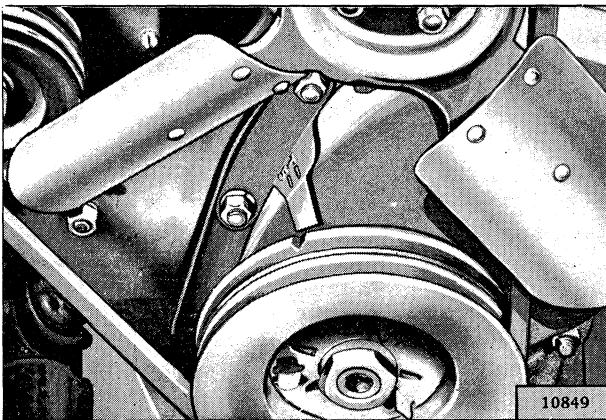


FIG. 27—TIMING MARKS (Late Engines)

C-11. Check Ignition Wires and Connections

Examine and clean the insulation on all ignition wires and check all connections. Cables should be free from roughness, firm, flexible, and free from minute cracks. Bend wires to check for brittle, cracked, or loose insulation. Because defective insulation will permit cross-firing or missing of the engine, defective wires should be replaced.

C-12. Service Air Cleaner

Clean and refill the air cleaner, See Par. B-23.

C-13. Check Fuel Line and Screens

Check all fuel line connections to guard against leakage. Clean the fuel filtering screen and fuel pump bowl.

C-14. Check Fuel Pump

The fuel pump should be checked for pressure, volume, and vacuum as follows:

a. Fuel pump pressure is important, for low pressure will seriously affect engine operation and high pressure will cause excessive fuel consumption and possibly flood the carburetor. Should there be any doubt of normal operation, check the pressure with a gauge as shown in Fig. 28.

The minimum and maximum allowable pressures are 2½ to 3¾ lb. [0,176 a 0,264 kg-cm²].

Also check the condition of the vacuum line rubber connector.

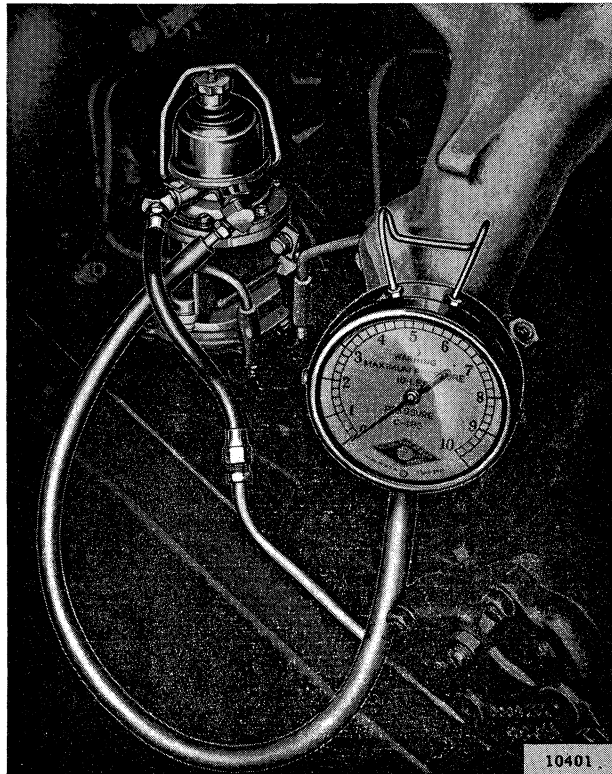


FIG. 28—CHECKING FUEL PUMP PRESSURE

b. Test for volume as a pump may build up sufficient pressure but fail to produce sufficient volume. 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 bottle or similar measure, pump ½ pint [0,24 lt.] of fuel by cranking the engine with the starter motor. Count the strokes necessary to fill the measure. If more than 20 strokes are required, the fuel pump is inefficient, the tank line is leaking air, or the fuel supply is restricted.

c. To test the pump for vacuum, disconnect the tank line and connect a vacuum gauge in its place. Crank the engine and observe the vacuum reading. If less than 8 inches [20,8 cm.] of mercury [Hg] the pump is at fault. If 10 inches [25,4 cm.] or more, check the fuel line.

C-15. Vacuum Check

Disconnect the vacuum line fitting from the head just below the carburetor and install the proper adapter. Connect a 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 and interpret as follows:

- a. A steady reading from 18 to 21 inches [46 a 63 cm.] of mercury [Hg.] is a normal reading indicating that valve and spark timing, valve seating, and piston ring sealing are all satisfactory.
- b. A steady but below normal reading 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. A slowly fluctuating or drifting reading indicated that the idle mixture is incorrect and the cause should be looked for in the fuel system.
- d. A rhythmic pulsating reading is caused by a condition affecting one or more cylinders, but not all, and indicates leaky valve, gasket blowby, restricted intake port, or an electrical miss.
- e. An intermittent pulsating reading is caused by an occasional malfunction such as a sticking valve (all valves may be erratic in operation if the valve springs are weak), and 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. A normal reading that quickly falls off (with engine running at 2000 rpm.) indicates exhaust back pressure caused by a restriction in the exhaust system.
- g. Make indicated corrections or advise vehicle owner of engine condition.

C-16. Adjust Carburetor

Refer to Fig. 29

Before adjusting the idle speed and mixture, start the engine and allow it to run until operating

temperature is reached. Then proceed as follows:

- a. Set the idle speed adjusting screw. Do not set the engine idle below 600 rpm.

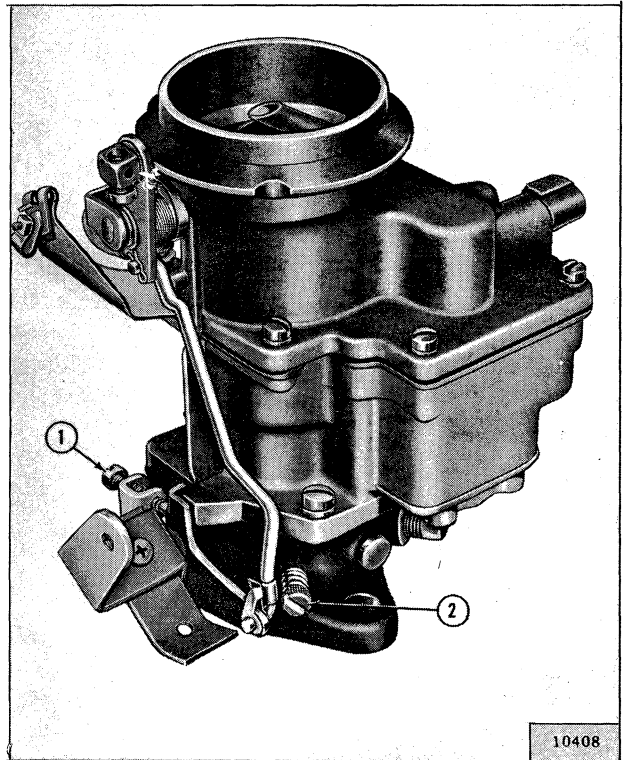


FIG. 29—CARBURETOR

- 1—Idle Speed Adjusting Screw
- 2—Idle Mixture Adjusting Screw

- b. Adjust the idle mixture adjusting screw to provide smooth idle. For richer mixture, turn the screw out; for leaner mixture, turn the screw in. Normal opening is $\frac{3}{4}$ to $1\frac{3}{4}$ turns.

C-17. Check Fan Belt

Inspect fan belt for serviceability and proper tension. Correct tension is obtained when thumb pressure midway between pulleys causes the belt to flex $\frac{1}{2}$ " [$1\frac{1}{4}$ cm.].

C-18. Road Test Vehicle

After completing the tune-up, road test the vehicle for power and over all performance. Make necessary adjustments.

C-19. 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

C-20. TUNE-UP SPECIFICATIONS

		Metric
Battery:		
Voltage.....	6 or 12 Volts	.....
Terminal Ground.....	Negative	.....
Specific Gravity:		
Fully Charged.....	1.260	.....
Recharge at.....	1.225	.....
Load Test, minimum:		
6-volt Battery.....	5 volts	.....
12-volt Battery.....	10 volts	.....
Spark Plugs:		
Make.....	Champion J-8	.....
Gap.....	.030"	0,762 mm.
Torque.....	25 to 33 lb-ft.	3,4 a 4,6 kg-m.
Distributor:		
Rotation viewed from top.....	Counterclockwise	.....
Cam Angle.....	42°	.....
Point Gap.....	.020"	0,508 mm.
Arm Spring Tension.....	17 to 20 oz.	0,482 a 0,567 kg.
Wiring order and direction.....	Firing- Counterclockwise	.....
Ignition Timing.....	5° BTC	.....
Marks.....	5, IGN, or TC	.....
Location:		
L4-134.....	} Flywheel or Timing Cover	.....
F4-134.....		.....
Compression Pressure Cranking:		
L4-134.....	90 to 110 psi.	6,3 a 7,3 kg-cm ²
F4-134.....	120 to 130 psi.	8,4 a 9,2 kg-cm ²
Valves:		
Tappet Clearance Cold:		
Intake:		
L4-134.....	.016"	.....
F4-134.....	.018"	.....
Exhaust:		
L4-134.....	.016"	.....
F4-134.....	.016"	.....
Timing (Intake Opens).....	9° BTC	.....
Engine Idle Speed.....	600 rpm.
Firing Order.....	1-3-4-2

L4-134 ENGINE MODELS CJ-2A, CJ-3A, DJ-3A

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D-1. GENERAL

Engine service and repair is covered in this section in the following manner:

- a. General description of the engine.
- b. Removal of the engine from the vehicle.
- c. Complete engine disassembly out of the vehicle. Special instructions are included with some operations to cover difference required when disassembly is done with the engine installed.
- d. Inspection and repair of engine components with the parts removed.
- e. Engine reassembly with the engine removed from the vehicle. The final paragraphs cover valve adjustment, oiling system of the engine, and crankcase ventilation.

D-2. Description

The Model L4-134 engine is an L-head four-cylinder engine. The cylinder block and crankcase are cast integrally. Both intake and exhaust valves are mounted in the cylinder block with through water jacketing to provide effective cooling. The valves are operated by conventional valve tappets.

The engine is equipped with a fully counterbalanced crankshaft supported by three main bearings. To better control balance, the counterweights are independently forged and permanently attached to the crankshaft with dowels and capscrews that are tack-welded. Crankshaft end play is adjusted by shims placed between the crankshaft thrust washer and the shoulder on the crankshaft.

Aluminum pistons, forged steel connecting rods, and replaceable main and connecting rod bearings are used in this engine. The camshaft on current production engines is gear driven from the crankshaft (chain driven on early production engines).

The water pump is mounted on the front of the cylinder block, and is belt driven by the crankshaft. Circulation of the coolant is controlled by a thermostat installed in the water outlet which is mounted on top of the cylinder head.

The engine is pressure lubricated. An oil pump, gear driven by the camshaft, is mounted externally on the left side of the crankcase. The pump forces the lubricant through oil channels and drilled passages in the crankshaft to efficiently lubricate the main and connecting rod bearings. Lubricant is also force fed to the camshaft bearings and timing gears. Cylinder walls and piston pins are lubricated from spurt holes in the "follow" side of the connecting rods.

The carburetor is mounted on top of the intake manifold. The intake and exhaust manifolds are mounted on the left side of the cylinder block. A thermostatically controlled valve in the exhaust manifold controls the temperature of fuel-air mixture in the intake manifold.

As is common practice with manufacturers, some engines are built with oversize cylinder bores or undersize crankshaft journals. These engines are considered standard as replacement parts of the correct sizes are supplied. Before ordering parts or doing any work with a particular engine, it is important to check the engine serial number to determine if oversize or undersize parts are required. Definite identification is given by a letter stamped after the engine serial number. The letters used and their meanings are given here:

<p>A — .010" [0,254 mm.] undersize main and connecting rod bearings.</p> <p>B — .010" [0,254 mm.] oversize pistons.</p> <p>AB — Combination of A and B.</p>
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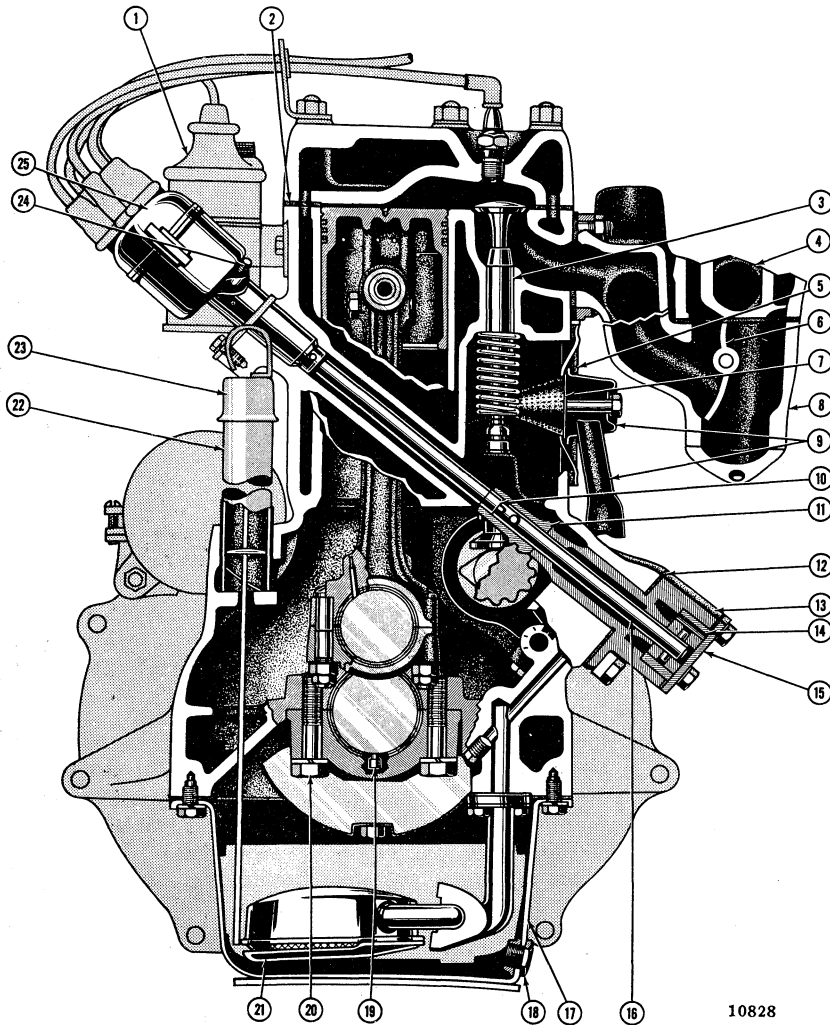


FIG. 30—FOUR-CYLINDER L-HEAD ENGINE—END VIEW

- 1—Ignition Coil
- 2—Cylinder Head Gasket
- 3—Exhaust Valve Guide
- 4—Intake Manifold
- 5—Valve Spring Cover
- 6—Heat Control Valve
- 7—Crankcase Ventilator Gasket
- 8—Exhaust Manifold
- 9—Crankcase Ventilator
- 10—Distributor Shaft Friction Spring
- 11—Oil Pump Driven Gear
- 12—Oil Pump Gasket
- 13—Oil Pump
- 14—Oil Pump Rotor
- 15—Oil Pump Cover
- 16—Oil Relief Plunger
- 17—Relief Plunger Spring
- 18—Relief Valve Shim
- 19—Relief Plunger Spring Retainer
- 20—Oil Pump Shaft
- 21—Oil Pan
- 22—Drain Plug
- 23—Oil Float Support
- 24—Crankshaft Bearing Dowel
- 25—Bearing Screw
- 26—Oil Float
- 27—Oil Filler Tube
- 28—Oil Filler Cap & Level Indicator
- 29—Distributor Oiler
- 30—Distributor

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Detailed specifications for the L4-134 engine are given at the end of this section. Torque specifications are at the end of this manual in Section U. When adjustments are necessary, refer to these specifications so that factory clearances are maintained.

D-3. Engine Mountings

The front of the engine is supported by two rubber insulator mountings attached to the frame side rail brackets. The rear of the engine-transmission assembly is supported by a rubber insulator mounting under the rear of the transmission on the frame center cross member. This cross member is bolted to the frame side rails so that it can be dropped when removing the transmission or engine-transmission assembly. The rubber insulators allow free side and vertical oscillation to effectively neutralize engine vibration at the source.

The rubber insulator mountings should be inspected for separation and deterioration by jacking the power plant away from the frame, near the supports. Vibration cannot be effectively absorbed by

separated or worn insulators. They should be replaced if faulty.

D-4. Engine Ground Strap

To be sure of an effective ground for the electrical circuits, a ground strap bridges the right front (on some models, 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-5. ENGINE REMOVAL

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

- a. Drain the cooling system by opening the drain cocks at the bottom of the radiator and lower right side of the cylinder block.
- b. Disconnect the battery at the positive terminal to avoid the possibility of a short circuit.
- c. Remove both the upper and lower radiator hoses, and the heater hoses if so equipped.

- 1—Fan
- 2—Water Pump Bearing & Shaft
- 3—Water Pump Seal Washer
- 4—Water Pump Seal
- 5—Water Pump Impeller
- 6—Piston
- 7—Piston Pin
- 8—Thermostat
- 9—Water Outlet Fitting
- 10—Thermostat Retainer
- 11—Exhaust Valve
- 12—Inlet Valve
- 13—Cylinder Head
- 14—Exhaust Manifold
- 15—Valve Spring
- 16—Valve Tappet Self-Locking Adjusting Screw
- 17—Engine Rear Plate
- 18—Camshaft
- 19—Flywheel Ring Gear
- 20—Crankshaft Rear Packing
- 21—Oil Pan
- 22—Crankshaft Rear Lower Bearing
- 23—Valve Tappet
- 24—Crankshaft
- 25—Oil Pump & Distributor Drive Gear
- 26—Connecting Rod Cap Bolt
- 27—Oil Float Support
- 28—Oil Float
- 29—Crankshaft Center Lower Bearing
- 30—Connecting Rod Assembly No. 2
- 31—Connecting Rod Bolt Lock Nut
- 32—Crankshaft Front Lower Bearing
- 33—Crankshaft Front Upper Bearing
- 34—Engine Front Plate
- 35—Crankshaft Gear
- 36—Crankshaft Gear Spacer
- 37—Crankshaft Oil Slinger
- 38—Fan Belt
- 39—Crankshaft Front End Packing
- 40—Fan & Generator Drive Pulley Nut
- 41—Crankshaft Gear Key
- 42—Fan & Generator Drive Pulley Key
- 43—Timing Gear Oil Jet
- 44—Fan & Generator Pulley
- 45—Camshaft Thrust Plate
- 46—Camshaft Gear Washer
- 47—Camshaft Gear Screw
- 48—Camshaft Thrust Plate Screw
- 49—Camshaft Gear

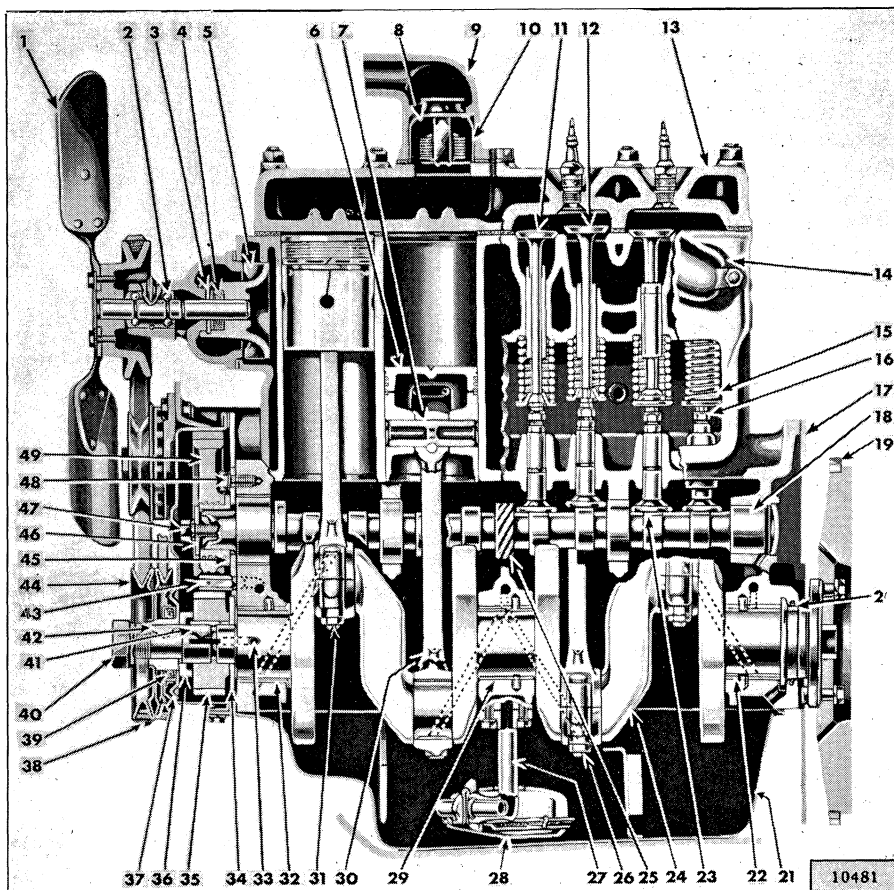


FIG. 31—FOUR-CYLINDER L-HEAD ENGINE—SIDE VIEW

- d. Remove the four bolts from the fan hub and fan blades.
- e. Remove the four radiator attaching screws and remove the radiator.
- f. Disconnect the fuel line at the fuel pump and the windshield wiper hose.
- g. Remove the air cleaner from the carburetor.
- h. Disconnect the carburetor choke and throttle controls.
- i. Remove the starting motor cables and the starting motor.
- j. Disconnect the generator wires.
- k. Disconnect the ignition primary wire at the coil.
- l. Disconnect the oil pressure sender unit and temperature sender unit wires at the units.
- m. Disconnect the exhaust pipe from the exhaust manifold.
- n. Remove the two nuts and bolts from each front engine support and remove the supports. This will allow the engine to drop slightly and will permit access to the two top bolts on the bell housing.
- o. Install a suitable lifting sling on the engine. Attach the sling to a chain hoist or other lifting device and take up all slack.
- p. Remove the bolts which attach the flywheel bell housing to the engine.
- q. Pull the engine forward, or roll the vehicle backward, until the clutch clears the bell housing. Lift the engine from the vehicle.

D-6. ENGINE DISASSEMBLY

Engine disassembly is presented in the sequence to be followed when the engine is to be completely overhauled after removal from the vehicle. Some 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 parts. Special instructions are given to cover different operations required when disassembly is performed with the engine installed in the vehicle. 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 from the crankcase. During disassembly operations, the engine should be mounted in a suitable engine repair stand. Where practicable, modify or adapt an existing repair stand as necessary to accommodate the engine. If an engine repair stand is not used, take care to perform disassembly operations in a manner that will protect personnel against an accident and the engine and its parts against damage.

D-7. Remove Water Pump

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

D-8. Remove Manifolds

On models so equipped, remove the crankcase ventilator tube which extends from the ventilator valve mounted in the intake manifold to an elbow mounted on the valve cover plate. Remove the seven nuts from the manifold-to-cylinder-block studs. Pull the intake and exhaust manifolds as an assembly off the studs. Remove the manifold-to-block gasket.

D-9. Remove Oil Filler Tube

Loop a piece of 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. Pull the tube, tapping it just above the crankcase opening.

D-10. Remove Water Outlet Fitting

Remove the bolts and lockwashers that attach the water outlet fitting to the cylinder head. Lift the outlet fitting and thermostat from the cylinder head.

D-11. Remove Crankshaft Pulley

Remove the crankshaft nut. Install a puller and pull the pulley from the crankshaft.

D-12. Remove Oil Pump

The oil pump is located externally on the left side of the engine. If the oil pump is to be removed with the engine in the vehicle, set No. 1 piston at TDC for reference for reinstalling the oil pump without greatly disturbing the ignition timing. Then remove the distributor cover and note the position of the rotor. If the distributor has already been removed, sight through the distributor hole before removing the oil pump. The slot should be near vertical. Remove the capscrews and lockwashers attaching the oil pump to the cylinder block. Carefully slide the oil pump and its drive shaft out of the cylinder block.

D-13. Remove Crankcase Ventilator Valve

On vehicles so equipped, remove the capscrew and ventilator body gasket securing the crankcase vent body and related parts to the exhaust valve spring compartment cover and to the cylinder block. Remove the crankcase vent body and the engine ventilating system parts threaded to it. Remove the valve cover plate screws and the valve cover plate.

D-14. Remove Cylinder Head

Remove the spark plugs. Remove the cylinder head nuts and the temperature sending unit, then lift the head from the block. Removal is made easy by using lifting hooks screwed into No. 1 and No. 4 spark plug holes. Remove and discard the cylinder head gasket.

CAUTION: Do not use a screw driver, chisel, or other sharp instrument to drive between the cylinder head and block to break the head loose from the gasket.

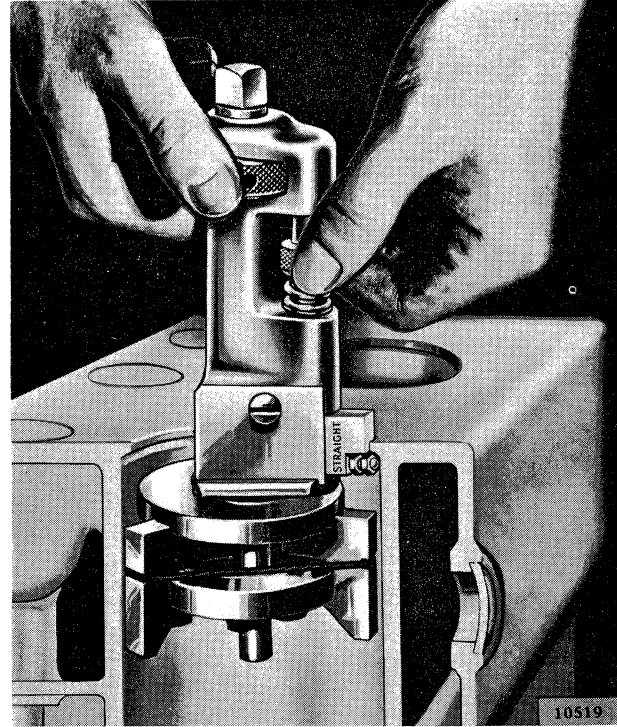


FIG. 32—REMOVING RIDGE WITH REAMER

D-15. Ream Cylinder Bore Ridges

To prevent breaking the piston lands, the ridge at the top of each cylinder bore must be removed. To remove this ridge, use a cylinder ridge reamer, following the instructions furnished by the reamer manufacturer. Use care not to cut below the top of the upper ring travel in the bore. Keep each piston top covered with an oil-soaked cloth to prevent cuttings from falling into the cylinder.

NOTE: This operation should be performed at this time before the engine is rotated for the sequence steps following.

D-16. Remove Oil Pan

Rotate the engine to the upside down position. Remove the screws and lockwashers that attach the oil pan to the cylinder block.

Remove the oil pan and gasket. Discard the gasket.

D-17. Remove Piston and Connecting Rod Assemblies

Remove the stamped locking nuts from the lower end of each connecting rod bearing bolt. Remove the connecting rod nuts. Remove the bearing cap evenly. 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. 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 in 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.

Piston and connecting rod assemblies may be removed for repair with the engine in the vehicle after draining the cooling system, removing the oil pan and the cylinder head, and reaming the ridges as previously described.

D-18. Remove Timing Gear Cover

Remove the bolts, nuts, and lockwashers that attach the timing gear cover (timing chain cover on early models) to the engine. Remove the cover, timing pointer, and cover gasket. Discard the gasket. Remove the crankshaft oil seal. Remove the oil slinger and spacer from the crankshaft.

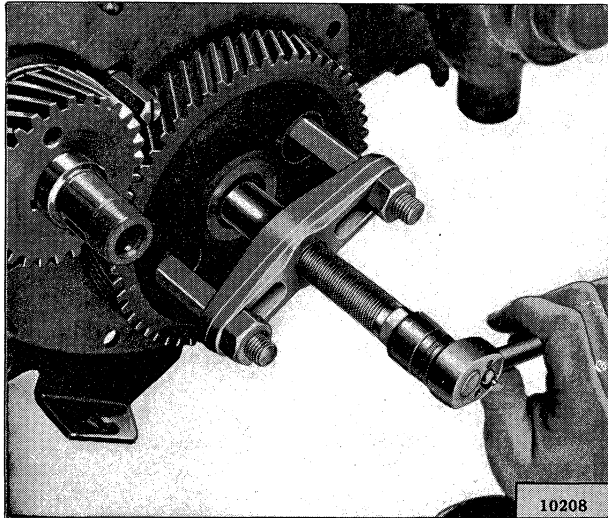


FIG. 33—PULLING TIMING GEARS

D-19. Remove Timing Gears

Pull both the crankshaft and camshaft gears (chain sprockets on early models). Use puller W-172 for pulling the gears. See Fig. 33. With the threaded capscrews supplied, adapt the puller to the crankshaft gear and pull the gear. With the special hook-type puller bolts that fit behind the camshaft gear flange, pull the camshaft gear. Remove the Woodruff keys.

D-20. Remove Front End Plate

Remove the screws and lockwashers that attach the front end plate to the cylinder block. Remove the front end plate and gasket. Discard the gasket.

D-21. Remove Clutch

NOTE: Crankshaft, flywheel, and clutch are balanced as a unit in production. Before disassembly, mark these components to insure reassembly in their original relative positions to maintain this balance.

Remove four bolts and lockwashers diagonally opposite from each other that attach the clutch assembly to the flywheel, leaving two opposed bolts to be loosened alternately until the clutch spring pressure is relieved. Then, supporting the clutch assembly with one hand, remove the two remaining bolts. For information on disassembly, inspection, repair and assembly of the clutch refer to Section J. Instructions for removing the clutch when the engine is in the vehicle are also given in Section J.

D-22. Remove Flywheel

The flywheel is attached to the crankshaft with two tapered dowel bolts and four special bolts. Remove these attaching parts. Use a pry bar between the flywheel and the back of the engine and carefully loosen the flywheel from the crankshaft. If the flywheel is to be removed with the engine in the vehicle, the transmission and clutch must first be removed as detailed in Section J.

D-23. Remove Crankshaft

Slide the crankshaft thrust washer and all end-play adjusting shims off the front end of the crankshaft. Pull the two pieces of rear main bearing cap packing out of position between the side of the bearing cap and the cylinder block.

Note the marks on the bearing caps and cylinder block for bearing number and position. Remove the screws and lockwashers that attach the main bearing caps to the cylinder block. Use a lifting bar beneath the ends of each bearing cap. Being careful not to exert enough pressure to cause damage to the caps or dowels, pry the caps free.

CAUTION: If main bearing caps are not removed carefully by raising both sides of each cap evenly until free of the dowels, the dowels may be bent. A bent main bearing cap dowel can cause misalignment of the cap and result in rapid bearing wear. Therefore, remove each main bearing cap carefully. If there is reason to believe any of the dowels have been bent during the bearing cap removal, replace them as detailed in Par. D-31c.

Lift the crankshaft from the cylinder block.

Remove the upper half of the rear main bearing oil seal from the cylinder block and the lower half from the oil seal groove in the rear main bearing cap. Install the main bearing caps and bearings on the cylinder block in their original positions.

NOTE: Removal of the crankshaft may be accomplished only with the engine out of the vehicle.

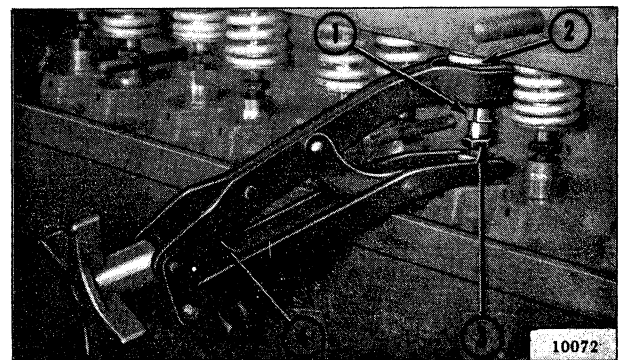


FIG. 34—REMOVING VALVE SPRING LOCKS

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

D-24. Remove Valves and Springs

The valve spring cover was previously removed. Use cloths to block off the three holes in the exhaust valve chamber to prevent the valve retaining locks from falling into the crankcase should they be accidentally dropped. Using Valve Spring Compressor

tool C-482, compress the valve springs on those valves which are in the closed position. (valve seated against cylinder block). Remove the valve spring retainer locks, retainer, valve, and spring. Close the other valves by rotating the camshaft and repeat the above operation for the other valves in the same manner. When lifting out the valves, either tag them or place them in a rack to indicate the location where each was removed from the cylinder block. If a valve sticks in the 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.

D-25. Remove Camshaft

- a. Push the valve tappets into the cylinder block as far as possible so the ends of the tappets are not in contact with the camshaft.
- b. Secure each tappet in the raised position by installing a common clip-type clothes pin on the shank of each tappet or tie them up in the valve chamber.
- c. Remove the camshaft thrust plate attaching screws, thrust plate and spacer on engines so equipped.
- d. Pull the camshaft forward out of the cylinder block using care to prevent damage to the camshaft bearing surfaces.
- e. To remove a camshaft with the engine in the vehicle, first drain the radiator and cylinder head. Then remove the radiator, grille, cylinder head, manifolds, valves and valve springs, fuel pump, oil pump, oil pan, crankshaft pulley, fan, nuts from front engine supports, timing cover, camshaft sprocket or gear, and thrust plate. Then proceed with steps a, b and c above. Then place a jack with a block of wood under the crankcase and raise the front of the engine until the camshaft will clear the frame front cross member. Then proceed with step d above.

D-26. Remove Valve Tappets

Remove the valve 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 reassembled in their original positions.

D-27. Remove Oil Gallery Plugs

Remove the plug at each end of the oil gallery in the cylinder block. This operation is only applicable when the engine is out of the vehicle and will allow access to the oil gallery so it may be cleaned.

D-28. 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 individually with the engine in the vehicle. Wherever the procedure differs due to the engine being in the vehicle, the necessary special instructions are provided. Inspection and repair instructions are included to cover the

cylinder block, cylinder head, 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 undersize bearings or oversize pistons. Refer to Par. D-2.

D-29. Cylinder Block

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

D-30. 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, valve chamber, crankcase, and cylinder walls to remove all sludge, dirt carbon deposits. After cleaning, use air pressure to dry the block thoroughly.

D-31. Inspection

Examine the cylinder block for minute cracks and fractures. Rusted valve springs or evidence of rust in the valve chamber or the cylinder walls is a good indication of a possible crack in the block.

- a. Examine all machined surfaces of the cylinder block for burrs and scores. Check for 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. Maximum permissible out of line for service is .010" [0,254 mm.].
- b. Check the cylinder bores for out-of-round and taper to determine if the bores require honing or reboring. For detail information refer to Par. D-32.
- c. If there is any reason to believe that any of the main bearing cap dowels have been bent during bearing cap removal, install new ones. The dowels must fit tightly to ensure cap alignment and as they are hardened they may be difficult to grip and 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. Before installing a new dowel in the cylinder block, make sure the dowel hole is clean. Start the dowel straight in the hole, then tap the dowel lightly with a hammer until it bottoms.
- d. When installing bearing caps, be sure to tighten the bolts evenly in each cap to pull it into place 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.

D-32. Cylinder Bores

The cylinder bores may be reconditioned by honing or reboring. Use oil-soaked rags to protect crankshaft journals and other engine parts from abrasive dust during all reconditioning operations.

Both honing and reboring of the cylinders must be done carefully to fit the pistons and to obtain specified clearances. If reboring of the cylinder bores is not required but the walls are glazed, use a finishing hone to remove the glaze. Reboring the cylinders must not be attempted unless adequate facilities and experienced service technicians are available. The amount of material to be removed is determined from the original diameter of the cylinder bores (3.125" to 3.127") [79,375 a 79,426 mm.] plus the amount of oversize in diameter of the oversize pistons to be fitted. Pistons are available in the following oversizes.

.010" [0,254 mm.]	.030" [0,762 mm.]
.020" [0,508 mm.]	.040" [1,016 mm.]

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. The maximum rebore should not exceed .040" [1,016 mm.] from standard.

Measure the cylindrical diameters by making measurements both parallel to and at right angles to crankshaft over entire piston travel and at bottom of cylinder. Proceed as follows:

a. If bores are scored; if out-of-round exceeds .005" [0,127 mm.]; if diameters differ more than .005"; or if taper exceeds .005" 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, allow .0015" [0,0381 mm.] for final honing.

All cylinder bore diameters must be within .002" [0,0508 mm.] after reconditioning.

b. If bore measurements are within the above limits, but indicate hollows or waviness, cylinders should be honed with 250 grit stone hone. 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 250 grit stone hone or with a suitable deglazing tool. Operate the hone or deglazer to obtain diamond cross-hatched pattern previously mentioned.

d. Regardless of type of correction on cylinder walls, wash out bores thoroughly afterwards and apply a light coat of engine oil. If cylinders have been rebored or honed heavily, measure cylinder diameters again to assure proper selection of piston size.

D-33. Pistons, Rings, and Connecting Rods

Pistons are each fitted with two compression rings and one oil control ring. Pistons have an extra groove above the top ring which acts as a heat dam or insulating groove to protect against sealing of the

top ring in the ring groove with hard carbon. The piston pin is secured by a lock screw.

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. Use standard size pistons in cylinder bores up to .009" [0,2286 mm.] oversize measured at the bottom of the bore. For oversize, use the following chart:

OVERSIZE PISTON APPLICATION CHART

Oversize Piston	Use in Oversize Cylinder Bore Range	Metric
.010"	.010" to .019"	0,254 a 0,438 mm.
.020"	.020" to .029"	0,508 a 0,737 mm.
.030"	.030" to .039"	0,762 a 0,991 mm.
.040"	.040"	1,016 mm.

Disassemble the pistons and rods. Remove the two compression rings, the oil control ring, and the oil control ring expander from each piston. Do not remove the bolts from the lower end of the connecting rods unless the bolts are damaged. Clamp each connecting rod and piston assembly in a padded bench vise and remove the piston pin lock screw and lockwasher. Press the piston pin out of the piston and connecting rod. Clean all carbon, gum, and lacquer deposits from both the inner and outer surfaces of each piston, connecting rod, and piston pin. Use a ring groove cleaner or a broken ring filed to a sharp square edge to clean the carbon from the piston ring grooves and the insulator groove. Use care not to scrape metal from the sides of the grooves or make burrs on ring groove surfaces. Run a length of wire through the oil spray hole near the lower end of the connecting rod to clear the hole of hardened oil deposits or foreign matter. Carefully inspect the pistons and replace any that are broken or cracked. Replace pistons if any of the ring lands are chipped, broken, or rounded on the edges; or if the piston is scored, scratched, or burned so seriously that the imperfections cannot be removed with a hand honing stone or crocus cloth.

NOTE: Effective with engine S/N 50705, the piston head thickness was increased from 3/16" to 1/4" [4,76 a 6,35 mm.] to provide greater strength and heat conductivity. When replacing pistons singly or in sets, procure the correct parts or engine vibration will result from unbalanced pistons.

Replace the pistons as follows:

a. After cylinder bores have been carefully checked for out-of-round and taper (Par. D-32), check fit of each piston to cylinder bore with block and pistons clean and dry and at approximately 70°F. [21°C.] by using Piston Fitting Gauge And Scale tool C-690 as shown in Fig. 35. Use a .003" [0,076 mm.] thickness gauge 3/4" [19 mm.] wide. The piston is fitted upside down in the block to facilitate the operation. The gauge must extend the full length of the piston on the thrust side (opposite side from slot in piston skirt). Scale should register 5 to 10 pounds [2,3 a 4,5 kg.] pull to remove the thickness gauge from between cylinder wall and piston. Excessive pull indicates need for a slightly smaller

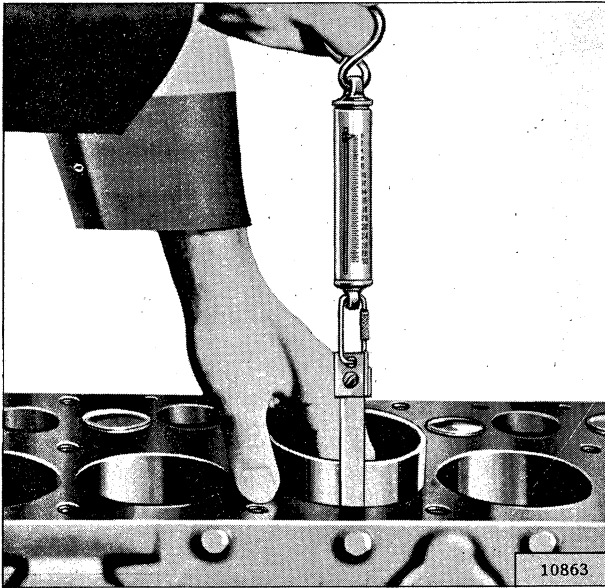


FIG. 35—PISTON FITTING

piston or additional honing of cylinder. Insufficient pull indicates need for fitting a larger piston.

b. Check and if necessary correct connecting rod alignment using a connecting rod aligning fixture (such as the one shown in Fig. 36) in accordance with the instructions furnished with the fixture.

c. Check the piston pin fit. The piston pins are fitted with a clearance of .0001" to .0003" [0,0025

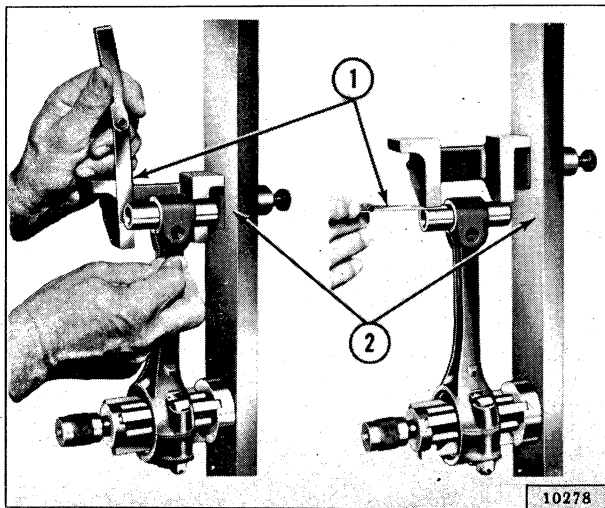


FIG. 36—CHECKING CONNECTING ROD ALIGNMENT

1—Feeler Gauge
2—Fixture

a 0,0076 mm.] which approximates a light thumb push fit at room temperature. See Fig. 37. The piston pins are anchored in the rods with lock screws. Installation of oversize pins in this engine is not recommended as experience has shown that should a pin be worn sufficiently to require replacement, the piston should also be replaced.

Clamp the connecting rod in a vise using jaw shields of soft metal or two pieces of hardwood, one on each side of the rod and positioned approximately

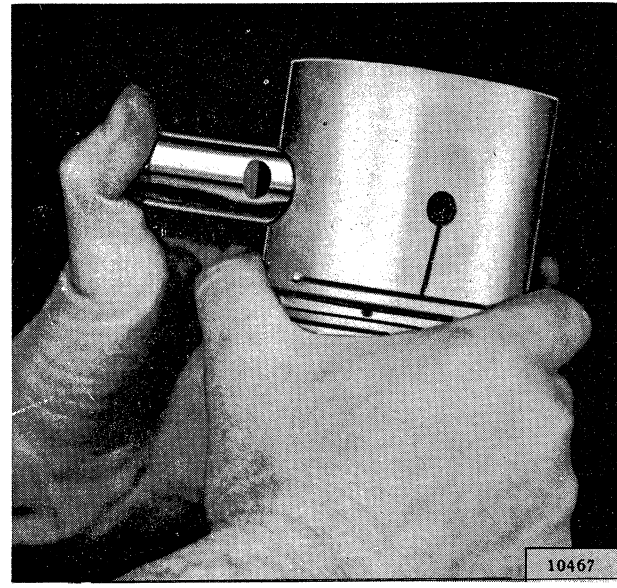


FIG. 37—PISTON PIN FITTING

3" [76 mm.] from the piston pin end. Start the piston pin in the piston with the lock screw groove facing down. Assemble piston to connecting rod with piston skirt T-slot on the opposite side from the oil spray hole, in the bearing end of the connecting rod. See Fig. 38. Install the

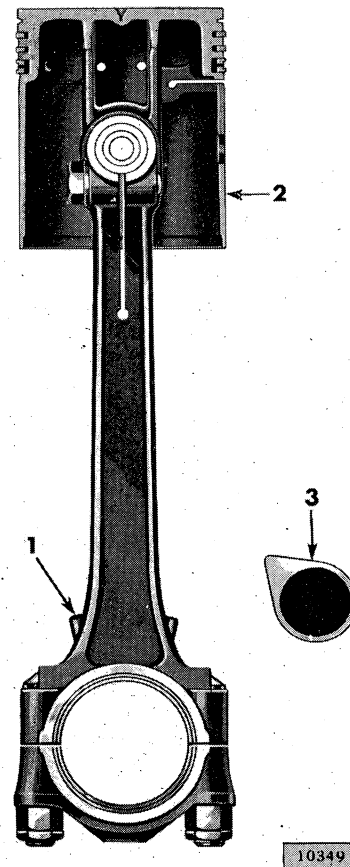


FIG. 38—CONNECTING ROD AND PISTON

1—Oil Spray Hole
2—Piston Skirt T-slot
3—Relative Position of Camshaft

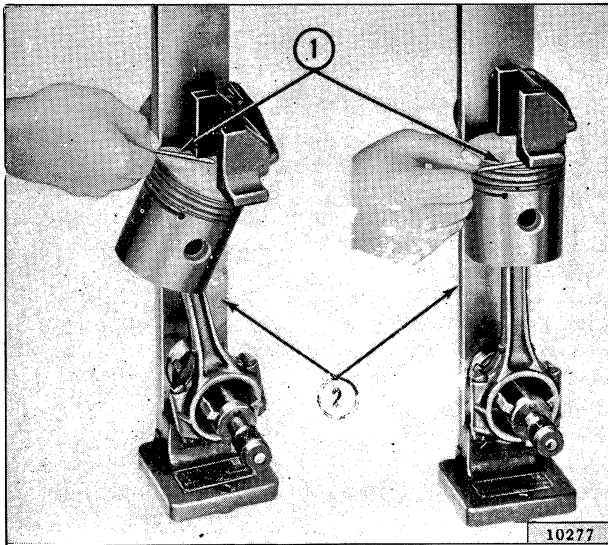


FIG. 39—CHECKING PISTON AND CONNECTING ROD ALIGNMENT

1—Feeler Gauge
2—Fixture

piston pin lock screw and torque 35 to 41 lb-ft. [4,8 a 5,7 kg-m.].

d. Place piston and rod assembly in a connecting rod aligning fixture and check alignment of the assembly as shown in Fig. 39. Follow instructions furnished with the fixture.

e. Using a feeler gauge and new piston rings, check the width of the two companion ring grooves and the oil ring groove. Replace the piston if the widths of the grooves are not within the limits given in the specifications.

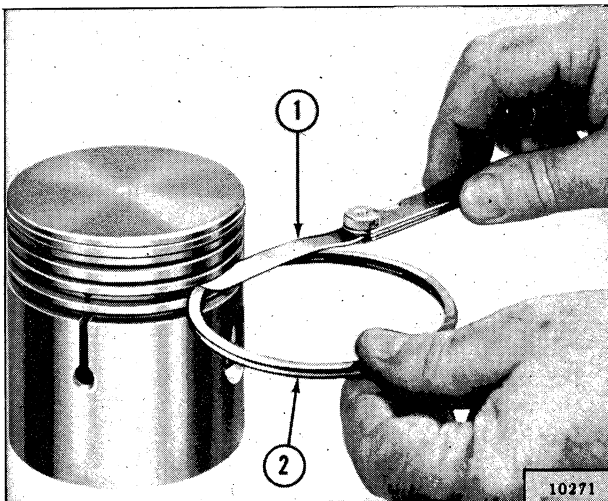


FIG. 40—CHECKING PISTON RING SIDE CLEARANCE

1—Feeler Gauge
2—Piston Ring

Insert feeler gauge between ring and piston to back of groove. Replace piston if ring grooves are not within allowable tolerances. If a feeler gauge larger

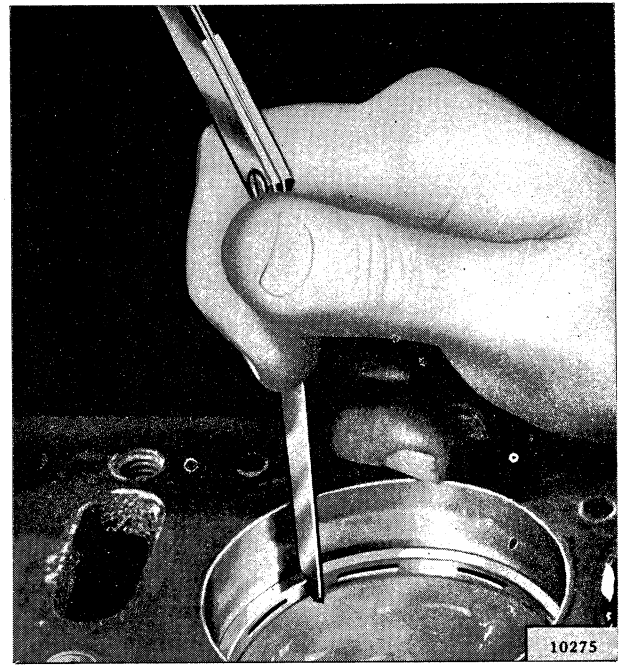


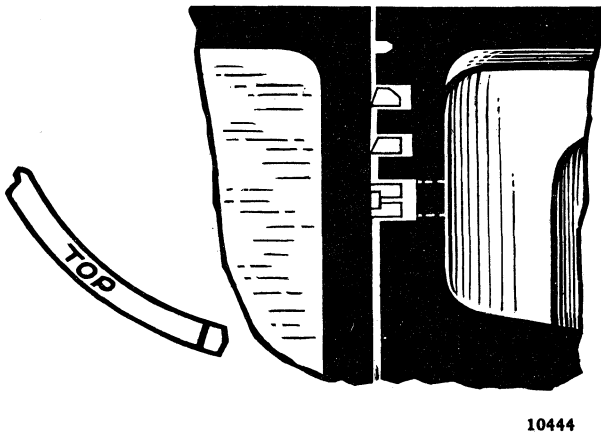
FIG. 41—PISTON RING GAP

than .006" [0,152 mm.] can be inserted $\frac{1}{16}$ " [1,6 mm.] between piston and upper compression ring, groove is worn excessively bell-mouthed and piston should be replaced.

f. Check piston ring end gap by placing compression ring in cylinder bore below ring travel using head of an inverted piston as a plunger to push ring in squarely. End gap must be as shown in Par. D-34 for all rings. If less, file ends to obtain minimum gap. With cylinders bored to an exact ring oversize of +.020", +.030", or +.040" [0,508-0,762-1,016 mm.] the proper end clearance as indicated in Par. D-34 will result. If end gaps are not within the limits given, rings are of the wrong size or were incorrectly filed for fitting.

g. Install a new ring set using either production replacement rings or service type oil control rings. Production type replacement piston rings are the same as the original factory-installed rings while service oil control ring sets have different components, notably the oil ring expander. Follow instructions of manufacturer for proper installation. Use a piston ring expander to install rings on pistons. Do not expand rings more than necessary to install, also be careful not to burr the piston with ends of rings. Install bottom (oil) ring first, center ring second, and top ring last.

The width of the compression rings is $\frac{3}{32}$ " [2,38 mm.] and that of the oil control ring is $\frac{3}{16}$ " [4,78 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. 42. The upper compression ring has an inside beveled edge which must be installed toward the piston top. The face of the lower compression ring is tapered approximately .001" [0,03 mm.].



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FIG. 42—PISTON RING INSTALLATION

The letters **T** or **TOP** on the upper edge indicate how the ring is to be installed.

D-34. Piston Ring Application Chart

Cylinder Bore Oversize	Correct Ring Size	Ring Gap Fitting	End Gap
Std. to .009" [a 0,483 mm.]	Std.	None	.007" to .045" [0,1778 a 1,1430 mm.]
.010" to .019" [0,254 a 0,4826 mm.]	-.020"	File fit	.007" to .017" [0,1778 a 0,4318 mm.]
.020" to .024" [0,508 a 0,6096 mm.]	-.020"	None	.007" to .029" [0,1778 a 0,7366 mm.]
.025" to .029" [0,635 a 0,7366 mm.]	-.030"	File fit	.007" to .017"
.030" to .034" [0,762 a 0,8636 mm.]	-.030"	None	.007" to .029"
.035" to .039" [0,8890 a 0,9906 mm.]	-.040"	File fit	.007" to .017"
.040" [1,016 mm.]	-.040"	None	.007" to .017"

D-35. Crankshaft

The crankshaft is machined from a heat-treated carbon steel forging and is carefully balanced both dynamically and statically. The crankshaft is supported by three replaceable main bearings. The front main bearing is flanged to take the end thrust of the crankshaft. A flanged section on the rear of the crankshaft acts as an oil slinger. While the crankshaft is out of the engine, handle it carefully to prevent damage to the connecting rod crankpins and the main bearing journals. See Fig. 43.

D-36. Crankshaft Inspection and Repair

Clean out the drilled oil passages in the crankshaft journals with a small rifle brush making sure to get rid of all sludge or gum deposits. Blow out the passages with compressed air after cleaning. Clean the crankshaft thoroughly with a suitable cleaning solvent. Inspect the crankshaft for cracks, alignment, and condition of the crankpins and the main bearing journals. Use magnaflux equipment, if available, to check for cracks or structural flaws. Cracks, misalignment, and scored or worn journals and crankpins necessitate crankshaft repair or replacement.

Check crankshaft counterweights to be sure they are not loose.

D-37. Checking Crankshaft Alignment

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

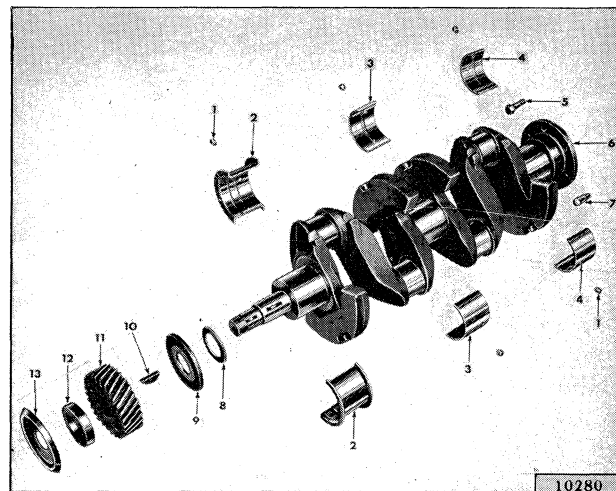


FIG. 43—CRANKSHAFT AND BEARINGS

- 1—Bearing Dowel
- 2—Front Bearing
- 3—Center Bearing
- 4—Rear Bearing
- 5—Flywheel Bolt
- 6—Crankshaft
- 7—Flywheel Dowel-Bolt
- 8—Crankshaft Shim
- 9—Thrust Washer
- 10—Woodruff Key No. 9
- 11—Crankshaft Gear
- 12—Gear Spacer
- 13—Oil Slinger

D-38. Checking Main Bearing Journals

An ordinary 3" [7,62 cm.] micrometer may be used. The standard journal diameter is 2.3341" to 2.3331" [5,9286 a 5,9261 cm.] for all main bearings. Allowable taper or out-of-round of the journals is .001" [0,025 mm.].

D-39. Checking Connecting Rod Crankpins

Check the crankpin diameters with a micrometer to ensure that they are not out-of-round or tapered more than .001" [0,025 mm.] The standard crankpin diameter is 1.9383" to 1.9375" [4,9233 a 4,9213 cm.].

D-40. Crankshaft Pilot Bushing

Inspect the crankshaft pilot bushing in the flywheel end of the crankshaft. To remove the bushing use a clutch shaft pilot bushing remover. Fig. 183 and 184. The pilot bushing is installed with a driver and then burnished with a clutch shaft pilot bushing burnisher.

D-41. Crankshaft Main Bearings

The crankshaft rotates on three main bearings with a running clearance of .0003" to .0029" [.0008 a .0074 mm.]. These bearings are positioned and prevented from rotating in their supports in the cylinder block by dowel pins. Dowel pins are used in both the center and the rear bearing caps. No dowel pins are used in the front bearing cap because the bearing has a flange. The front main bearing takes the end thrust of the crankshaft. The main bearings are of premium type which provides long bearing life. They are replaceable and when correctly installed, provide proper clearance without filing, boring, scraping, or shimming. Crankshaft bearings can be removed from this engine only with the engine out of the vehicle. Crankshaft bearings must be replaced as a complete set of three bearings, each bearing consisting of two halves. Main bearings are available in the standard size and the following undersizes:

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

The .001" and .002" undersize main bearings are for use with standard size crankshafts having slightly worn journals. The .010", .020", and .030" undersize bearings are for use with undersize crankshafts in those sizes. The .012" undersize bearings are for use with .010" undersize crankshafts having slightly worn journals. Bearing sizes are rubber stamped on the reverse side of each bearing half.

D-42. Crankshaft Main Bearing Inspection

The crankshaft journals must be carefully inspected as detailed previously in Par. D-38. Worn journals will require undersize bearings. Scored, flaked, or worn bearings must be replaced. Measure the main bearing bores in the cylinder block using a telescope gauge and micrometer. Measure the bores at right angles to the split line and at 45° to the split line. The bores should not be over .001" [0,025 mm.] out-of-round or .001" in taper from end to end. Also, the bores should not be more than .001" oversize, considering the average diameter of the bore.

D-43. Fitting Crankshaft Main Bearings

Fit the crankshaft main bearings using either "Plastigage" or shim stock. Refer to the instructions in Section E for "Plastigage" (Par. E-46) or shim stock (Par. E-47).

D-44. Connecting Rod Bearings

The connecting rod bearings, like the crankshaft main bearings, are of the replaceable type. When correctly installed, the bearings provide proper clearance without filing, boring, scraping, or shimming.

Main bearings with maximum wearing surfaces are obtained through the use of offset connecting rods. When the rods are installed, the offset "A" in Fig. 44 is placed away from the nearest main bearing "B".

The oil spray hole should be on the "follow" side

or away from the camshaft, toward the right side of the vehicle. Because of the offset and oil spray hole, No. 1 and 2 or No. 3 and 4 connecting rods 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.

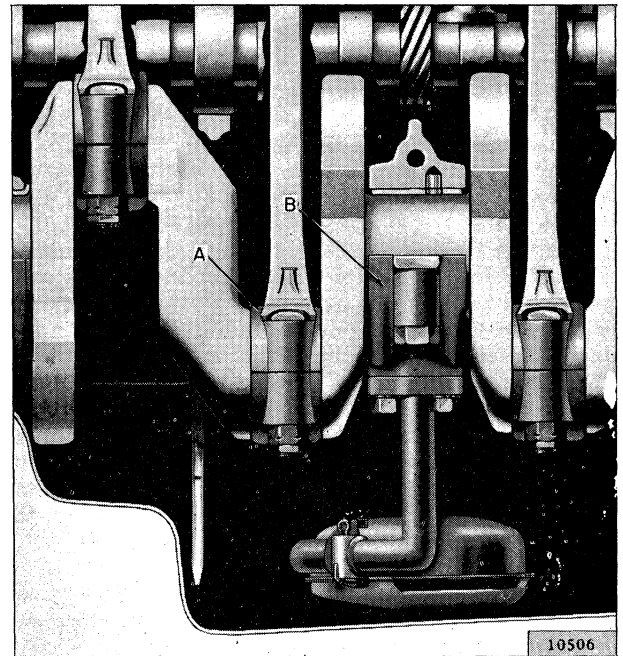


FIG. 44—CONNECTING ROD OFFSET

Connecting rod bearings should be replaced as a complete set. Each bearing consists of two halves. Connecting rod bearing sets are available in standard size and the following undersize:

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

The .001" and .002" undersize bearings are for use with standard size crankshafts having slightly worn crankpins that do not require grinding. The .012" undersize bearings are for use with slightly worn crankshafts that have been previously ground for .010" undersize bearings.

Should it be necessary to replace the bearings due to wear, replacement of piston rings and piston pins is also recommended.

D-45. Connecting Rod Bearing Inspection

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 crankpins must be carefully inspected as detailed previously in Par. D-38. Worn crankpins will require undersize bearings. Scored, flaked, or worn bearings must be replaced.

D-46. Installing Connecting Rod Bearings

New bearings must be installed so that the oil spray hole in the upper bearing half aligns with the oil spray hole in the connecting rod. Each bearing cap must be installed to seat evenly on the

connecting rod from which it was removed, and in the same position. After wiping and carefully inspecting the bearing bore in the connecting rod, install the proper bearing. 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" to .0019" [0,025 a 0,048 mm.]. With a dimension in excess of this standard running fit, a satisfactory bearing replacement cannot be made and it will be necessary to regrind the crankshaft. 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 the recommended torque of 35 to 45 lb-ft. [4,8 a 6,2 kg-m.] is reached. If the bearings are of the correct size, and have been properly lubricated with light engine oil before installation, the connecting rod should be easy to slide 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 "Plasti-gage" or shim stock of the proper size to measure .0010" to .0019" [0,025 a 0,0483 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. E-46 or E-47. Connecting rod bearings are fitted to the same clearance as the main bearings but the torque specified for connecting rod cap bolts is different.

NOTE: Should it be necessary to replace a scored or burned No. 1 connecting rod bearing, see Par. D-84 regarding timing gear oil jet.

D-47. Connecting Rod Side Play

Check the connecting rod side play with a feeler gauge as shown in Fig. 45. The side clearance is .004" to .010" [0,1016 a 0,254 mm.].

D-48. Camshaft and Bearings

The camshaft is supported at four points in the cylinder block. The front is supported in a replaceable, steel-shell, babbitt-lined bearing. The bearing is pressed into place. The other three bearing surfaces are precision machined in the cylinder block. The camshaft bearings are pressure lubricated through drilled passages in the crankcase. End thrust of the camshaft is taken by a thrust plate bolted to the crankcase. The camshaft is driven by a silent helical-cut tooth timing gear at the front of the engine. A worm gear, integral with the camshaft, drives the oil pump and distributor.

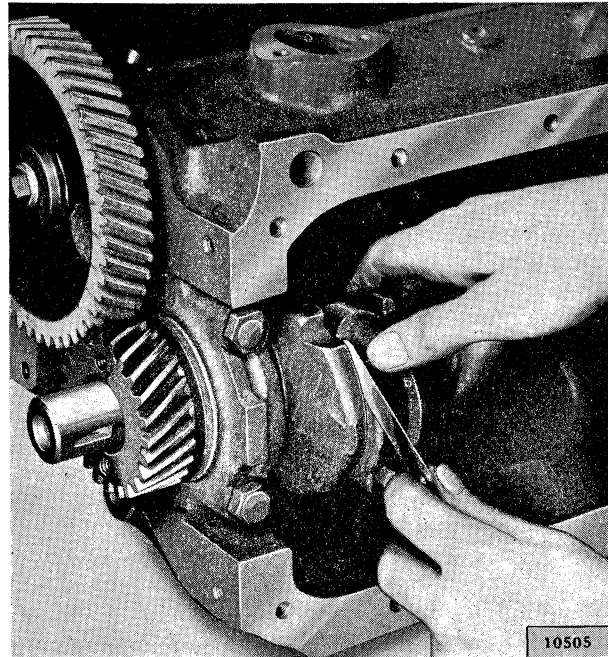


FIG. 45—CONNECTING ROD SIDE PLAY

The fuel pump is actuated by an eccentric forged onto the camshaft.

Clean the camshaft thoroughly in cleaning solvent. Inspect all camshaft bearing surfaces to determine if they are scored or rough. The cam faces must be perfectly smooth throughout their contact face and must not be scored or worn.

D-49. Camshaft Front Bearing Replacement

Use a suitable driver to remove the camshaft front bearing from the cylinder block. To install a new bearing, align the oil hole in the bearing with the bored oil hole in the cylinder block and drive the bearing in until the front end of the bearing is flush with the front surface of the cylinder block. Make sure the oil hole is open and clear. It is not necessary to line-ream the bearing after installation because bearings for replacement are precision reamed to the finished size.

D-50. Camshaft End Play

End play of the camshaft is determined by running clearance between the rear face of the camshaft gear and the thrust plate and is established by the spacer thickness. The standard clearance is .004" to .007" [0,102 a 0,178 mm.] and can be measured by a dial indicator. As a general rule this clearance will change but little through wear or when a new gear is installed. To predetermine the correct end float with the gear, spacer, and thrust plate removed, measure the thickness of both the thrust plate and spacer with a micrometer. The thickness of the spacer should be approximately .006" [0,152 mm.] greater than that of the thrust plate. When this is correct and the parts are assembled and drawn tightly together by the gear retaining screw, the end play should come within standard limits.

D-51. Timing Gears (or Chain) and Cover

The timing gears (or chain) are mounted at the front of the engine. The silent type chain used on the earlier engines is nonadjustable. Lubrication is positive through drilled passages in the crankshaft and sprocket from the front main bearing. Oil passages should be checked whenever the chain or sprockets are removed to make sure they are clear.

Later engines are equipped with helical cut timing gears; a steel gear on the crankshaft and a pressed fiber gear on the camshaft. The gears are keyed to their respective shafts. The camshaft driven gear is secured on the front end of the camshaft by means of a capscrew and a plain washer. The crankshaft drive gear is secured on the front end of the crankshaft by a nut threaded onto the front end of the crankshaft holding the crankshaft pulley, crankshaft oil slinger, and the crankshaft drive gear spacer. The timing gears are lubricated through a jet threaded into the crankcase directly above the gear contact and oil supplied through a drilled passage from the front main bearing. The timing gears are enclosed by the sealed timing cover. The oil seal in the cover bears against the hub of the crankshaft pulley. Timing gears are accessible for inspection or replacement with the engine installed in the vehicle after removing the radiator, belt drive pulley, and timing cover.

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 (lash) of both gears. It is also advisable to check both the oil jet and oil passage to the crankshaft front bearing to be sure that they are clear.

D-52. Inspection and Repair

Check the general condition of both gears and inspect for evidence of excessive wear. Replace excessively worn or damaged gears. Inspect the cover and replace if bent or damaged. It is recommended that the crankshaft oil seal in the cover be replaced when the cover is removed to ensure a good seal around the crankshaft. To replace this seal with the engine in the vehicle requires removing the radiator and water pump.

D-53. Valves, Springs, and Guides

The valves seat on top of the cylinder block with the stems extending down through replaceable valve guides. The valves are actuated by the camshaft through valve tappets. The valve springs are assembled and locked on the lower end of the valve stems. The retaining locks are the split type, which fit in a recess on the valve stems and into the taper in the valve spring retainers. Adjustment of valves is by means of the adjusting screw threaded into the upper end of the valve tappets.

D-54. Inspection of Valves, Springs, and Guides

Clean the valves on a wire wheel, making sure that all carbon is removed from the top and the under-

side of the heads and that all gum and varnish deposits are removed from the stems.

Polish the valve stems with steel wool or crocus cloth. Visually inspect all valves for warpage, cracks, or excessive burning and discard if one of these conditions exists. Replace any worn, pitted, or corroded valves that cannot be cleaned with a wire brush. Replace any valves when seats are pitted, burned, or corroded so badly that they cannot be cleaned up with a light refacing on a valve refacing machine.

Replace valves with marks of scoring or abrasion visible on the stem. Replace any valves with bent stems which will be apparent when the valve is

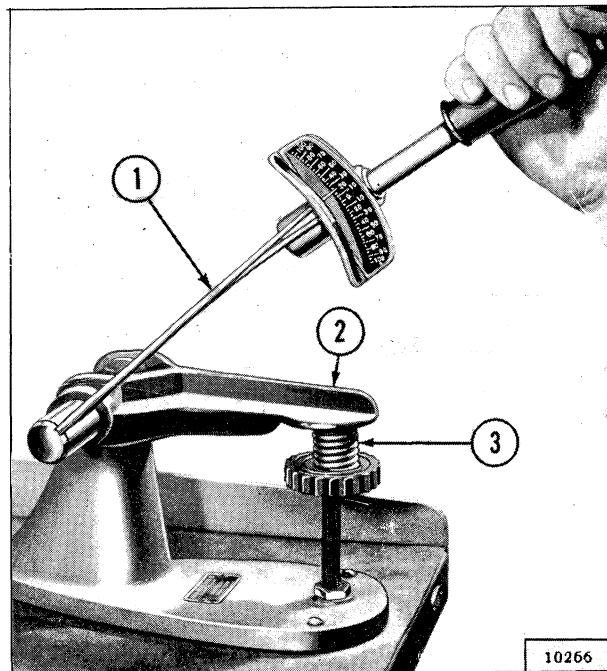


FIG. 46—TESTING VALVE SPRING

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

mounted in the valve refacing machine. Check the diameter of the valve stem at two or three places along the length of the stem with a micrometer. The intake valve stem diameter is .373" to .37225" [9,474 a 9,45515 mm.]. The exhaust valve stem diameter is .371" to .372" [9,423 a 9,449 mm.]. The specified valve stem-to-guide clearance is .0015" to .00325" [0,038 a 0,083 mm.] for the intake valves and .0025" to .0045" [0,0635 a 0,1143 mm.] for the exhaust valves.

Wash the valve springs thoroughly in solvent. Visually examine the springs and replace any that are deformed or obviously damaged. Examine for corrosion from moisture or acid etching which might develop into surface cracks and cause failure. Standard over all length of the springs is 2½" [63,5 mm.]. If possible, check each valve spring in a valve spring checking fixture as shown in Fig. 46. If the valve spring tension registers less than 47 lb. [21,3 kg.] when the spring is compressed to 2⅞" [54 mm.] or 110 lb. [49,9 kg.] when the spring is compressed to 1¾" [44 mm.], replace the spring.

NOTE: When using a spring checking fixture as shown in Fig. 46, it is necessary to convert the torque wrench reading which is in pounds-feet to the static pound pressure specified above according to the instructions furnished with the wrench. For example, should the torque wrench reading be 50 lb-ft. and the wrench is two feet long the static pressure of the spring will be 50×2 or 100 lbs.

Clean the valve guides with a standard valve guide cleaner or a wire brush. Check the valve guides in the cylinder block. Replace valve guides which are broken or worn enough to cause excessive valve stem-to-guide clearance. See Par. D-58.

Standard intake valve clearance is .0015 to .00325" [0,038 a 0,083 mm.] and the exhaust valve clearance is .0025" to .0045" [0,0635 a 0,1143 mm.]. Excessive clearance between the valve stems and guides will cause improper seating and burned valves. When there is a tendency to draw oil vapor through the guide 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. Check the clearance with a suitably mounted dial indicator or 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.

D-55. Refacing Valves

Reface the valves with a valve refacer. The valve refacer manufacturer's instructions should be fol-

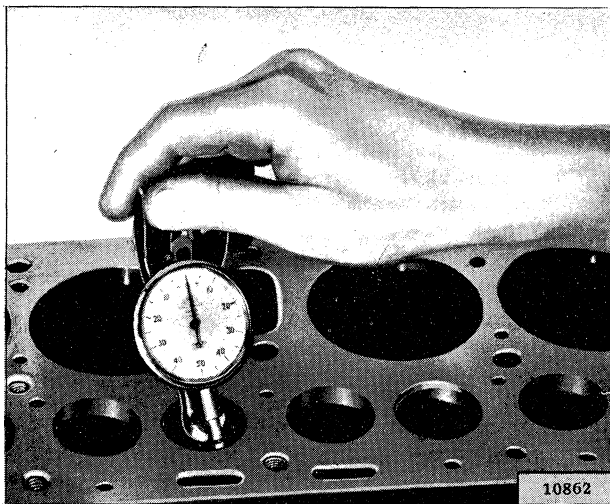


FIG. 47—GAUGING VALVE SEATS

lowed carefully to ensure a valve face concentric with the valve stem. Reface both intake and exhaust valves to an angle of 45°. Take off only the minimum of metal required to clean up the valve faces.

If the thickness of the edge of the valve head is reduced to less than $\frac{1}{32}$ " [0,8 mm.] replace the valve.

NOTE: Cocked or deformed valve springs or improperly installed or missing locks, can be responsible for valve problems.

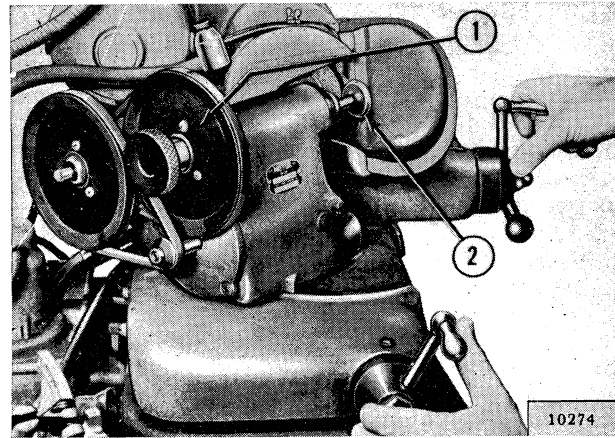


FIG. 48—REFACING VALVES

1—Valve Refacer
2—Valve

D-56. Valve Seat Inspection and Refacing

Inspect the valve seats for cracks, burns, pitting, ridges, or improper angle. 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. Note that later engines have hardened exhaust valve seat inserts.

When necessary to reface the valve seats, use a valve seat grinder in accordance with the grinder manufacturer's instructions. Any grinding of valve seats should be preceded by touching up the grinding stone so that their angles are accurate and the stone is not clogged. Grind each valve seat to a true 45° angle. Never grind any more than is necessary to clean up pits, grooves, or to correct the valve seat runout. Check the valve seats with a dial indicator as shown in Fig. 47 after refacing. The valve seat should not be out of round more than .002" [0,051 mm.]. A simple check can be made in the absence of a dial indicator by spreading a thin coat of pencil lead or bearing-fitting blue on the valve face and then inserting the valve into the valve seat. With hand pressure, rotate the valve a quarter turn and then remove the valve and observe the transfer of blue (or pencil lead) to the valve seat. An uneven transfer will indicate an inaccurate valve and valve seat refacing operation. After the seat is ground, check its width with a seat width scale or a steel scale placed across the face of the seat. The valve seat width after refacing should measure $\frac{3}{32}$ " [2,3 mm.] and not wider than $\frac{1}{8}$ " [3,2 mm.]. Valve seat width is vital. Too wide a seat can cause seat burning as it tends to trap and hold carbon particles. Seats that are too narrow will not transfer heat to the coolant rapidly enough to keep the valves in proper operating condition. 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. Narrow the seat without changing its position in relation to the valve face by using a valve seat relief counterbore above the seat and a valve seat narrowing cutter below the seat. These operations are performed only after the valve seats

have been refaced and then only when necessary. The finished valve seat should contact the approximate center of the valve face. Check by applying an extremely thin coat of pencil lead or bearing-fitting blue to the seat. Then install and rotate the valve with light pressure. Blue (or pencil marks) will transfer to the face of the valve. If the blue is near the top edge of the valve face, lower the valve seat by using the valve seat relief counter-bore. If the blue is transferred to the bottom edge of the valve face, raise the seat by using the valve seat narrowing cutter.

When the valve seat can no longer be corrected, it is advisable to investigate installing seat inserts.

NOTE: The insert should be sufficiently cooled to permit installation with light taps; excessive driving of the insert may cock it in the counterbore or crack the insert.

D-57. Exhaust Valve Seat Insert Replacement

Hardened valve seat inserts for exhaust valves were installed in production beginning with engine S/N 3J-161344 (For CJ-2A, beginning with replacement engine S/N RJ-297362). They will seldom 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 a driver that will keep the insert in true alignment with the bore. Cool the insert and the installing tool with dry ice for 30 minutes. Make certain the valve seat is facing out. Drive in the insert with the tool until it bottoms in the counterbore. After installation, grind the valve seat at an angle of 45° and then check with a dial indicator as shown in Fig. 47.

D-58. Valve Guide Replacement

Damaged, loose, or worn valve guides must be replaced.

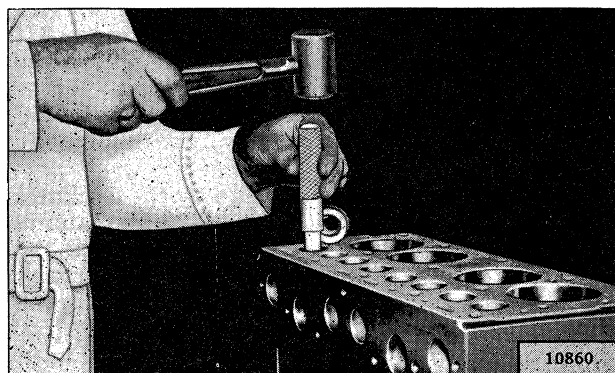


FIG. 49—REPLACING VALVE GUIDES

Should it be necessary to replace the guides, this installation can best be made by using Valve Guide Driver tool W-238 as shown in Fig. 49. The old guides are removed by driving them through the block into the valve compartment. If this driver is not available a suitable puller can be made from a piece of 2" [50,8 mm.] pipe, 6" [152,4 mm.] long and

$\frac{3}{8}$ " [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 $\frac{3}{8}$ " [9,525 mm.] hole in it.

When replacing the guides maximum engine performance can only be secured when the top of the exhaust guide is positioned 1" [2,54 cm.] and that of the intake $1\frac{5}{16}$ " [3,33 cm.] below the top face of the cylinder block as shown in Fig. 50. The Valve Guide Driver shown in Fig. 49 is equipped with adapter rings which act as stops to correctly locate the guides.

Should the standard driver be unavailable a substitute may be made from a piece of $\frac{1}{2}$ " [12,7 mm.] round steel 6" [15 cm.] long. Turn down one end to $\frac{3}{8}$ " [9,5 mm.] in diameter for a distance of 2" [50,8 mm.] to form a pilot and shoulder. Should this type driver be used it will be necessary to measure to correctly locate the guides.

Run a reamer (Tool C-38) through the new guides after they have been correctly positioned.

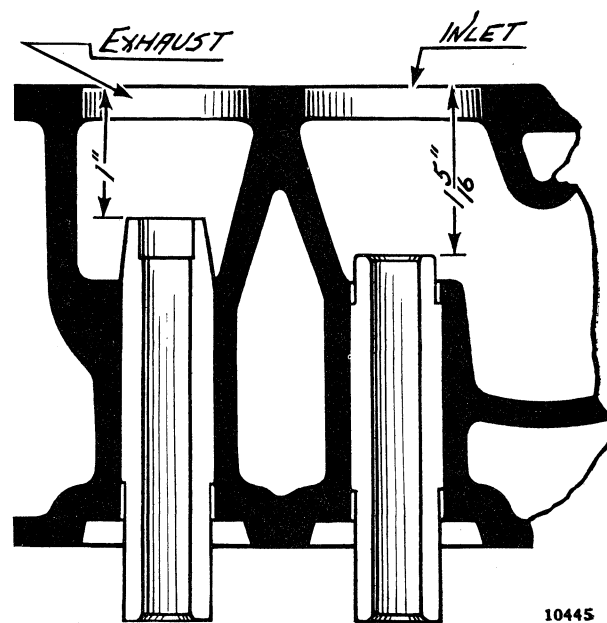


FIG. 50—POSITION OF VALVE GUIDES

D-59. Tappets and Cover

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

Check the threads and fit of the valve adjusting screw in the valve tappets. The fit of a screw should be such that a wrench is required to turn it into or out of the tappet as these are of the self-locking type. Replace the worn part, either the screw or the tappet, or both, if there is looseness between the parts.

D-60. 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.

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

- 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 .0029" [0,0736].
- 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 $\frac{1}{4}$ " [6 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 the crankcase.

D-61. Floating Oil Intake

The floating oil intake is attached to the bottom of the crankcase with two screws. The float and screen causes it to ride, raise and lower with the amount of oil in the pan. This prevents water or dirt, which may have accumulated in the bottom of the oil pan, from circulating through the engine because the oil is drawn horizontally from the top surface. Whenever removed, the float, screen, and tube should be cleaned thoroughly to remove 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 is flat. Clean both the flange and the crankcase surfaces thoroughly before installing a new gasket. Be sure the retaining screws are tight.

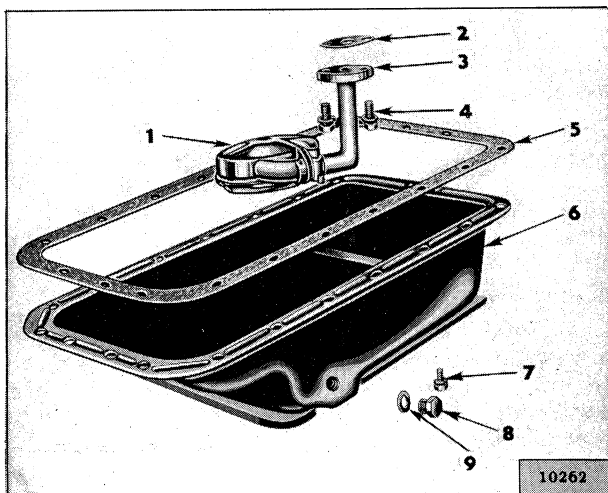


FIG. 51—FLOATING OIL INTAKE AND PAN

- 1—Oil Float
- 2—Gasket
- 3—Oil Float Support
- 4—Screw and Lockwasher
- 5—Oil Pan Gasket
- 6—Oil Pan
- 7—Bolt and Lockwasher
- 8—Drain Plug
- 9—Drain Plug Gasket

D-62. Oil Pump

The oil pump is located externally on the left side of the engine. In operation oil is drawn from the crankcase through the floating oil intake 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 distributor rotor 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 key on the distributor shaft with the pump shaft slot, without changing the position of the distributor rotor. Distributor can be installed only in one position as the slot and driving key are machined off-center.

Effective with engine S/N 44417 a different oil pump was installed in production. The early production pump shown in Fig. 53 and the later production pump shown in Fig. 52 are similar in design. The major differences are that the later pump employs an inner and outer rotor within the pump body in place of gears and that the oil relief valve is mounted on the pump body instead of on the cover. To disassemble the later type of pump, first remove the gear which is retained by a gear retaining pin. It will be necessary to file off one end of the pin before driving it out with a small drift. By removing the cover, the outer rotor and the inner rotor and shaft may be removed through the cover opening.

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

Match the rotors together with one lobe of the inner rotor pushed as far as possible into a notch of the outer rotor. Measure the clearance between the lobes of the rotors as shown in Fig. 54. This clearance should be .010" [0,254 mm.] or less. If more, replace both rotors. Measure the clearance between the outer rotor and the pump body as shown in Fig. 55. Should this clearance exceed .012" [0,305 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 that can be only slightly compressed. Check the cover to be sure the inner surface is not rough or scored and that it is flat within .001" [0,025 mm.]. Measure with feeler gauges as shown in Fig. 56. Measure the thickness of the rotors which must be within .001" of each other. Assemble the rotors in the pump body and install the cover without its 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. The rotors should then rotate freely, proving that end float of the rotors is less than the thickness of the gasket when compressed or .004" [0,102 mm.].

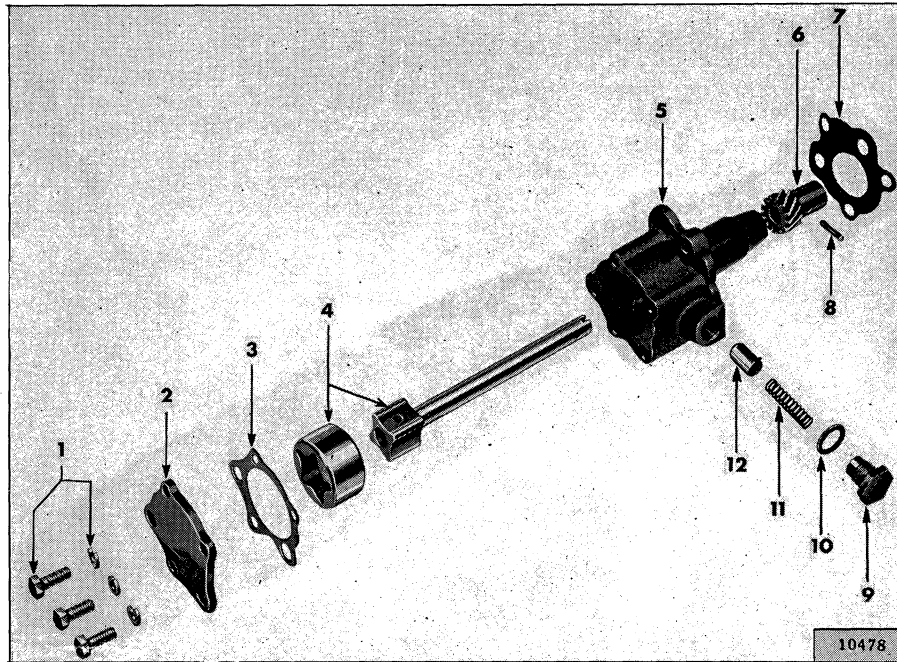


FIG. 52—OIL PUMP — LATE TYPE

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

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" [0,0762 a 0,254 mm.].

The early production pump is disassembled in the same manner as the later pump. Standard end play of the rotor gear is .002" to .005" [0,0508 a 0,127 mm.]. End float of the pump shaft is .002" to .004" [0,0508 a 0,1016 mm.] which is secured by selection of parts or installing an extra cover gasket. After being reinstalled, the pump should be primed before starting the engine. Remove the cover plug and fill the pump housing with oil of the same grade used in the engine. Replace the cover plug.

Maximum pressure of both pumps is controlled by a similar oil relief valve. The oil pressure relief spring is calibrated. Never stretch this spring to alter the relief valve pressure setting. Adjust pressure setting by the use of shims only. Shims are available that can be added between the retainer

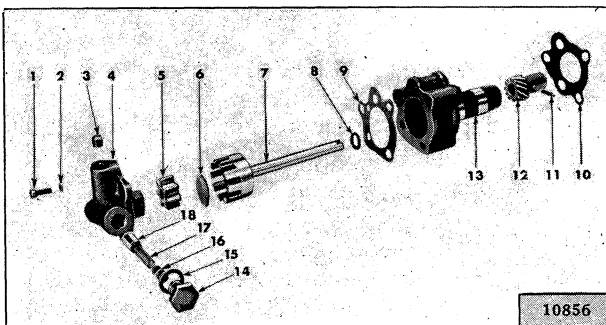


FIG. 53—OIL PUMP — EARLY TYPE

- | | |
|------------------------------|--------------------------------------|
| 1—Cover to Body Screw | 11—Driven Gear Pin |
| 2—Cover to Body Screw Gasket | 12—Driven Gear |
| 3—Cover Plug | 13—Oil Pump Body |
| 4—Cover | 14—Oil Relief Spring Retainer |
| 5—Pinion | 15—Oil Relief Spring Retainer Gasket |
| 6—Rotor Disc | 16—Relief Spring Shims |
| 7—Shaft Assembly | 17—Relief Plunger Spring |
| 8—Shaft Gasket | 18—Relief Plunger |
| 9—Cover Gasket | |
| 10—Oil Pump to Block Gasket | |

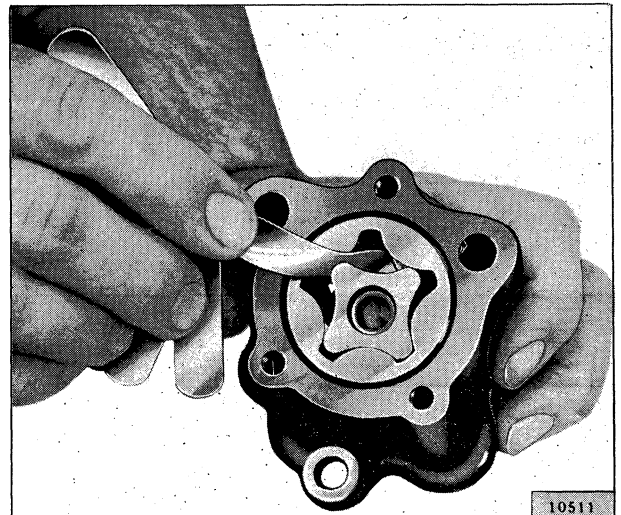


FIG. 54—CHECKING OIL PUMP ROTORS

and the spring to increase pressure. When shims are present, removing shims will decrease pressure. This adjustment will change the pressure at higher speeds but not at idle speed.

Safe minimum pressure is 6 lb. [0,421 kg-cm²] at idle, at which point the oil pressure light goes out

on later models, and 20 lb. [1,406 kg-cm²] at 2000 rpm. (32 mph. [51 kph.]).

NOTE: Safe minimum pressure of the earlier type pump is 10 psi. [0,7 kg-cm²] at idle speed. Normal gauge reading will be 50 at 30 mph. [48 km-hr.]

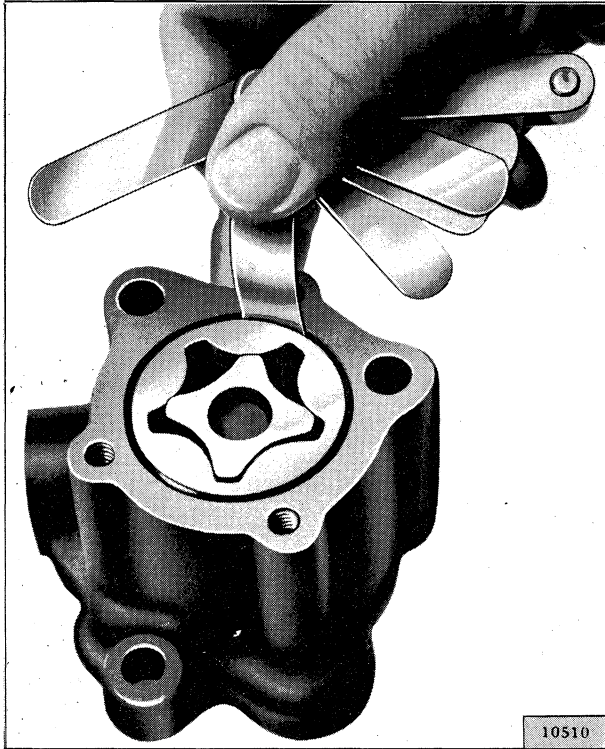


FIG. 55—CHECKING OUTER ROTOR TO OIL PUMP BODY

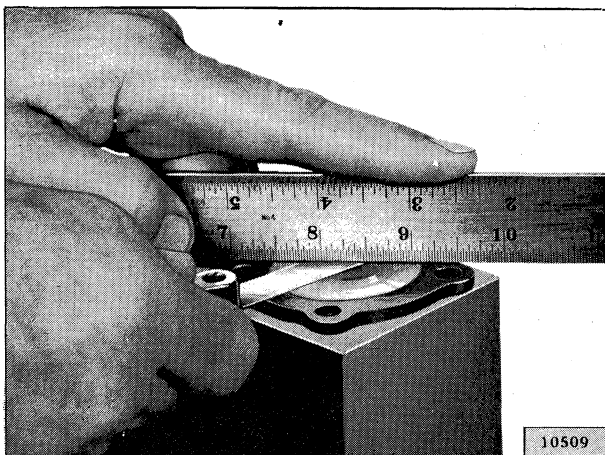


FIG. 56—CHECKING OIL PUMP COVER

D-63. Oil Pan

Examine the oil pan carefully for evidence of corrosion, dents, or other damage. Special attention should be given to the mounting flange to be sure of proper alignment and a tight seal at the cylinder block, oil pan, and engine front plate. Whenever the oil pan is removed, it is best to install a new oil pan gasket.

D-64. Flywheel

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

D-65. Flywheel Inspection

Clean the flywheel thoroughly with cleaning solvent. Inspect the clutch face of the flywheel for a burned or scuffed condition or rivet grooves. Check the flywheel for run-out or improper mounting according to the installation procedure given in Par. D-79.

If the inner ends of the flywheel ring gear teeth are only slightly burred or snubbed, remove the burrs and reshape the teeth using a small emery wheel. If, however, the teeth are broken, cracked, or seriously burred, the ring gear should be replaced.

D-66. Ring Gear Replacement

The ring gear is secured on the flywheel by a shrink fit. Before starting the operation of replacing the ring gear, place the new ring gear against the old gear to make certain both have the same number of teeth.

To remove the ring gear from the flywheel, drill a $\frac{3}{8}$ " [9,5 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 a range of 650°F. to 700°F. [343°C. a 371°C.] and place it on the cold flywheel, making certain that the chamfer on the teeth is on the crankshaft 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. Do not quench the ring gear; allow it to slowly air cool.

D-67. Flywheel Housing

The flywheel housing, which encloses the flywheel and clutch is bolted to the engine rear plate and cylinder block. 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 engine rear end plate without evidence of warpage. The rear face must be parallel to the front face. Improper alignment may cause transmission gear disengagement. In addition, the opening in the rear of the housing, which serves as a pilot for the transmission, must be concentric with the crankshaft. The flywheel housing should be checked for alignment after it is installed on the engine.

D-68. Core Hole Expansion Plugs

Any evidence of coolant leakage around any of the core hole expansion plugs will require replacement of the plug. The expansion plug at the rear end of the cylinder block can be driven out with a 24" [60 cm.] length of half-inch bar stock carefully inserted through the camshaft bore in the cylinder

block. The other core hole expansion plugs in the cylinder block can be removed by piercing the center with a sharp tool and prying them out. Before attempting to install a new plug, clean the hole thoroughly. Apply a thin coat of sealer on the new plug and install the plug with a driver.

D-69. Cylinder Head

Be sure that water passages are open and that all carbon is removed. Inspect all tapped openings. Repair any damaged threads or broken studs. Run a tap in the threaded holes to clean up rough or damaged threads. Before using a tap, squirt penetrating oil on the threads. Discard or repair cracked cylinder heads, also those warped $\frac{1}{32}$ " [0,793 mm.] or more over the full length of the head.

D-70. 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 covered in detail are made 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 not be required.

Mount the cylinder block in an engine repair stand. If an engine stand is not available, perform the following assembly operation in a manner designed to protect personnel against an accident and the engine and its parts against damage.

D-71. Install Oil Gallery Plug

Coat plug threads with a suitable sealing compound and install the plugs in the front and rear ends of the oil gallery in the cylinder block and the rear end of the cylinder head.

There is also a pipe plug ($\frac{1}{8}$ " [3,2 mm.] slotted, headless) in the opening in the main oil gallery inside the cylinder block at No. 2 cylinder and another pipe plug ($\frac{1}{8}$ " square-head) in the opening in the oil passage directly below the oil pump intake passage. If these two pipe plugs were removed, make certain they are reinstalled in the locations described above or the counterweight of the crankshaft might strike the projecting head of the square-head plug.

D-72. Install Tappets

Turn the block upside down. Install the valve tappets in the tappet bores in the cylinder block in their original positions. Check the tappet-to-bore fit of each tappet as it is installed in the block. If the stem-to-block clearance of .0005" to .002" [.0013 a .0051 mm.] is exceeded, install a new tappet to fit within this tolerance or ream the bore to accommodate an oversize tappet (available in .004" [.009 mm.] oversize).

D-73. Install Camshaft and Thrust Plate

Lubricate all camshaft bearings and cam surfaces generously with clean, light engine oil. Carefully, so not to damage or score the camshaft front bearing, install the camshaft, locating it properly in the bearings. Do not allow the rear end of the cam-

shaft to strike sharply against the expansion plug installed in the rear end of the bore.

Install the camshaft thrust plate. Slide the thrust plate spacer onto the end of the camshaft with the beveled inner edge of the spacer facing the camshaft. If the same camshaft is being reinstalled, install any shims previously removed. These shims are placed between the camshaft shoulder and the spacer. Torque the thrust plate attaching bolts 20 to 26 lb-ft. [2,8 a 3,6 kg-m.].

End play of the camshaft is determined by running clearance between the rear face of the camshaft gear and the thrust plate. The standard clearance is .004" to .007" [0,102 a 0,178 mm.] as measured by a dial indicator. Should a check show too little end play, place a shim of suitable thickness between the camshaft shoulder and the spacer. Too much end play may be corrected by removing shims or dressing off the spacer a slight amount.

D-74. Install Crankshaft and Bearings

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

NOTE: It is possible to incorrectly install the front main bearing. The bearing is properly installed in the cap with the narrower of the two radial oil grooves toward the front edge of the cap. If this bearing is not properly installed, the oil grooves in the two halves of the bearing will not match at the parting line and premature failure of the bearing will result.

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. Torque the bolts 65 to 75 lb-ft. [9,0 a 10,4 kg-m.] rotating the crankshaft after each bearing cap is tightened.

Early model L4-134 crankshafts had counterweights forged as an integral part of the crankshaft. Later production crankshafts that have separately forged counterweights can be installed in place of the former crankshaft when the following points of possible interference are checked:

a. After installation, turn the crankshaft slowly to determine if it clears the pipe plug in the crankcase main oil line at the rear of the oil pump. Should there be insufficient clearance, either install a new slotted headless plug or grind off and slot the present plug.

b. After installation of the floating oil intake, check to determine that the crankshaft clears the float when the float is in the up position.

c. On gear-driven-camshaft engines, check the clearance of the connecting rod bolt head with the camshaft intake cam for No. 2 cylinder when that cam is pointed toward the crankshaft. If there is interference or very little clearance, grind the bolt head to give about .05" [1,2 mm.] clearance with the cam.

d. Before installing the oil pan, it may be necessary to bend the rear main bearing oil return pipe slightly toward the flywheel to clear the rear

counterweight. Temporarily install the oil pan and then check clearance of the front counterweight and the oil pan front end. Should there be interference, bend the pan forward to obtain clearance.

D-75. Check Crankshaft End-Play

End play 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" [0,102 a 0,152 mm.] which is controlled by .002" [0,051 mm.] shims placed between the thrust washer and the shoulder on the crankshaft. Check the end play with a dial indicator as shown in Fig. 57. If clearance is incorrect, adjustment is made by adding or removing shims.

Install the thrust washer with the beveled inner edge toward the front bearing.

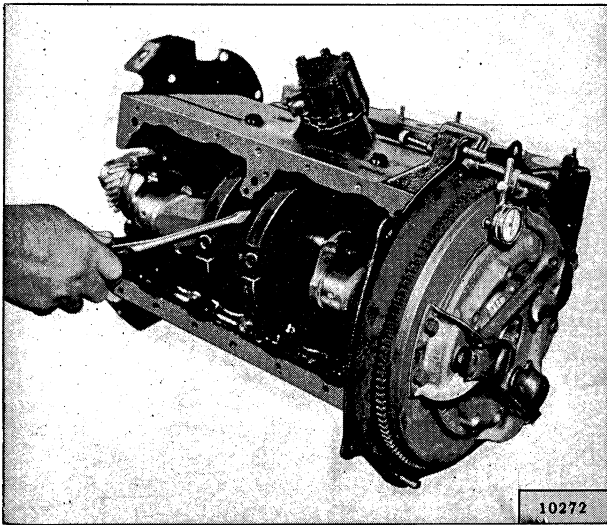


FIG. 57—GAUGING CRANKSHAFT END PLAY

D-76. Install Crankshaft Timing Gear

Install the woodruff key in the longer of the two keyways on the front end of the crankshaft. Install the crankshaft timing gear or sprocket on the front end of the crankshaft with the timing mark facing out, away from the cylinder block. Align the keyway in the gear with the woodruff key and then drive or press the gear or sprocket onto the crankshaft firmly against the thrust washer.

D-77. Install Crankshaft Rear Bearing Seal

On early L4-134 engines the crankshaft rear bearing is sealed by a wick packing. This packing is installed in a groove machined in the crankcase and the rear main bearing cap.

To install a packing in the main bearing cap, insert the packing in the groove with the fingers. Then with a round piece of wood or steel, roll the packing into the groove as shown in Fig. 59. When rolling the packing, start at one end and roll the packing to the center of the groove. Then start from the other end and again roll toward the center. This procedure will ensure that the packing is firmly pressed into the bottom of the groove.

The small portion of the packing which protrudes above the surface of the cap at each end should be cut off flush with the cap.

To install a new wick packing in the crankcase, the engine must be removed and the crankshaft taken out.

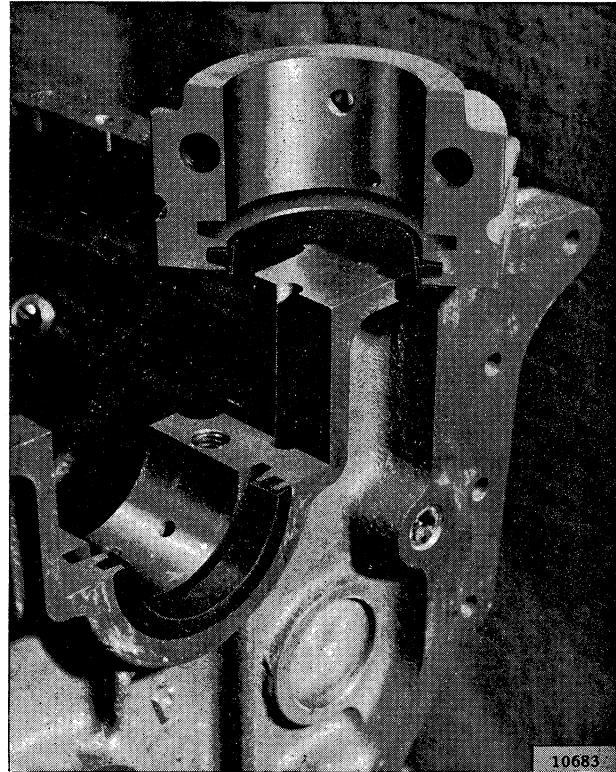


FIG. 58—STEEL-BACKED LIP SEAL INSTALLED

On later L4-134 engines a steel-backed lip seal is used in production. See Fig. 58. This new seal can be used in place of the wick seal and can be installed in the crankcase without removing the crankshaft. Apply a film of light cup grease when installing seal to aid in installation and to provide initial lubrication.

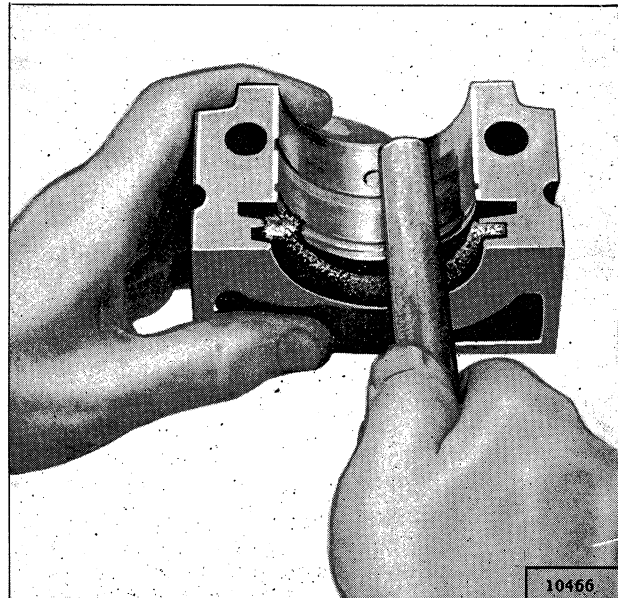


FIG. 59—REAR MAIN BEARING PACKING

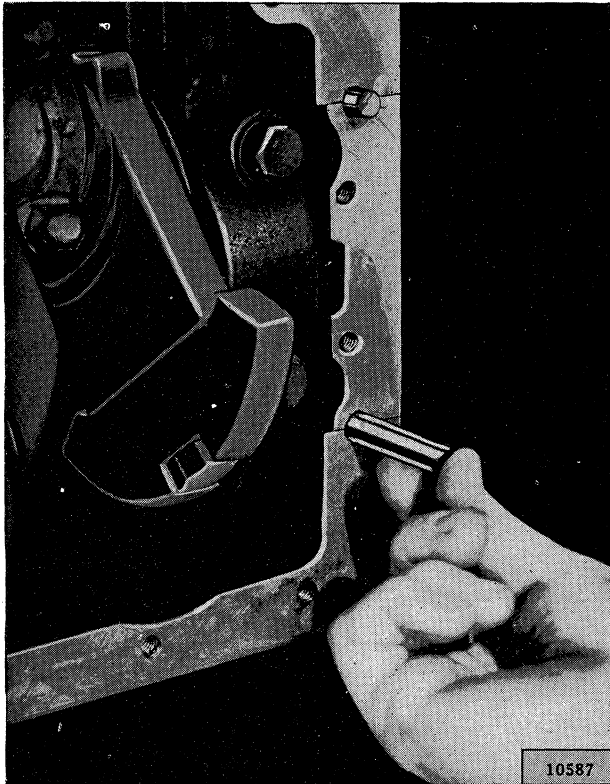


FIG. 60—REAR BEARING CAP PACKING

When installing the rear main bearing cap in the crankcase, place a small amount of plastic-type gasket cement on both sides and face of the cap to prevent oil leakage. Insert the rubber packings shown in Fig. 60 into the holes between the bearing cap and the case. Do not trim these packings. The packings are of a predetermined length that will cause them to protrude approximately $\frac{1}{4}$ " [6,4 mm.] from the case. When the oil pan is installed, it will force them tightly into the holes and effectively seal any opening between the bearing cap and the crankcase.

D-78. Install Front End Plate

Assemble the gasket to the front end plate making certain that it is positioned properly down to the bottom of the crankcase. Install the front end plate on the cylinder block and tighten in place.

D-79. Install Flywheel

Be sure the crankshaft flange and flywheel mating surfaces are clean to permit proper flywheel alignment. With the crankshaft in the cylinder block, place the flywheel on the mounting bolts in the crankshaft. When installing a new crankshaft or flywheel, replace the tapered dowel bolts with straight snug-fitting special bolts provided. Using Flywheel Dowel Bolt Installing tool kit W-231. Assemble the crankshaft and flywheel in proper relation; then install the straight bolts previously used and tighten securely. Next, use a $\frac{35}{64}$ " [13,9 mm.] drill to enlarge the tapered holes. Ream the holes with a $\frac{9}{16}$ " [14,3 mm.] straight reamer and install the two special flywheel bolts with nuts and

lockwashers in place of the two tapered dowel bolts formerly used. This procedure overcomes the necessity of reaming special tapered holes. Tighten the nuts alternately and evenly until each is tightened 35 to 41 lb-ft. [4,8 a 5,7 kg-m.].

After installation check the run-out of the flywheel with a dial indicator attached to the engine plate as illustrated in Fig. 61. Mount the dial indicator with the contact button of the indicator resting against the clutch face of the flywheel. Set the indicator at zero and rotate the flywheel. Maximum allowable run-out is .008" [0,203 mm.] near the outer edge of the rear face of the flywheel.

With the flywheel housing installed temporarily, the alignment can be checked with a dial indicator. Without the clutch installed on the flywheel, a dial indicator can be mounted on one of the flywheel bolts. Set the dial indicator with the button resting against the rear face of the flywheel housing. Rotate the flywheel, noting the run-out on the indicator. Maximum allowable run-out is .005" [0,127 mm.]. Relocate the dial indicator so that the button is against the side of the rear opening to check the radial run-out. Rotate the flywheel and note the run-out which should not exceed .006" [0,152 mm.].

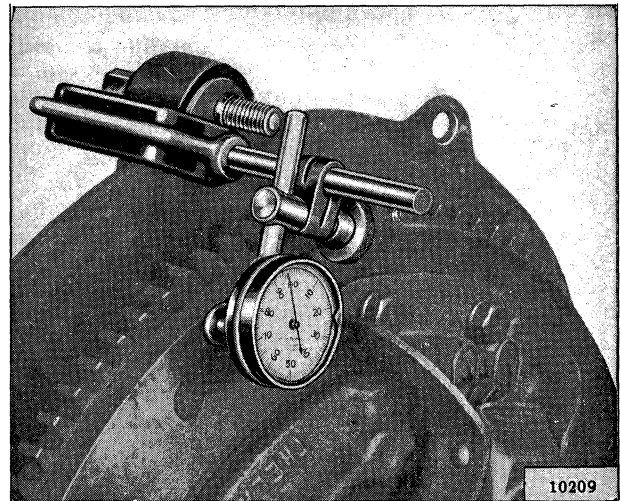


FIG. 61—CHECKING FLYWHEEL RUN OUT

D-80. Install Clutch

To install the clutch assembly with the engine out of the vehicle use a clutch plate aligning arbor. Place the clutch driven plate in position against the flywheel. Insert the arbor into the clutch driven plate and clutch shaft bushing and expand the arbor in the bushing to hold it in place. Hold the clutch pressure plate assembly in position against the clutch driven plate and install the attaching bolts and washers, tightening the bolts alternately and evenly. Remove the arbor.

D-81. Install Valves and Springs

Install one valve spring and valve spring retainer for each valve. Slip the top end of the spring onto the bottom end of the valve guide and, with a large screwdriver, snap the spring and retainer over the tappet adjusting screw. Make certain that the two

closely wound coils of each spring are at the top (placed up to seat against the block). See Fig. 62.

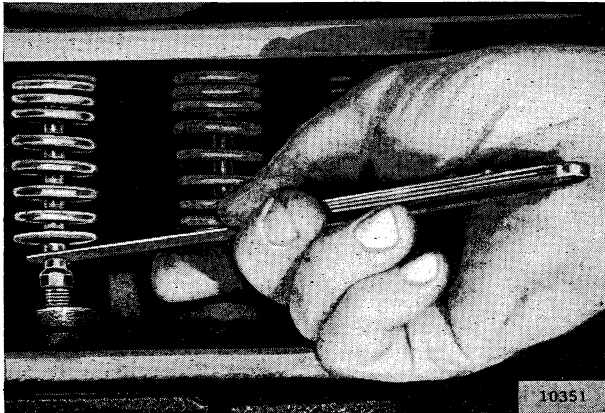


FIG. 62—VALVE TAPPETS AND SPRINGS

Turn the crankshaft as necessary to bring each valve tappet to its lowest position. Using a valve spring compressor, compress each valve spring while holding the valve down so that the 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. When installation of valves is complete, remove any cloths used to block the valve compartment floor openings.

Oil the valve stems. Insert all valves in the valve guides from which they were removed. Adjust the valve tappets to the proper specified clearance of .016" [0,406 mm.] cold. Refer to Par. D-96, D-97, D-98, and specifications at the end of this section for specifications and adjustment procedure.

D-82. Install Camshaft Sprocket and Chain

Before installing the camshaft sprocket on engines with chain driven camshafts turn the crankshaft so No. 1 and 4 pistons are at top center as indicated by the "TC" mark on the flywheel which can be seen through the timing hole in the flywheel housing on the right side of the engine, Fig. 67 and Fig. 68. Place the camshaft sprocket on the shaft and turn the shaft until the punch mark on the rim of the sprocket faces the punch mark on the crankshaft sprocket.

Remove the camshaft sprocket and place the timing chain in position over the crankshaft sprocket. Position the camshaft sprocket within the chain and change the position until the screw holes in the sprocket and camshaft match.

Timing is correct when a line drawn through the sprocket centers cuts through the timing marks on both sprockets. See Fig. 63. In this position No. 4 piston is at top of compression stroke and the distributor rotor arm should be under the distributor cap segment for that cylinder.

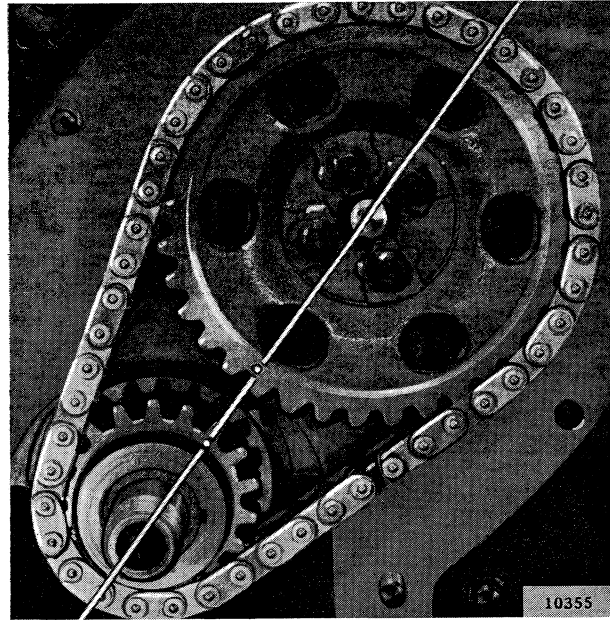


FIG. 63—TIMING SPROCKETS

D-83. Install Camshaft Timing Gear

Turn the camshaft or crankshaft as necessary so that the timing marks on the two gears will be together after the camshaft timing gear is installed. Refer to Fig. 66. Install the woodruff key in the keyway on the front end of the camshaft. Start the large timing gear on the camshaft with the wide hub of the gear facing out. Do not drive on the camshaft gear, or the camshaft may dislodge the plug at the rear of the cylinder block causing an oil leak. Install the camshaft gear retaining screw and torque it 30 to 40 lb-ft. [4,1 a 5,5 kg-m.] drawing the gear onto the camshaft in the process. Standard running tolerance between the timing gears is .000" to .002" [0 a 0,051 mm.] which should be checked with a dial indicator.

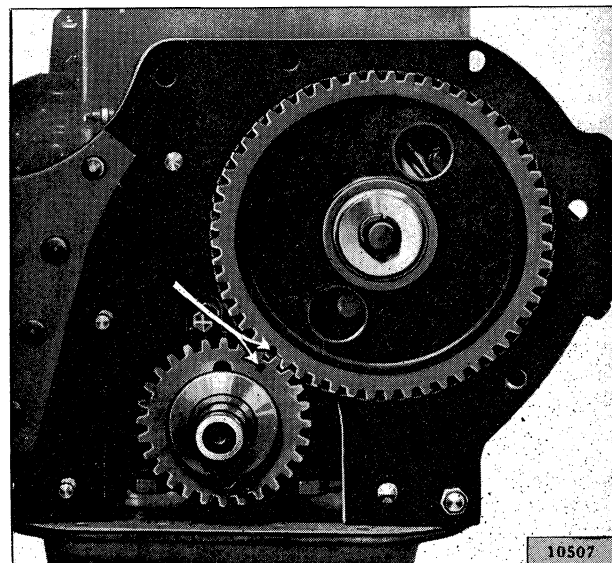


FIG. 64—TIMING GEARS

D-84. Install Timing Gear Oil Jet

Install the timing gear oil jet in the tapped hole in the front of the cylinder block. Position the oil hole in the side of the oil jet so that it will direct the oil stream against the camshaft driven gear just ahead of the point of engagement with the crankshaft drive gear.

Note: A new timing gear oil jet entered production with engine S/N 3J-166871. The earlier jet has a .070" [0,178 mm.] diameter aperture; the later jet has a .040" [0,102 mm.] aperture. The later jet reduces oil pressure variation at No. 1 connecting rod bearing. It is recommended that the .040" jet be installed in engines with serial numbers lower than above whenever it has been necessary to replace a scored or burned No. 1 connecting rod bearing.

D-85. Install Oil Pump

The oil pump is driven from the camshaft by means of a spiral (worm) gear. The distributor, in turn, is driven by the oil pump by means of a tongue on the end of the distributor shaft which engages a slot in the end of the oil pump shaft. Because the tongue and the slot are both machined off center, the two shafts can be meshed in only one position. Since the position of the distributor shaft determines the timing of the engine, and is controlled by the oil pump shaft, the position of the oil pump shaft with respect to the camshaft is important.

Turn the crankshaft to bring together the timing marks on the crankshaft and camshaft gears. See Fig. 64. Install the oil pump mounting gasket on the pump. With the wider side of the shaft on top (nearer the top of the cylinder block), start the oil pump drive shaft into the opening in the left side of the cylinder block with the mounting holes in the body of the pump in alignment with the holes in the cylinder block. Insert a long-blade screwdriver into the distributor shaft opening in the opposite side of the block and engage the slot in the oil pump shaft. Turn the shaft so that the slot is positioned at what would be roughly the nine-thirty position on a clock face.

Remove the screwdriver and, looking down the distributor shaft hole with a flashlight, observe the position of the slot in the end of the oil pump shaft to make certain it is properly positioned. Replace the screwdriver and, while turning the screwdriver clockwise to guide the oil pump drive shaft gear into engagement with the camshaft gear, press against the oil pump to force it into position. Remove the screwdriver and again observe the position of the slot. If the installation was properly made, the slot will be in a position roughly equivalent to eleven o'clock position on a clock face with the wider side of the shaft still on the top. If the slot is improperly positioned, remove the oil pump assembly and repeat the operation.

Coat the threads of the capscrews with gasket cement and secure the oil pump in place with two lockwasher-equipped capscrews installed through

the body of the oil pump and into the cylinder block and one lockwasher-capscrew installed through the oil pump mounting flange.

D-86. Install Timing Gear Cover

Apply a thin coat of gasket paste to the timing gear cover. Position the gasket on the cover and carefully locate the cover on the front of the front mounting plate. Attach the cover and timing indicator and tighten the bolts.

D-87. Install Pistons and Connecting Rods

Before installing each piston and connecting rod assembly in the cylinder block, generously lubricate the entire assembly with engine oil. Space the ring gaps around the piston so that no two gaps are aligned vertically and are not located over the T-slot in the piston skirt. Insert the assembly in the correct cylinder with the connecting rod identifying number toward the camshaft side of the cylinder block. When installing each assembly, rotate the crankshaft so that the crankpin is in the down position. Fit a piston ring compressor tightly around the piston rings. Reach up from the bottom of the cylinder block and guide the end of the connecting rod over the crankshaft journal as the piston is tapped down into the cylinder bore with hammer handle.

Lubricate the connecting rod bearing surfaces generously with engine oil and install the bearing cap with the numbered side matched to the numbered side of the connecting rod. Torque the nuts evenly 35 to 45 lb-ft. [4,8 a 6,2 kg-m.]. The connecting rod cap nuts are locked with stamped nuts. Used stamped nuts should be discarded and replaced with new ones. These locking stamped nuts should be installed with the flat face toward the connecting rod nut. Turn the locking nut finger tight and then $\frac{1}{8}$ turn more with a wrench. Refer to Par. D-33 for detailed information on fitting pistons and rings in the cylinder bores.

D-88. Install Crankshaft Pulley

Align the keyway in the pulley with the woodruff key installed in the crankshaft. Drive the pulley onto the crankshaft and secure it in place with the crankshaft pulley nut. Insert a block of wood between one of the counterweights on the crankshaft and the side of the cylinder block to prevent the crankshaft from turning, then tighten the nut.

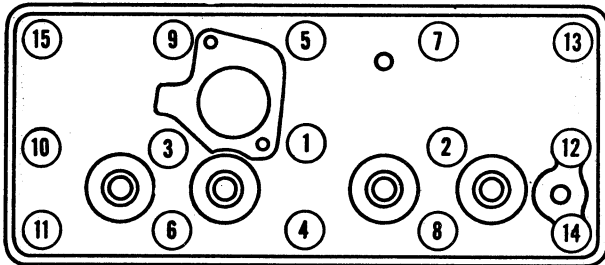
D-89. Install Oil Pan

Before installing the oil pan, make a final internal inspection particularly making certain that the inside of the cylinder block is clean. Apply a thin coat of gasket paste on the oil pan. Place the new oil pan gasket in position. Set the oil pan in position on the cylinder block and install the oil pan. Torque the attaching bolts 9 to 14 lb-ft. [1,2 a 1,9 kg-m.]. Install the oil pan drain plug and gasket and tighten the plug securely.

D-90. 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 the cylinder head and gasket are installed. Install the gasket without using sealer or other compound. Install the cylinder head on the cylinder block. Install the cylinder head bolts. Tighten the bolts with a torque wrench to 60 to 70 lb-ft. [8,3 a 9,7 kg-m.] in the sequence shown in Fig. 65.



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FIG. 65—CYLINDER HEAD BOLT TIGHTENING SEQUENCE

D-91. Install Spark Plugs

Clean and adjust the spark plugs, setting the electrode gaps at .030" [0,762 mm.]. Install the plugs to prevent any foreign matter entering the combustion chambers during the remaining operations. Torque the spark plugs 25 to 33 lb-ft. [3,4 a 4,6 kg-m.].

D-92. Install Manifold

If manifold studs were removed for replacement, apply a sealer on the stud threads before installing a new stud. Make certain that no foreign objects are inside the manifolds and that all passages are clear. Place a new manifold gasket in position on the side of the cylinder block. Then, carefully slide the intake and exhaust manifolds as an assembly onto the studs and against the cylinder block being careful not to damage the gasket. Torque all manifold attaching nuts evenly 29 to 35 lb-ft. [4,0 a 4,8 kg-m.].

D-93. Install Oil Filler Tube

When installing the oil filler 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 to prevent damage to the cap gasket seat.

D-94. Install Water Pump

Make certain that the mating surfaces of the water pump and the cylinder block are clean and smooth. Install the gasket on the flange of the pump and install the pump in position on the cylinder block. Torque the water pump attaching bolts alternately and evenly 12 to 17 lb-ft. [1,7 a 2,3 kg-m.].

D-95. Install Water Outlet Fitting

Install the thermostat and the water outlet fitting. Torque the water outlet fitting attaching bolts 20 to 25 lb-ft. [2,8 a 3,4 kg-m.].

D-96. Final Operations

Before starting the engine, adjust the valve tappets to .016" [0,4064 mm.].

Start the engine and let it warm up to normal operating temperature. Then retorque all head bolts in the proper sequence. See Fig. 65.

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

Check all head bolts and the head gasket for leaks. Cement a new gasket on the valve cover. Install the cover and ventilator tube using a new gasket back of the tube and new copper ring gaskets under the attaching screw heads. Torque the valve tappet cover nuts 7 to 10 lb-ft. [1,0 a 1,4 kg-m.].

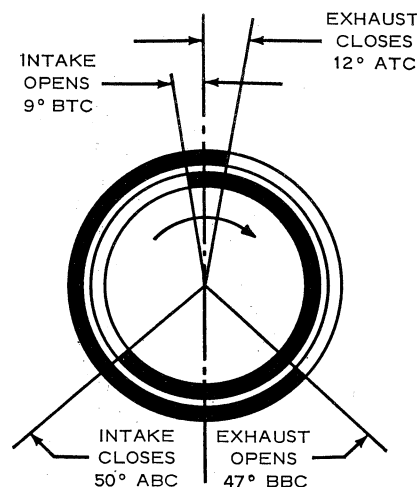
D-97. VALVE ADJUSTMENT

Proper valve adjustment is important to prevent burning of valves and poor engine performance. This adjustment consists of obtaining a specified clearance in the valve mechanism. The valve tappets should be adjusted to the proper clearance with the engine cold (at room temperature). Valve clearance can be properly adjusted only when the tappet is on the heel or low portion of the cam.

D-98. Valve Adjustment Procedure

The valve tappets are adjusted by turning the adjusting screw in or out of the tappet as necessary to obtain the proper clearance. Where special wrenches can be obtained, they should be used to facilitate the adjustment. The proper clearance is .016" [0,406 mm.] between the end of the adjusting screw and the bottom of the valve.

Crank the engine over to close a valve and check the clearance with a feeler gauge. To adjust, hold the tappet with one wrench and turn the adjusting screw, with the other. Check and adjust each of the tappets in proper sequence.



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FIG. 66—VALVE TIMING

D-99. Check Valve Timing

To check the valve timing, carefully set the intake valve adjustment for No. 1 cylinder to .020" [0,508 mm.] between the tappet and the valve stem. Rotate the crankshaft clockwise until the piston in No. 1 cylinder is ready for the intake stroke. The intake valve opens 9° before top center (BTC). Note the distance between the "TC" and "5°" marks on the indicator on the timing gear cover and estimate the 9° before top center position. With the crankshaft in this position, timing is correct if the tappet is just tight against the intake valve stem. Do not overlook resetting the tappet adjustment to the correct running clearance.

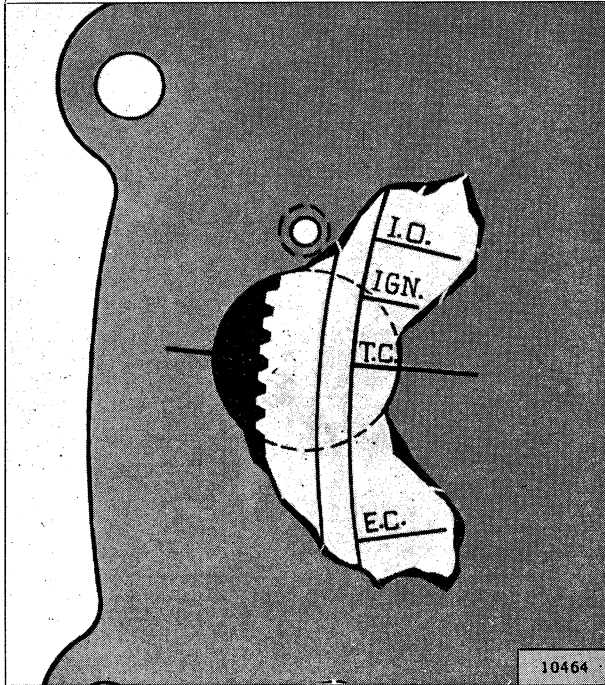


FIG. 67—FLYWHEEL TIMING MARKS
(Before CJ-2A Engine S/N 175402)

Note: On all model CJ-2A and early model CJ-3A, the timing marks are on the flywheel and are viewed through a hole in the engine plate. On model CJ-2A before engine S/N 175402, No. 1 cylinder is ready for the intake stroke when the flywheel IO mark is in the center of the inspection hole as shown in Fig. 67. On model CJ-2A beginning with engine S/N 175402 and on model CJ-3A before engine S/N 130859 top center and 5° before top center are marked on the flywheel as shown in Fig. 68. On model CJ-3A beginning with engine S/N 130859 and all DJ-3A engines the timing marks are on the timing gear cover.

Note: A 4½" [114,3 mm.] starting motor was placed in production of Model CJ-3A, beginning with engine S/N 130859. To use the larger starting motor it was necessary to increase the width of the cylinder block flange at the motor mounting. This increased flange width partially covers the location of the flywheel timing mark inspection hole making it impossible to provide an opening for timing

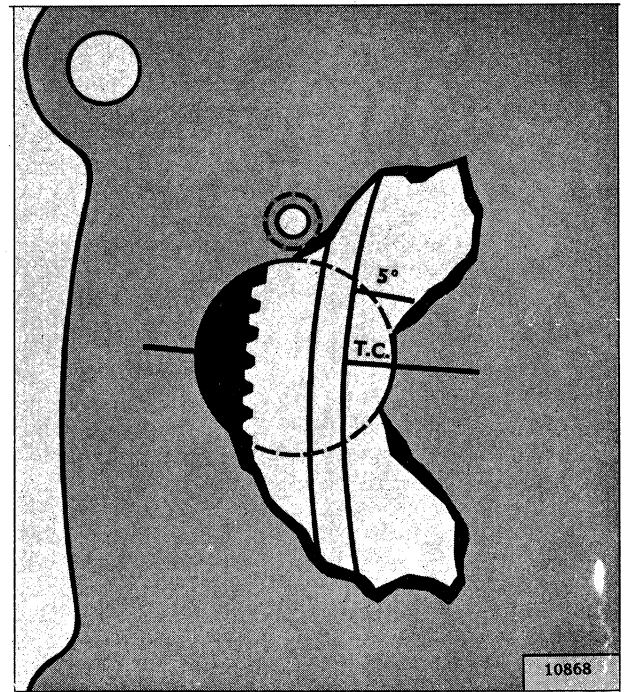


FIG. 68—FLYWHEEL TIMING MARKS
(After CJ-2A Engine S/N 175402)

purposes. This is not important however, as timing marks were transferred to the timing gear cover and crankshaft pulley.

Should it be necessary to install a new cylinder block on an earlier engine equipped with the smaller starting motor it may be necessary to use the timing hole as no other marks are available. Should such an installation be made, cut away the flange as required to uncover the timing hole in the engine plate as shown in Fig. 69.

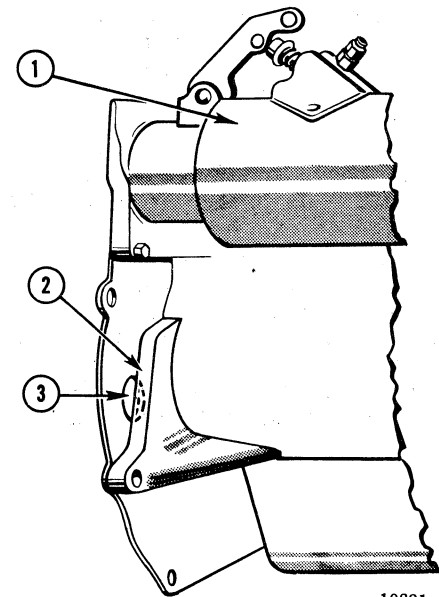


FIG. 69—UNCOVERING TIMING INSPECTION HOLE
1—Starter Motor
2—Cut Away Mounting Flange
3—Timing Inspection Hole

D-100. OILING SYSTEM

The engine oil pressure system is designed to provide adequate lubrication to all working parts of the engine. The gear-type oil pump is driven from the engine camshaft. The pump is provided with a floating, screened intake that prevents the circulation of any sediment that might accumulate in the oil pan. By means of this pump, the main bearing journals and crankpins are efficiently lubricated through an oil gallery and passages in the cylinder block. Oil is forced under pressure to the main bearings and through the cheeks of the crankshaft to the connecting rod bearings. Oil is also force-fed to the camshaft bearings and timing gears. The oil pressure is controlled by relief valve located in the oil pump. The valve is designed to open when excessive pressure develops in the system, relieving the pressure and returning the excess oil to the oil pan. The cylinder walls, piston pins, and tappets are supplied with oil from spurt holes in the connecting rods. A portion of the oil is continually passed through an oil filter which effectively removes any foreign matter suspended in the oil. A flanged section on the rear of the crankshaft acts as an oil slinger and, in combination with the rear main bearing upper and lower oil seal, prevents the leakage of oil from the rear end of the cylinder block. Leakage of oil from the front of the cylinder block is controlled by the crankshaft oil slinger and the front oil seal installed in the timing gear cover. The oil pressure indicator light 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.

D-101. Crankcase Ventilation

- Models CJ-2A, CJ-3A and DJ-3A.

The crankcase ventilating system provides thorough, positive ventilation which reduces to a minimum the formation of sludge. The crankcase is ventilated by a sealed system. The system is actuated through a valve attached to the intake manifold which is connected by a tube to the valve cover. Clean air is drawn into the oil filler tube and through a hose from the air cleaner. Any vapors in the crankcase are carried into the manifold and burned.

Be sure there are no air leaks at the tube connections between the air cleaner and the oil filler tube, and that the oil filler tube cap gasket is in good condition. Always keep the cap locked securely in place. When tuning the engine or grinding valves, remove the control valve and clean it thoroughly. If the valve is blocked with carbon, the ventilating

system will not operate and, should the valve fail to seat, it will be impossible to make the engine idle satisfactorily.

Some Model DJ-3A engines have a trailer-tube ventilating system. The cone-shaped baffle attached to the inside of the valve cover should be removed and cleaned periodically.

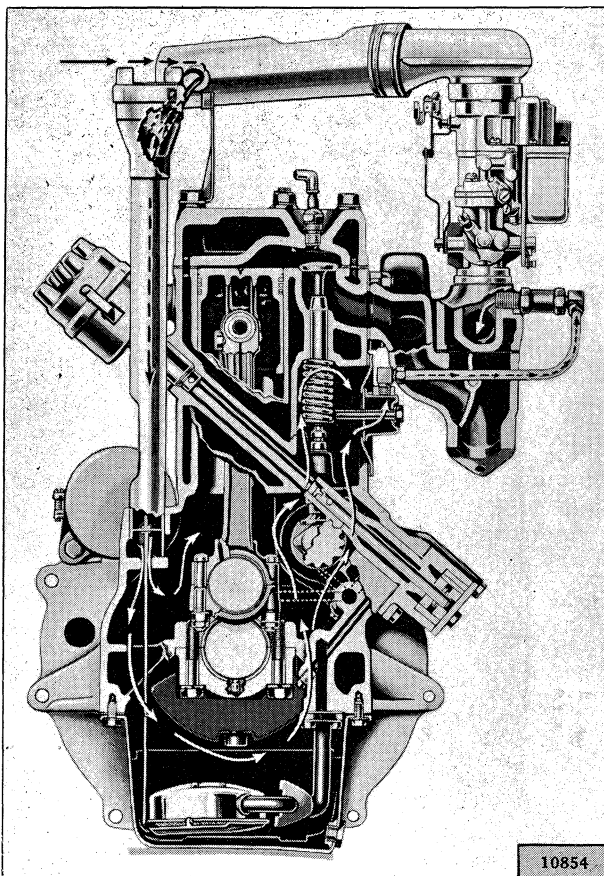


FIG. 70—CRANKCASE VENTILATING SYSTEM
(MODELS CJ-2A AND CJ-3A)

- 1—Valve Open
- 2—Valve Closed

D-102. Oil Filter

The engine is equipped with a 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 filter and gasket. The filter assembly may be replaced by detaching the oil lines at the case and removing the mounting bracket.

D-103. 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
- Defective Spark Plugs—Clean or Replace
- Defective Breaker Points—Replace Points
- Incorrect Breaker Point Gap—Reset Points
- Defective Condenser or Coil—Replace
- Loose Electrical Connections—Locate and Tighten
- Broken Valve Spring—Replace Spring
- Broken Piston or Rings—Replace
- Defective Head Gasket—Replace Gasket
- Cracked Distributor Cap—Replace Cap

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

Burned Valves and Seats—Continued

- 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
- 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

D-104. L4-134 ENGINE SPECIFICATIONS

MODEL:	CJ-2A, CJ-3A, DJ-3A	METRIC
ENGINE:		
Type	L-Head	
Number of Cylinders	4	
Bore	3 $\frac{1}{8}$ "	79,375 mm.
Stroke	4 $\frac{3}{8}$ "	111,12 mm.
Piston Displacement	134.2 cu. in.	2199 cm ³
Bore Spacing (center to center):		
1 and 2, 3 and 4	3.437"	8,729 cm.
2 and 3	4.938"	12,542 cm.
Firing Order	1-3-4-2	
Compression Ratio	7.00:1	
Compression Pressure	90 to 110 psi.	6,33 a 7,73 kg-cm ²
Number of Mounting Points:		
Front	2	
Rear	1	
Horsepower (SAE)	15.63	
Horsepower (Max. Brake)	60@ 4000 rpm.	
Maximum Torque @ 2000 rpm.	105 lb-ft.	14,52 kg-m.
Idle Speed	600 rpm.	
PISTONS:		
Material	Aluminum Alloy	
Description	Cam Ground, T-slot, Tin or Brass Plated	
Length	3 $\frac{3}{4}$ "	9,525 cm.
Diameter (near bottom of skirt; right angle to pin)	3.1225"-3.1245"	7,9311 a 7,9362 cm.
Weight	13.5 oz.	382,7 gr.
Clearance Limits:		
Piston-To-Cylinder Bore	Selective Feeler Fit	
Ring Groove Depth:		
No. 1 and 2 Ring .....	.1593" to .1655"	4,046 a 4,203 mm.
No. 3 Ring .....	.1693" to .1755"	4,300 a 4,457 mm.
Ring Groove Width:		
No. 1 Ring .....	.0955" to .0965"	2,4257 a 2,4511 mm.
No. 2 Ring .....	.095" to .096"	2,413 a 2,438 mm.
No. 3 Ring .....	.1875" to .1885"	4,7625 a 4,7879 mm.
Piston Pin Hole Bore .....	.8120" to .8122"	19,304 a 19,558 mm.
Cylinder Bore—Standard	3.125" to 3.127"	7,9375 a 7,9425 cm.
—max. out of round .....	.005"	0,1270 mm.
—max. taper .....	.005"	0,1270 mm.
—max. rebore .....	.040"	1,0160 mm.
PISTON RINGS:		
Function:		
No. 1 and 2	Compression	
No. 3	Oil	
Material:		
No. 1	Cast Iron, Chrome-plated Face	
No. 2 and 3	Cast Iron	
Width:		
No. 1 and 2	$\frac{3}{32}$ "	2,38 mm.
No. 3	$\frac{3}{16}$ "	4,76 mm.
Side Clearance in Groove:		
No. 1 Ring .....	.002" to .004"	0,051 a 0,102 mm.
No. 2 Ring .....	.0015" to .0035"	0,038 a 0,088 mm.
No. 3 Ring .....	.001" to .0025"	0,025 a 0,063 mm.
PISTON PINS:		
Material	SAE 1016 Steel	
Length	2.781"	70,637 mm.
Diameter .....	.8119"-.8121"	20,6223 mm.
Type	Locked in Rod	
Clearance in Piston (selective fit) .....	.0001" to .003"	0,0025 a 0,0076 mm.
CONNECTING RODS:		
Material	SAE 1141 Forged Steel	
Weight	32 oz.	907 gr.
Length (center to center)	9.187"	23,33 cm.
Bearing:		
Type	Removable	
Material	Steel-backed Babbitt	
Length Over All	1.089" to 1.099"	27,661 a 27,915 mm.
Clearance Limits .....	.001" to .0019"	0,025 a 0,0483 mm.
Undersize Bearings Available .....	.001"	0,025 mm.
	.002"	0,051 mm.
	.010"	0,254 mm.
	.012"	0,305 mm.
	.020"	0,508 mm.
	.030"	0,762 mm.
End Play .....	.004" to .010"	0,102 a 0,254 mm.

D-104. L4-134 ENGINE SPECIFICATIONS—(Continued)

MODEL:	CJ-2A, CJ-3A, DJ-3A	METRIC
CONNECTING RODS:—Continued		
Out-of-round and out-of-taper limits.....	.001"	0,025 mm.
Installation.....	From Above	
Bore:		
Upper.....	.8115" to .8125"	20,612 a 20,637 mm.
Lower.....	2.0432" to 2.0440"	51,8972 a 51,9176 mm.
CRANKSHAFT:		
Material.....	SAE 1040 Forged Steel	
End Thrust.....	Front Bearing	
End Play.....	.004" to .006"	0,102 a 0,152 mm.
Main Bearings:		
Type.....	Removable	
Material.....	Steel-backed Babbitt	
Clearance.....	.0003" to .0029"	0,0071 a 0,0736 mm.
Journal Diameter.....	2.3331" to 2.3341"	5,9286 a 5,9261 cm.
Undersize Bearings Available.....	.001"	0,025 mm.
	.002"	0,051 mm.
	.010"	0,254 mm.
	.012"	0,305 mm.
	.020"	0,508 mm.
	.030"	0,762 mm.
Bearing Length:		
Front.....	1.64"	41,66 mm.
No. 2.....	1.72"	43,69 mm.
No. 3.....	1.66"	42,16 mm.
Out-of-round and out-of-taper limits.....	.001"	0,025 mm.
Direction of Cylinder Offset.....	Right	
Amount of Cylinder Offset.....	.125"	3,175 mm.
Crankpin Journal Diameter.....	1.9375" to 1.9383"	49,2125 a 49,2328 mm.
Flywheel Run Out (max.).....	.005"	0,127 mm.
CAMSHAFT:		
Bearings:		
Material.....	Steel-backed Babbitt (Front only)	
Number.....	4	
Clearance.....	.001"-.0025"	0,025 a 0,063 mm.
Journal Diameter:		
Front.....	2.1860" to 2.1855"	55,518 mm.
Front Intermediate.....	2.1225" to 2.1215"	43,898 mm.
Rear Intermediate.....	2.0600" to 2.0590"	52,311 mm.
Rear.....	1.6230" to 1.6225"	41,217 mm.
Bearing Diameter:		
Front.....	2.1870" to 2.1890"	55,5498 a 55,6006 mm.
Front Intermediate.....	2.125" to 2.126"	53,9750 a 54,0004 mm.
Rear Intermediate.....	2.0625" to 2.0635"	52,3875 a 52,4129 mm.
Rear.....	1.625" to 1.626"	41,2750 a 41,3004 mm.
End Play.....	.004" to .007"	0,101 a 0,178 mm.
Drive:		
Type.....	Gear	
Crankshaft Gear.....	Cast Iron	
Camshaft Gear.....	Pressed Fiber-Steel Hub	
VALVE SYSTEM:		
Tappets:		
Clearance — Cold:		
Intake.....	.016"	0,406 mm.
Exhaust.....	.016"	0,406 mm.
Clearance for Timing (intake).....	.020"	0,508 mm.
Over All Length:		
Intake.....	2 7/8"	7,30 cm.
Exhaust.....	2 7/8"	7,30 cm.
Stem Diameter.....	.6245" to .6240"	15,8623 a 15,8496 mm.
Clearance in Block.....	.0005" to .002"	0,0127 a 0,0508 mm.
Timing:		
Intake:		
Opens.....	9° BTC	
Closes.....	50° ABC	
Duration.....	239°	
Exhaust:		
Opens.....	47° BBC	
Closes.....	12° ATC	
Duration.....	239°	
Valve Opening Overlap.....	21°	
Valves:		
Intake:		
Material.....	SAE 5150	
Length Over All.....	5.797"	147,244 mm.
Head Diameter.....	1.531"	38,887 mm.
Angle of Seat.....	45°	

D-104. L4-134 ENGINE SPECIFICATIONS—(Continued)

MODEL:	CJ-2A, CJ-3A, DJ-3A	METRIC
VALVE SYSTEM:—Continued		
Stem Diameter	.373"	9,474 mm.
Stem-to-Guide Clearance	.0007" to .0022"	0,017 a 0,055 mm.
Lift	.351"	8,915 mm.
Exhaust:		
Material	Uniloy 21-12	
Length Over All	5.797"	147,244 mm.
Head Diameter	1.47"	37,34 mm.
Angle of Seat	45°	
Seat Inset Material	Eatonite EMS 58	
Stem Diameter	.371" to .372"	9,423 a 9,449 mm.
Stem-to-Guide Clearance	.0025" to .0045"	0,0635 a 0,1143 mm.
Lift	.351"	8,915 mm.
Springs:		
Free Length	2 1/2"	63,5 mm.
Pressure @ Length:		
Standard:		
Valve Closed	53 lb. @ 2.109"	24 kg. @ 53,5 mm.
Valve Open	120 lb. @ 1.750"	54,3 kg. @ 44,4 mm.
Service Minimum:		
Valve Closed	47 lb. @ 2 1/4"	21,3 kg. @ 53,5 mm.
Valve Open	110 lb. @ 1 3/4"	49,9 kg. @ 44,4 mm.
LUBRICATION SYSTEM:		
Type of Lubrication		
Main Bearings	Pressure	
Connecting Rods	Pressure	
Piston Pins	Splash	
Camshaft Bearings	Pressure	
Tappets	Splash	
Timing Gears	Nozzle	
Cylinder Walls	Nozzle	
Oil Pump:		
To Engine S/N 44417:		
Type	Planetary Gear	
Drive	Camshaft Gear	
Minimum Safe Oil Pressure @ Idle	10 psi.	0,7 kg-cm ²
Relief Valve Opens	25 psi.	1,7 kg-cm ²
Normal Gauge Reading	50 @ 30 mph.	50 @ 48 km-hr.
Engine S/N 44417 and On:		
Type	Internal Rotor	
Drive	Camshaft Gear	
Minimum Safe Oil Pressure:		
At Idle	6 psi.	0,4 kg-cm ²
At 2000 rpm. (35 mph.)	20 psi.	1,4 kg-cm ²
Relief Valve Opens	40 psi.	2,8 kg-cm ²
Normal Oil Pressure	35 psi. @ 2000 rpm.	2,4 kg-cm ² @ 2000 rpm.
Oil Pressure Sending Unit	Electric	
Oil Intake	Floating	
Oil Filter System	Partial Flow	

F4-134 ENGINE MODELS CJ-3B, CJ-5, CJ-6

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E-1. GENERAL

Engine service and repair is covered in this section in the following manner:

- a. General description of the engine.
- b. Removal of the engine from the vehicle.
- c. Complete engine disassembly out of the vehicle. Special instructions are included with some operations to cover differences required when disassembly is done with the engine installed.
- d. Inspection and repair of engine components with the parts removed.
- e. Engine reassembly with the engine removed from the vehicle. The final paragraphs cover valve adjustment, oiling system of the engine, and crankcase ventilation.

E-2. Description

The Model F4-134 engine is an F-head, four-cylinder engine of combination valve-in-head and valve-in-block construction. Large intake valves mounted in the head allow rapid, unobstructed flow of fuel and air to the combustion chambers through short, water-jacketed intake passages. The intake valves are operated by push rods through rocker arms. The exhaust valves are mounted in the block with through water jacketing to provide effective cooling. The exhaust valves are operated by conventional valve tappets.

The engine is pressure lubricated. An oil pump driven from the camshaft forces the lubricant through oil channels and drilled passages in the crankshaft to efficiently lubricate the main and connecting rod bearings. Lubricant is also forced to the camshaft bearings, rocker arms, timing gears, etc. Cylinder walls and piston pins are

lubricated from spurt holes in the "follow" side of the connecting rods.

Circulation of the coolant is controlled by a thermostat in the water outlet elbow cast as part of the cylinder head.

The cylinder head assembly when installed on the engine consists of the inlet valve guides, inlet valves, inlet valve springs, rocker arm and shaft assemblies, spark plugs, temperature indicator fitting, water outlet fitting, and other assembled parts. The carburetor and air cleaner assembly bolt to the top of the cylinder head. The rocker arm cover is attached to the top of the head to enclose the inlet valve mechanism.

The engine is equipped with a fully counterbalanced crankshaft supported by three main bearings. To better control balance, the counterweights are independently forged and permanently attached to the crankshaft with dowels and cap screws that are tack-welded. Crankshaft end play is adjusted by shims placed between the crankshaft thrust washer and the shoulder on the crankshaft.

The exhaust manifold is a separate unit. 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 passages and assists in vaporizing the fuel when the engine is cold. Therefore, there is no heat control valve required in the exhaust manifold. Individual exhaust ports in the cylinder block direct gasses into the exhaust manifold for unobstructed flow through the exhaust system.

The pistons have an extra groove directly above the top ring which acts as a heat dam or insulator.

Text continued on page 60.

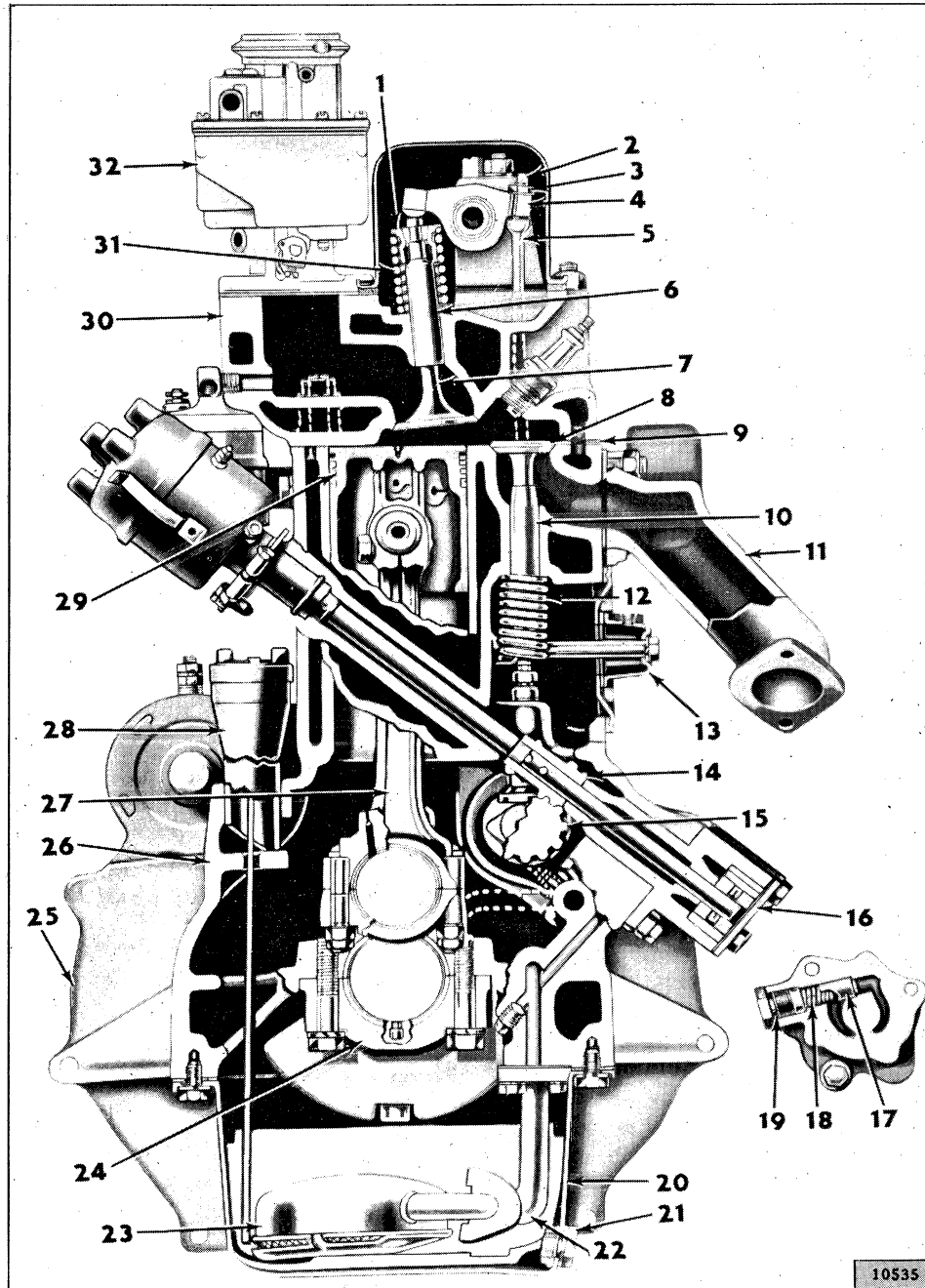


FIG. 71—END SECTION VIEW OF F4-134 ENGINE

- | | |
|--------------------------------|---------------------------|
| 1—Intake Valve Spring Retainer | 17—Relief Plunger |
| 2—Adjusting Screw | 18—Relief Plunger Spring |
| 3—Nut | 19—Relief Spring Retainer |
| 4—Rocker Arm | 20—Oil Pan |
| 5—Push Rod | 21—Drain Plug |
| 6—Intake Valve Guide | 22—Oil Float Support |
| 7—Intake Valve | 23—Oil Float |
| 8—Exhaust Valve | 24—Crankshaft |
| 9—Cylinder Head Gasket | 25—Engine Rear Plate |
| 10—Exhaust Valve Guide | 26—Cylinder Block |
| 11—Exhaust Manifold | 27—Connecting Rod |
| 12—Exhaust Valve Spring | 28—Oil Filler Tube |
| 13—Crankcase Ventilator | 29—Piston |
| 14—Oil Pump Gear | 30—Cylinder Head |
| 15—Camshaft | 31—Intake Valve Spring |
| 16—Oil Pump | 32—Carburetor |

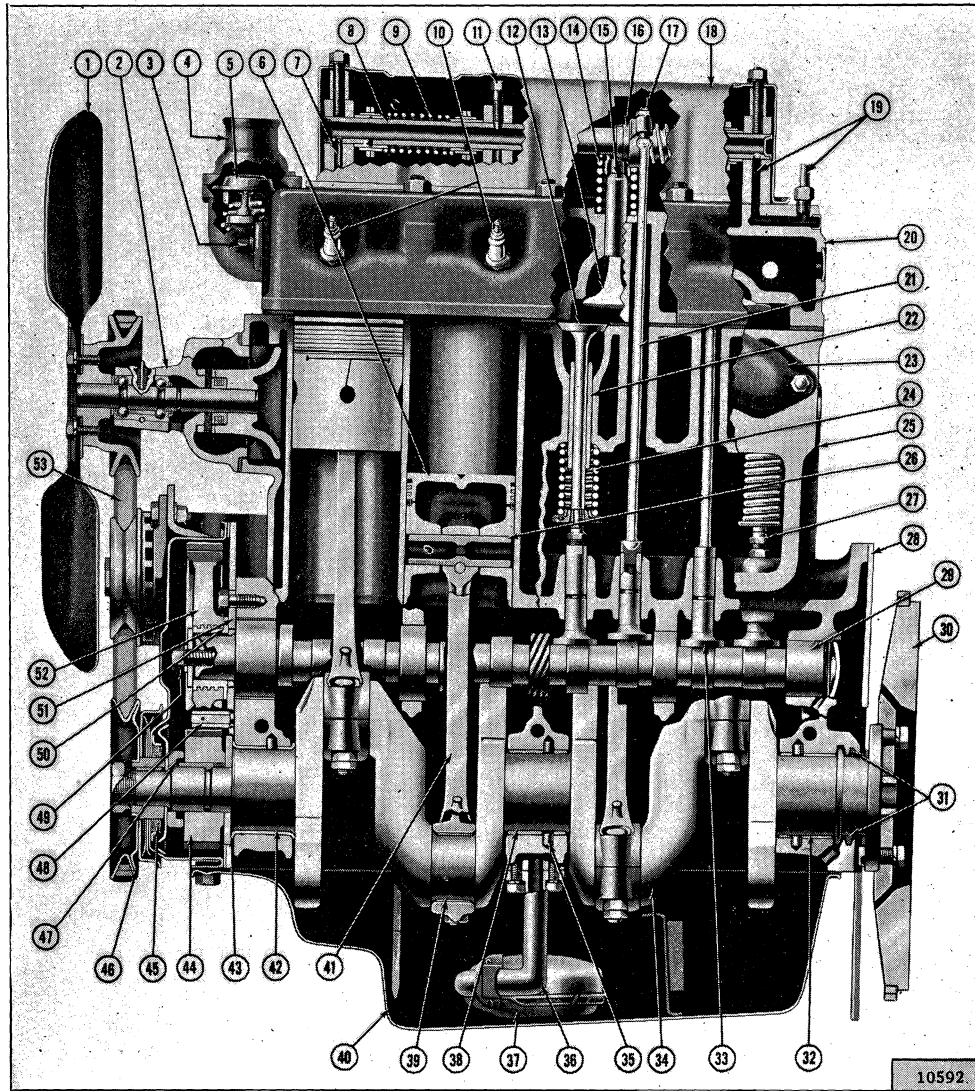


FIG. 72—SIDE SECTIONAL VIEW OF F4-134 ENGINE

- | | |
|-----------------------------------|--------------------------------------|
| 1—Fan | 28—Engine Rear Plate |
| 2—Water Pump | 29—Camshaft |
| 3—Pipe Plug | 30—Flywheel |
| 4—Water Outlet Fitting | 31—Crankshaft Rear Bearing Seal |
| 5—Thermostat | 32—Crankshaft Rear Bearing |
| 6—Piston | 33—Intake Valve Tappet |
| 7—Rocker Shaft Bracket | 34—Crankshaft |
| 8—Rocker Arm Shaft | 35—Crankshaft Bearing Dowel |
| 9—Rocker Shaft Spring | 36—Oil Float Support |
| 10—Spark Plug | 37—Oil Float |
| 11—Rocker Shaft Lock Screw | 38—Crankshaft Center Bearing |
| 12—Exhaust Valve | 39—Connecting Rod Bearing |
| 13—Intake Valve | 40—Oil Pan |
| 14—Intake Valve Spring | 41—Connecting Rod |
| 15—Intake Valve Guide | 42—Crankshaft Front Bearing |
| 16—Rocker Arm | 43—Engine Front Plate |
| 17—Intake Tappet Adjusting Screw | 44—Crankshaft Gear |
| 18—Rocker Arm Cover | 45—Crankshaft Oil Seal |
| 19—Oil Line | 46—Drive Pulley |
| 20—Cylinder Head | 47—Crankshaft Gear Spacer |
| 21—Intake Valve Push Rod | 48—Oil Jet |
| 22—Exhaust Valve Guide | 49—Bolt |
| 23—Exhaust Manifold | 50—Camshaft Gear Thrust Plate Spacer |
| 24—Exhaust Valve Spring | 51—Camshaft Thrust Plate |
| 25—Cylinder Block | 52—Camshaft Gear |
| 26—Piston Pin | 53—Fan-and-Generator Belt |
| 27—Exhaust Tappet Adjusting Screw | |

As is common practice with manufacturers, some engines are built with oversize cylinder bores or undersize crankshaft journals. These engines are considered standard as replacement parts of the correct sizes are supplied. Before ordering parts or doing any work with a particular engine, it is important to check the engine serial number to determine if oversize or undersize parts are required. Definite identification is given by a letter stamped after the engine serial number. The letters used and their meanings are given here:

- A** — .010" [0,254 mm.] undersize main and connecting rod bearings.
- B** — .010" [0,254 mm.] oversize pistons.
- AB** — Combination and A and B.

Detailed specifications for the F4-134 engine are at the end of this section. Torque specifications for engine service are at the end of this manual in Section V. When adjustments are necessary, refer to these specifications so that factory clearances are maintained.

E-3. Engine Mountings

The front of the engine is supported by two rubber insulator mountings attached to the frame side rail brackets. The rear of the engine-transmission assembly is supported by a rubber insulator mounting under the rear of the transmission on the frame center cross member. This cross member is bolted to the frame side rails so that it can be dropped when removing the transmission or engine-transmission assembly. The rubber insulators allow free side and vertical oscillation to effectively neutralize engine vibration at the source.

The rubber insulator mountings should be inspected for separation and deterioration by jacking the power plant away from the frame, near the supports. Vibration cannot be effectively absorbed by separated or worn insulators. They should be replaced if faulty.

E-4. Engine Ground Strap

To be sure of an effective ground for the electrical circuits, a ground strap bridges the right 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.

E-5. ENGINE REMOVAL

Should the engine require overhauling, it is necessary to remove it from the vehicle. The following procedure covers removal of the engine only. On Models CJ-5 and CJ-6, the engine, transmission and transfer case may be removed as a unit by removing (in addition to the following procedure) the radiator guard and the access plates in the floor pan.

- a.** Drain the cooling system by opening the drain cocks at the bottom of the radiator and lower right side of the cylinder block.
- b.** Disconnect the battery at the positive terminal to avoid the possibility of short circuit.

- c.** Remove the air cleaner horn from the carburetor and disconnect the breather hose at the oil filler pipe.
- d.** Disconnect the carburetor choke and throttle controls by loosening the clamp bolts and set screws.
- e.** Disconnect the fuel-tank-to-fuel-pump line at the fuel pump by unscrewing the connecting nut.
- f.** Plug the fuel line to prevent fuel leakage. Disconnect the windshield wiper hose at the fuel pump.
- g.** Remove the radiator stay bar on Model CJ-3B.
- h.** Remove the upper and lower radiator hoses by loosening the hose clamps and slipping the clamps back on the hose. If so equipped, remove the heater hoses (one to the water pump, one to the rear of the cylinder head) in the same manner.
- i.** Remove the four bolts from the fan hub and remove the fan hub and fan blades.
- j.** Remove the four radiator attaching screws. Remove the radiator and shroud as one unit.
- k.** Remove the starting motor cables. Remove the starting motor.
- l.** Disconnect the wires from the generator. Disconnect the ignition primary wire at the ignition coil.
- m.** Disconnect the oil pressure and temperature sending unit wires at the units.
- n.** Disconnect the exhaust pipe at the exhaust manifold by removing the stud nuts.
- o.** Disconnect the spark plug cables at the plugs and remove the cable bracket from the rocker arm cover stud.
- p.** Remove the rocker arm cover by removing the attaching stud nuts.
- q.** Attach a lifting bracket to the engine using existing head bolt locations. Be sure the bolts selected will hold the engine with the weight balanced. Attach lifting bracket to a boom hoist, or other lifting device, and take up all slack.
- r.** Remove the two nuts and bolts from each front engine support. Disconnect the engine ground strap. Remove the engine supports. Lower the engine slightly to permit access to the two top bolts on the flywheel housing.
- s.** Remove the bolts which attach the flywheel housing to the engine.
- t.** Pull the engine forward, or roll the vehicle backwards, until the clutch clears the flywheel housing. Lift the engine from the vehicle.

E-6. ENGINE DISASSEMBLY

Engine disassembly is presented in the sequence to be followed when the engine is to be completely overhauled after removal from the vehicle. Some 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 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.

During disassembly operations, the engine should be mounted in a suitable engine repair stand. Where practicable, modify or adapt an existing repair stand as necessary to accommodate the engine. If an engine repair stand is not used, take care to perform disassembly operations in a manner that will protect personnel against an accident and the engine and its parts against damage.

NOTE: If the engine is being disassembled because of possible valve failure, check the valve tappet clearance before disassembly. Improper valve clearance could be the possible cause of valve failure, indicating a need for more frequent valve checks and adjustments.

E-7. Remove Water Pump

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

E-8. Remove Exhaust Manifold

Remove the five nuts from the manifold studs. Pull the manifold off the mounting studs. Remove the center and two end gaskets from the cylinder block.

E-9. Remove Oil Filler Tube

Loop a piece of 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 fitting. Pull on the tube, tapping it just above where it enters the crankcase.

E-10. Remove Water Outlet Fitting

Remove the nuts and lockwashers that attach the water outlet fitting to the cylinder head. Lift the outlet fitting from the cylinder head.

E-11. Remove Thermostat

With the water outlet fitting removed, the thermostat can be lifted from the water outlet elbow on the cylinder head.

E-12. Remove Crankshaft Pulley

Remove the crankshaft nut. Install a puller and pull the pulley from the crankshaft.

E-13. Remove Oil Pump

The oil pump is located externally on the left side of the engine. If only the oil pump is being removed with the engine in the vehicle, set No. 1 piston at TDC for reference for reinstalling the oil pump without greatly disturbing the ignition timing. First remove the distributor cover and note the position of the distributor rotor.

If the distributor is already removed, sight through the distributor hole before removing the oil pump. The slot should be near vertical. Remove the capscrews and lockwashers attaching the oil pump

to the cylinder block. Carefully slide the oil pump and its drive shaft out of the cylinder block.

E-14. Remove Crankcase Ventilator Valve

Remove the capscrew and ventilator body gasket securing the crankcase vent body and related parts to the exhaust valve spring compartment cover and to the cylinder block. Remove the crankcase vent body and the engine ventilation system parts threaded to it.

E-15. Remove Rocker Arm Assemblies

The rocker arm cover was previously removed as a step of the engine removal (Par. E-5).

Remove the nuts from the rocker arm shaft support studs, and lift the rocker arm assembly off the studs. Lift the intake valve push rods out of the cylinder block.

E-16. Remove Cylinder Head

Some engines will have a by-pass hose (from front of cylinder head to water pump) that must be removed. On later production engines, this by-pass hose is not used and a pipe plug is installed at the front of the cylinder head.

Disconnect the oil line from the flared tube connector and remove the rocker arm attaching stud nuts, and rocker arm shaft assembly if not previously removed. Two end head bolts cannot be removed until the rocker arm shaft is removed. Remove the cylinder head bolts. There is one cylinder head bolt located below the carburetor mounting, inside the intake manifold, that must not be overlooked.

Carefully lift the cylinder head off the block. Remove the valve push rods and the valve lifters. Remove and discard the cylinder head gasket. Dis-

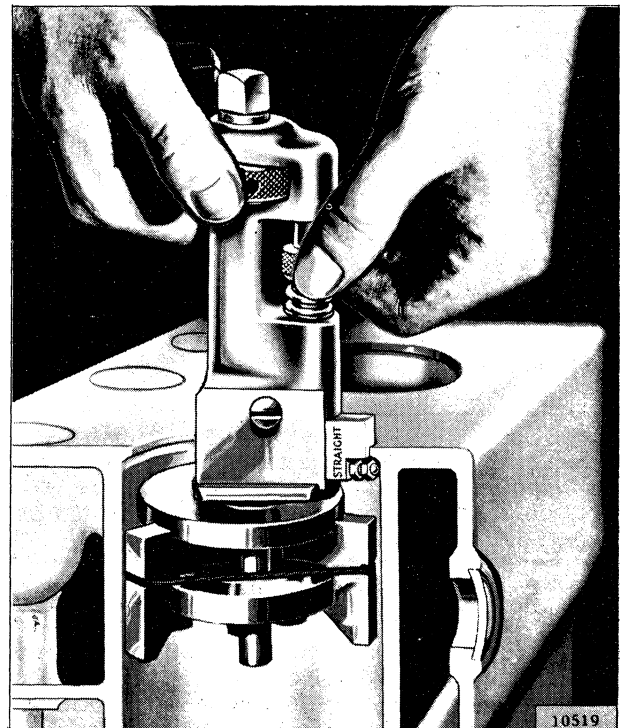


FIG. 73- REMOVING RIDGE WITH REAMER

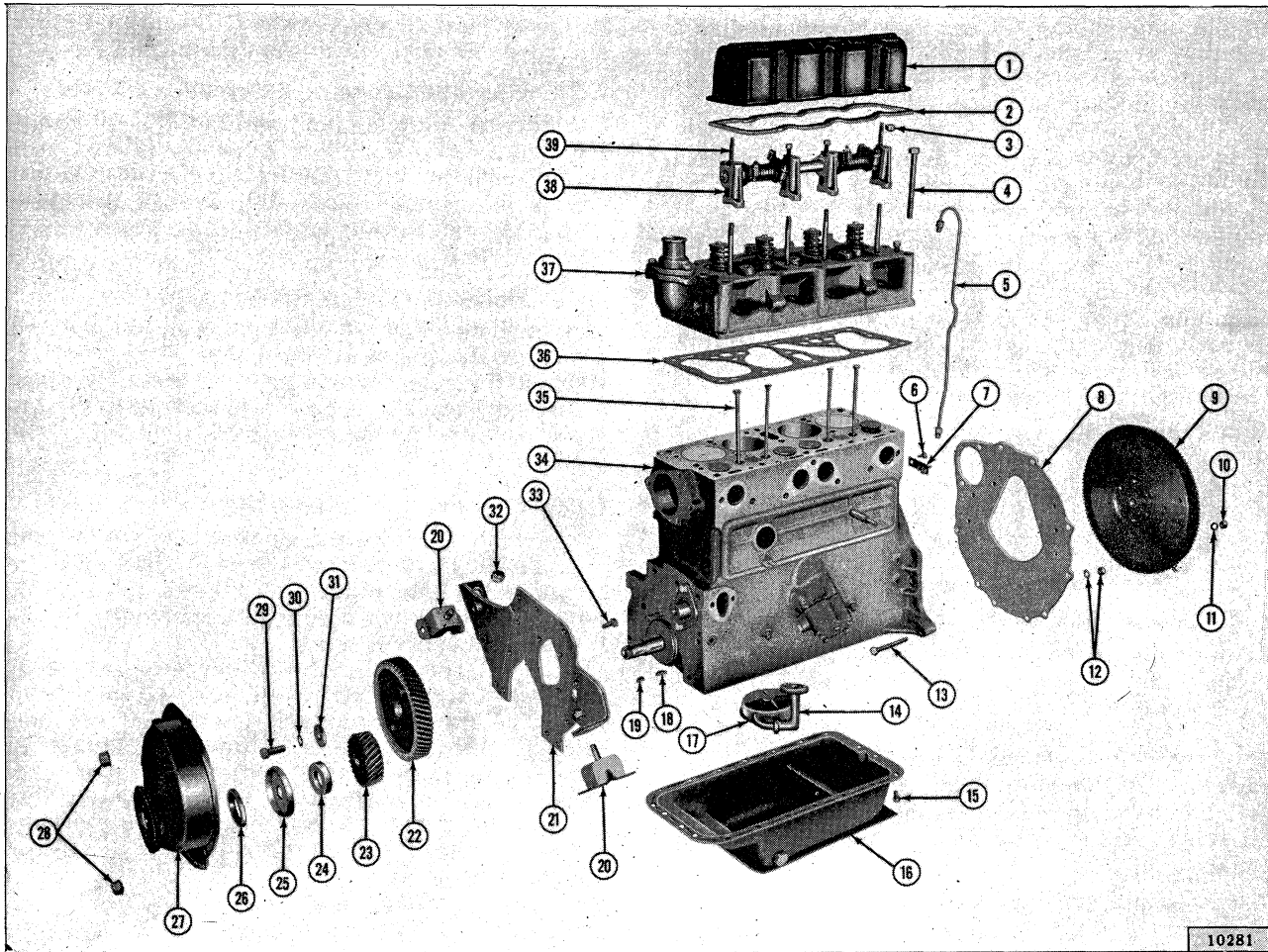


FIG. 74—F4-134 ENGINE

- | | | |
|-------------------------------|-----------------------------------|-------------------------------|
| 1—Rocker Arm Cover | 14—Oil Float Support | 27—Timing Gear Cover |
| 2—Gasket | 15—Screw and Lockwasher | 28—Nut and Lockwasher |
| 3—Rocker Shaft Stud Nut | 16—Oil Pan | 29—Bolt |
| 4—Cylinder Head Bolt | 17—Oil Float | 30—Lockwasher |
| 5—Crankshaft-to-Head Oil Line | 18—Woodruff Key No. 13 | 31—Camshaft Gear Washer |
| 6—Screw and Lockwasher | 19—Woodruff Key No. 9 | 32—Nut |
| 7—Oil Line Clip Bracket | 20—Engine Support Front Insulator | 33—Bolt |
| 8—Engine Rear Plate | 21—Engine Front Plate | 34—Cylinder Block |
| 9—Flywheel | 22—Camshaft Gear | 35—Intake Valve Push Rod |
| 10—Special Nut | 23—Crankshaft Gear | 36—Cylinder Head Gasket |
| 11—Lockwasher | 24—Thrust Washer | 37—Water Outlet Fitting |
| 12—Nut and Lockwasher | 25—Oil Slinger | 38—Rocker Shaft Bracket |
| 13—Dowel Bolt | 26—Crankshaft Front Oil Seal | 39—Valve Cover Hold Down Stud |

assemble the parts of the cylinder head as follows: With a spring compressor tool C-3422, remove the two-piece locks recessed in the valve spring retainers. Pull the O-ring, valve spring, and valve out of the cylinder head. Identify the valves for return to the same guides from which they are removed.

Note: Check the condition of the rubber O-rings. Defective O-rings could be the major cause of oil leakage into cylinders. Always discard and replace all O-rings removed as only new O-rings should be installed at reassembly.

E-17. Ream Cylinder Bore Ridges

To prevent breaking the piston lands, the ridge at the top of each cylinder bore must be removed first. To remove this ridge, use a cylinder ridge reamer, as shown in Fig. 73 following the instructions furnished by the reamer manufacturer. Use care not to cut below the top of the upper ring

travel in the bore. Keep each piston top covered with an oil-soaked cloth to prevent cuttings from falling into the cylinder.

Note: This operation should be performed at this time before the engine is rotated for the sequence steps following.

E-18. Remove Oil Pan

Rotate the engine to the upside down position. Remove the screws and lockwashers that attach the oil pan to the cylinder block. Remove the oil pan and gasket. Discard the gasket.

E-19. Remove Piston and Connecting Rod Assemblies

Remove the stamped locking nuts from the lower end of each connecting rod bearing bolt. Remove the connecting rod nuts. Remove the bearing cap evenly. Push the connecting rod and piston as-

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sembly out of the cylinder block with the handle end of a hammer until the piston rings are free from the cylinder bore.

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 in 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, removing the oil pan and the cylinder head, and reaming the ridges as previously described.

E-20. Remove Timing Gear Cover

Remove the bolts, nuts, and lockwashers, that attach the timing gear cover to the engine. Remove the cover, timing pointer, and cover gasket. Discard the gasket. Remove the crankshaft oil seal from the timing gear cover and discard the seal. Remove the oil slinger and spacer from the crankshaft.

E-21. Remove Timing Gears

Use puller W-172 for pulling both the crankshaft and the camshaft gears. With the threaded cap-screws supplied, adapt the puller to the crankshaft gear and pull the gear. With the special hook-type puller bolts that fit behind the camshaft gear flange, pull the camshaft gear. Remove the Woodruff Keys.

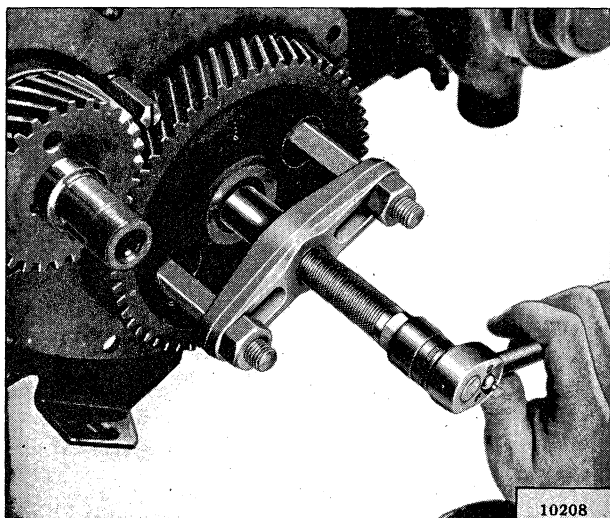


FIG. 75—PULLING TIMING GEARS

E-22. Remove Front End Plate

Remove the screws and lockwashers that attach the front end plate to the cylinder block. Remove the front end plate and gasket. Discard the gasket.

E-23. Deleted.

E-24. Remove Clutch

Remove four bolts and lockwashers diagonally opposite that attach the clutch assembly to the flywheel, leaving two opposed bolts to be loosened alternately until the clutch spring pressure is relieved. Then, support the clutch assembly with

one hand while removing the two remaining bolts. For information on disassembly, inspection, repair and assembly of the clutch refer to Section J. Instructions for removing the clutch when the engine is in the vehicle are also given in Section J.

E-25. Remove Flywheel

The flywheel is attached to the crankshaft with two tapered dowel bolts and four special bolts. Remove these attaching parts. Use a pry bar between the flywheel and the back of the engine and carefully loosen the flywheel from the crankshaft. If the flywheel is to be removed with the engine in the vehicle, the transmission and clutch must first be removed as detailed in Section J.

E-26. Remove Crankshaft

Slide the crankshaft thrust washer and all end-play adjusting shims off the front end of the crankshaft. Pull the two pieces of rear main bearing cap packing out of position between the side of the bearing cap and the cylinder block.

Note the marks on the bearing caps and cylinder block for bearing number and position.

Remove the screws and lockwashers that attach the main bearing caps to the cylinder block. Use a lifting bar beneath the ends of each bearing cap. Be careful not to exert too much pressure to cause damage to the cap or dowels and pry the caps free.

CAUTION: If main bearing caps are not removed carefully by raising both sides of each cap evenly until free of the dowels, the dowels may be bent. A bent main bearing cap dowel can cause misalignment of the cap and resultant rapid bearing wear necessitating replacement. Therefore, remove each main bearing cap carefully. If there is reason to believe any of the dowels have been bent during the bearing cap removal, remove them and install new dowels as detailed in Par. E-34c.

Remove the upper half of the rear main bearing oil seal from the cylinder block and the lower half from the oil seal groove in the rear main bearing cap. Install the main bearing caps and bearings on the cylinder block in their original positions.

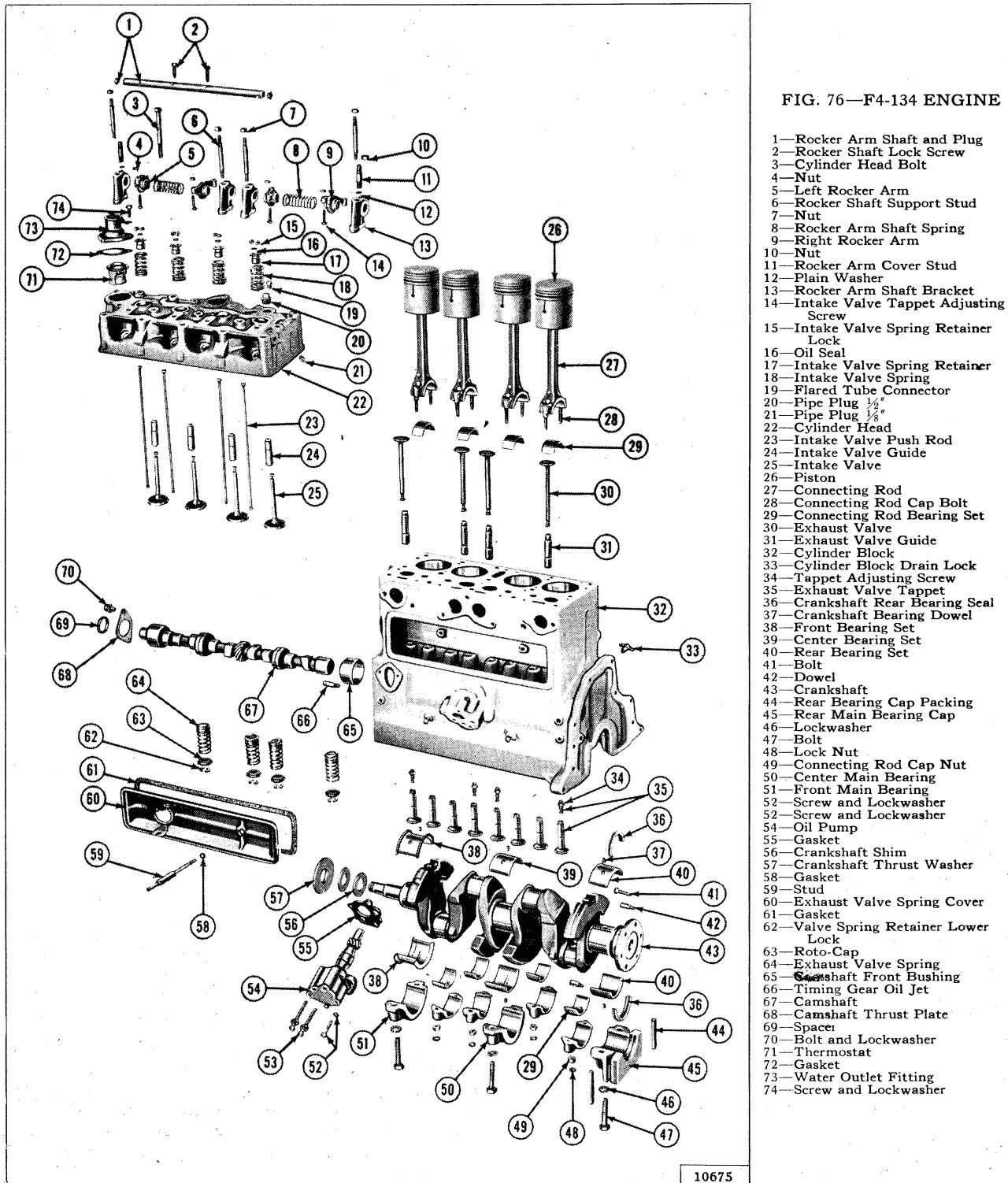
Note: Removal of the crankshaft may be accomplished only with the engine out of the vehicle.

E-27. Remove Exhaust Valves and Springs

Access to the valve chamber is obtained by removing the attaching parts and the valve spring cover and gasket from the cylinder block. Use cloths to block off the three holes in the exhaust valve chamber to prevent the valve retaining locks falling into the crankcase, should they be accidentally dropped.

With a valve spring compressor, C-482, compress the valve springs on those valves which are in the closed position (valve seated against cylinder block). Remove the exhaust valve spring retainer locks, the exhaust valve spring retainer, and the exhaust valve spring. Close the other valves by rotating the camshaft and repeat the above operation for the other valves in the same manner. Lift out all the exhaust valves and tag or place them in a rack to indicate the location where each was re-

FIG. 76—F4-134 ENGINE



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moved from the cylinder block. If a valve sticks in the 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.

For intake valve and spring removal, See Par. E-16.

E-28. Remove Camshaft

a. Push the intake and exhaust valve tappets into the cylinder block as far as possible so the ends of the tappets are not in contact with the camshaft.

b. Secure each tappet in the raised position by installing a common clip-type clothes pin on the

shank of each tappet or tie them up in the valve chamber.

c. Remove the camshaft thrust plate attaching screws. Remove the camshaft thrust plate and spacer.

d. Pull the camshaft forward out of the cylinder block using care to prevent damage to the camshaft bearing surfaces.

E-29. Remove Valve Tappets

Remove the intake and exhaust valve 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 reassembled in their original positions.

E-30. Remove Oil Gallery Plugs

Remove the plug at each end of the oil gallery in the cylinder block. This operation is only applicable when the engine is out of the vehicle and will allow access to the oil gallery so it may be cleaned.

E-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 individually with the engine in the vehicle. Wherever the procedure differs due to the engine being in the vehicle, the necessary special instructions are provided. Inspection and repair instructions are included to cover the cylinder block, cylinder head, 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 undersize bearings or oversize pistons. Refer to Par. E-2.

E-32. Cylinder Block

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

E-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, valve chamber, crankcase, and cylinder walls to remove all sludge, dirt carbon deposits. After cleaning, use air pressure to dry the block thoroughly.

E-34. Inspection

Examine the cylinder block for minute cracks and fractures. Rusted valve springs or evidence of rust in the valve chamber or the cylinder walls is a good indication of a possible crack in the block.

a. Examine all machined surfaces of the cylinder block for burrs and scores. Check for 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. Maximum permissible out of line for service is .010" [0,254 mm.] over the full length of the block.

Inspect tapped openings. Repair any damaged threads. Replace any broken studs.

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

c. If there is any reason to believe that any of the main bearing cap dowels have been bent during bearing cap removal, install new ones. The dowels must fit tightly to ensure cap alignment and as they are hardened they may be difficult to grip and 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. Before installing a new dowel in the cylinder block, make sure the dowel hole is clean. Start the dowel straight in the hole, then tap the dowel lightly with a hammer until it bottoms.

d. When installing bearing caps, be sure to tighten the bolts evenly in each cap to pull it into place 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.

E-35. Cylinder Bores

The cylinder bores may be reconditioned by honing or reboring. Use oil-soaked rags to protect crankshaft journals and other engine parts from abrasive dust during all reconditioning operations.

Both honing and reboring of the cylinders must be done carefully to fit the pistons and to obtain specified clearances. If reboring of the cylinder bores is not required but the walls are glazed, use a finishing hone to remove the glaze. Reboring the cylinders must not be attempted unless adequate facilities and experienced service technicians are available. The amount of material to be removed is determined from the original diameter of the cylinder bores (3.125" to 3.127") [79,375 a 79,426 mm.] plus the amount of oversize in diameter of the oversize pistons to be fitted. Pistons are available in the following oversizes.

.010" [0,254 mm.]	.030" [0,762 mm.]
.020" [0,508 mm.]	.040" [1,016 mm.]

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. The maximum rebore should not exceed .040" [1,016 mm.] from standard.

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. Proceed as follows:

a. If bores are scored; if out-of-round exceeds .005" [0,127 mm.]; if diameters differ more than .005"; or if taper exceeds .005" 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, allow .0015" [0,0381 mm.] for final honing.

All cylinder bore diameters must be within .002" [0,0508 mm.] after reconditioning.

b. If bore measurements are within the above limits, but indicate hollows or waviness, cylinders should be honed with 250 grit stone hone. 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 250 grit stone hone or with a suitable deglazing tool. Operate the hone or deglazer to obtain diamond cross-hatched pattern previously mentioned.

d. Regardless of type of correction on cylinder walls, wash out bores thoroughly afterwards and apply a light coat of engine oil. If cylinders have been rebored or honed heavily, measure cylinder diameters again to assure proper selection of piston size.

E-36. Pistons, Rings, and Connecting Rods

Pistons are each fitted with three rings, two compression rings and one oil control ring. The pistons have an extra groove above the top ring which acts as a heat dam or insulating groove to protect against sealing of the top ring in the ring groove with hard carbon. The piston pin is secured by the lock screw.

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. Use standard size pistons in cylinder bores up to .009" [0,2286 mm.] oversize measured at the bottom of the bore. For oversize, use the following chart:

OVERSIZE PISTON APPLICATION CHART

Oversize Piston	Use in Oversize Cylinder Bore Range	Metric
.010"	.010" to .019"	0,254 a 0,483 mm.
.020"	.020" to .029"	0,508 a 0,737 mm.
.030"	.030" to .039"	0,762 a 0,991 mm.
.040"	.040"	1.016 mm.

Disassemble the pistons and rods. Remove the two compression rings, the oil control ring, and the oil control ring expander from each piston. Do not remove the bolts from the lower end of the connecting rods unless the bolts are damaged. Clamp each connecting rod and piston assembly in a padded bench vise and remove the piston pin lock screw and lockwasher. Press the piston pin out of the piston and connecting rod. Clean all

carbon, gum, and lacquer deposits from both the inner and outer surfaces of each piston, connecting rod, and piston pin. Use a ring groove cleaner or a broken ring filed to a sharp square edge to clean the carbon from the piston ring grooves and the insulator groove. Use care not to scrape metal from the sides of the grooves or make burrs on ring groove surfaces. Run a length of wire through the oil spray hole near the lower end of the connecting rod to clear the hole of hardened oil deposits or foreign matter. Carefully inspect the pistons and replace any that are broken or cracked. Replace pistons if any of the ring lands are chipped, broken, or rounded on the edges; or if the piston is scored, scratched, or burned so seriously that the imperfections cannot be removed with a hand honing stone or crocus cloth.

Replace the pistons as follows:

a. After cylinder bores have been carefully checked for out-of-round and taper (Par. E-35), check fit of each piston to cylinder bore with block and pistons clean and dry and at approximately 70°F.

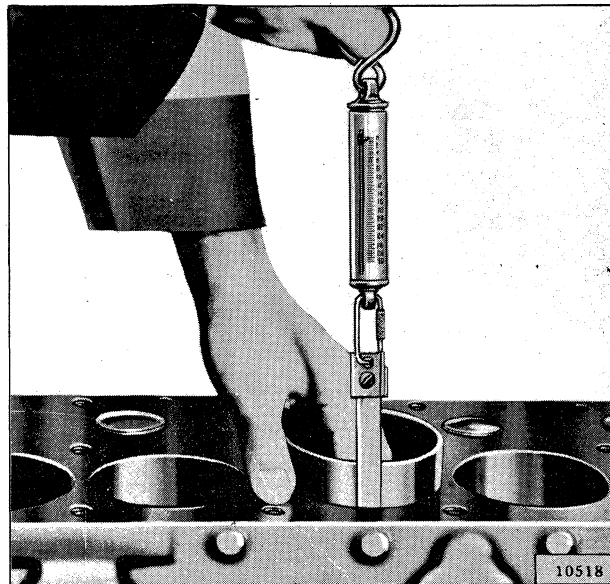


FIG. 77—PISTON FITTING

[21°C.] by using Piston Fitting Gauge And Scale Tool No. C-690 as shown in Fig. 77. Use a .003" [0,0762 mm.] thickness gauge 3/4" [19 mm.] wide. The piston is fitted upside down in the block to facilitate the operation. The gauge must extend the full length of the piston on the thrust side (opposite side from slot in piston skirt). Scale should register 5 to 10 pounds [2,3 a 4,5 kg.] pull to remove the 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 and if necessary correct connecting rod alignment using a connecting rod aligning fixture, such as the one shown in Fig. 78, in accordance with the instructions furnished with the fixture.

c. Check the piston pin fit. The piston pins are fitted with a clearance of .0001" to .0003" [0,0025

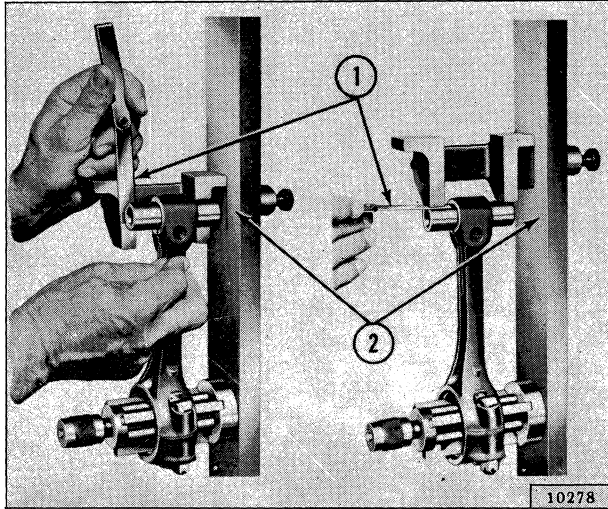


FIG. 78—CHECKING CONNECTING ROD ALIGNMENT

- 1—Feeler Gauge
- 2—Fixture

a 0,0076 mm.] which approximates a light thumb push fit at room temperature. See Fig. 79. The piston pins are anchored in the rods with lock screws. Installation of oversize pins in this engine

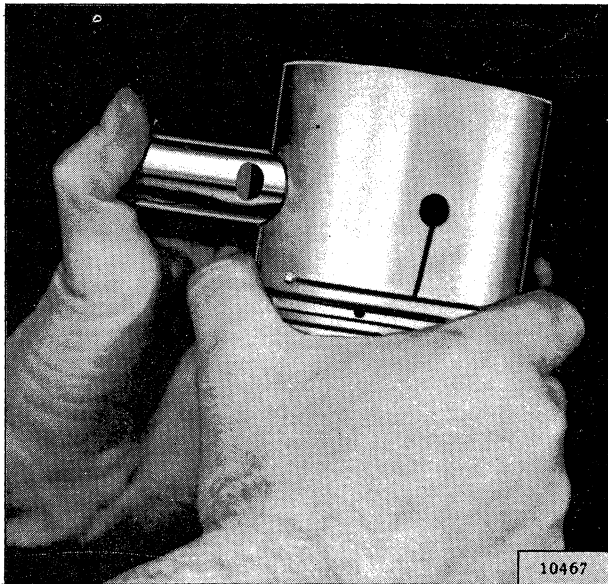


FIG. 79—PISTON PIN FITTING

is not recommended as experience has shown that should a pin be worn sufficiently to require replacement, the piston should also be replaced. Clamp the connecting rod in a vise using jaw shields of soft metal or two pieces of hardwood, one on each side of the rod and positioned approximately 3" [76 mm.] from the piston pin end. Start the piston pin in the piston with the lock screw groove facing down. Assemble piston to connecting rod with the piston skirt T-slot on the opposite side from the oil spray hole in the bearing end of the connecting rod. Install the

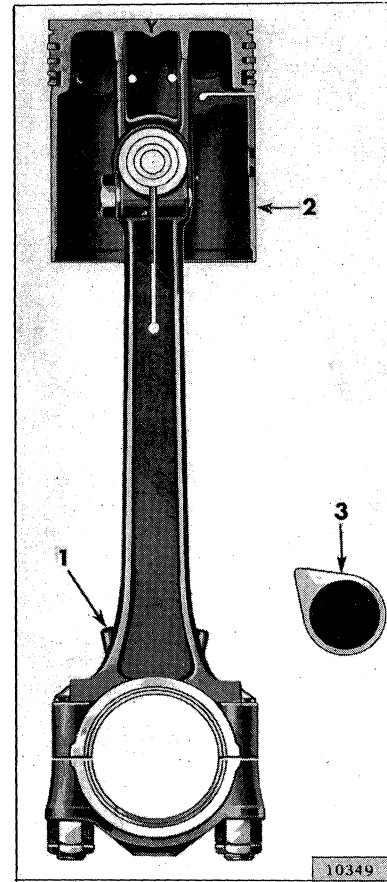


FIG. 80—CONNECTING ROD AND PISTON

- 1—Oil Spray Hole
- 2—Piston skirt T slot
- 3—Relative Position of Camshaft

piston pin lock screw and torque 35 to 41 lb-ft. [4,8 a 5,7 kg-m.].

d. Place piston and rod assembly in a connecting rod aligning fixture and check alignment of the

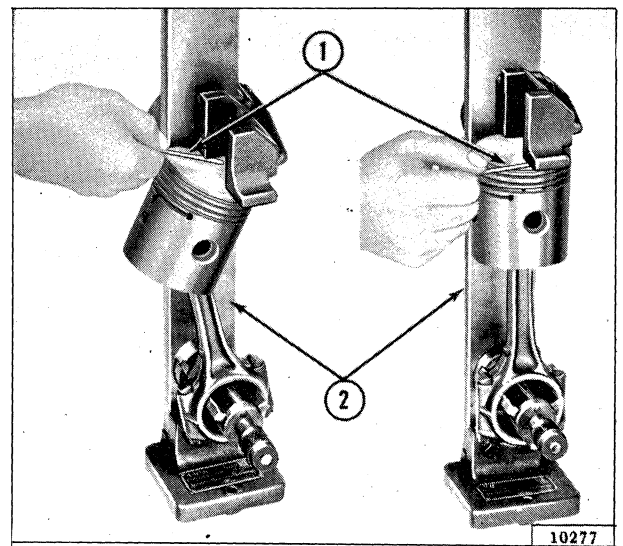


FIG. 81—CHECKING PISTON AND CONNECTING ROD ALIGNMENT

- 1—Feeler Gauge
- 2—Fixture

assembly as shown in Fig. 81. Follow instructions furnished with the fixture.

e. Using a feeler gauge and new piston rings, check the width of the two compression ring grooves and the oil ring groove. Replace the piston if the widths of the grooves are not with the limits given in the specifications.

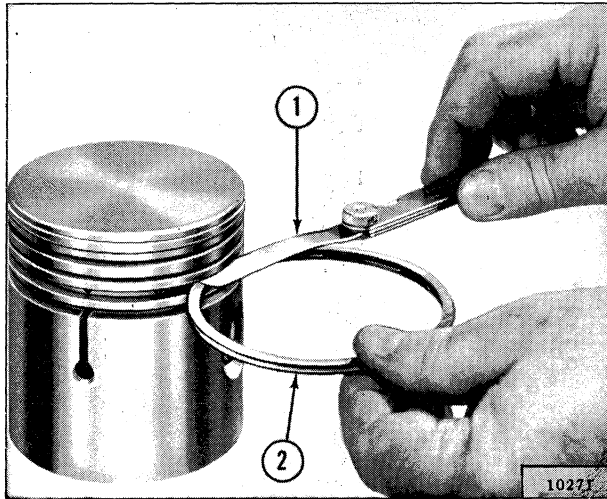


FIG. 82—CHECKING PISTON RING SIDE CLEARANCE
1—Feeler Gauge
2—Piston Ring

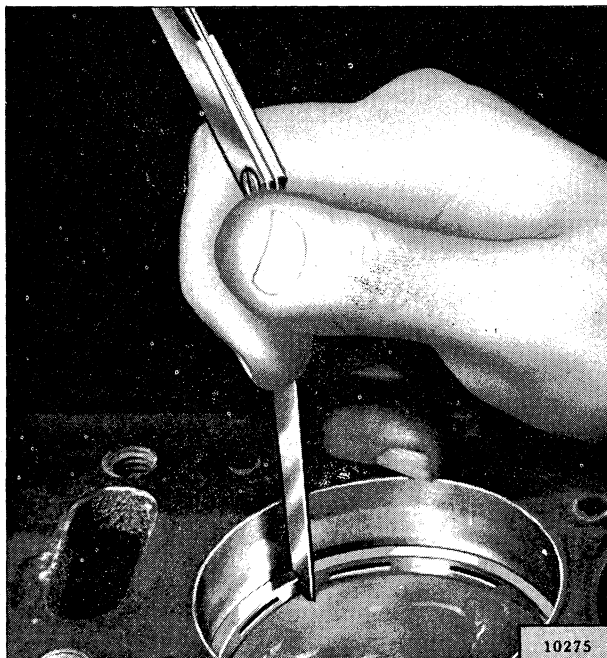


FIG. 83—PISTON RING GAP

Insert feeler gauge between ring and piston to back of groove. Replace piston if ring grooves are not within allowable tolerances. If a feeler gauge larger than .006" [0,152 mm.] can be inserted $\frac{1}{16}$ " [1,6 mm.] between piston and upper compression ring, groove is worn excessively bell-mouthed and piston should be replaced.

f. Check piston ring end gap by placing compression ring in cylinder bore below ring travel using

head of an inverted piston as a plunger to push ring in squarely. End gap must be as shown in Par. E-37 for all rings. If less, file ends to obtain minimum gap. With cylinders bored to an exact ring oversize of +.020", +.030", or +.040" [0,508-0,762-1,016 mm.] the proper end clearance as given in Par. E-37 will result. If end gaps are not within the limits given in Par. E-37, rings are of the wrong size or were incorrectly filed for fitting.

g. Install a new ring set using either production replacement rings or service type oil control rings. Production type replacement piston rings are the same as the original factory-installed rings while service oil control ring sets have different components, notably the oil ring expander. Follow instructions of manufacturer for proper installation. Use a piston ring expander to install rings on pistons. Do not expand rings more than necessary to install, also be careful not to burr the piston with ends of rings. Install bottom (oil) ring first, center ring second, and top ring last.

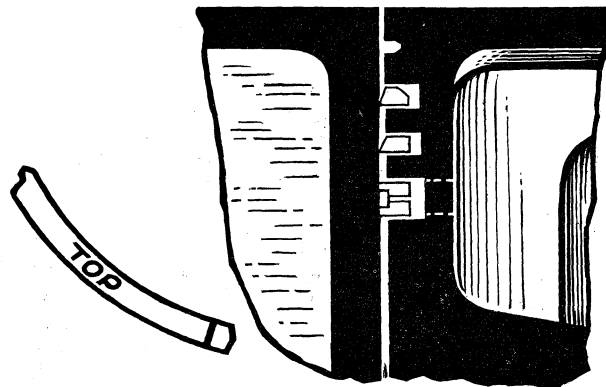


FIG. 84—PISTON RING INSTALLATION

The width of the compression rings is $\frac{3}{32}$ " [2,38 mm.] and that of the oil control ring is $\frac{3}{16}$ " [4,78 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. 84. The upper compression ring has an inside beveled edge which must be installed toward the piston top. The face of the lower compression ring is tapered approximately .001" [0,03 mm.]. The letters **T** or **TOP** on the upper edge indicate how the ring is to be installed.

E-37. Piston Ring Application Chart

Cylinder Bore Oversize	Correct Ring Size	Ring Gap Fitting	End Gap
Std. to .009" [a 0,483 mm.]	Std.	None	.007" to .045" [0,1778 a 1,1430 mm.]
.010" to .019" [0,254 a 0,4826 mm.]	-.020"	File fit	.007" to .017" [0,1778 a 0,4318 mm.]
.020" to .024" [0,508 a 0,6096 mm.]	-.020"	None	.007" to .029" [0,1778 a 0,7366 mm.]
.025" to .029" [0,635 a 0,7366 mm.]	-.030"	File fit	.007" to .017"
.030" to .034" [0,762 a 0,8636 mm.]	-.030"	None	.007" to .029"
.035" to .039" [0,8890 a 0,9906 mm.]	-.040"	File fit	.007" to .017"
.040" [1,016 mm.]	-.040"	None	.007" to .017"

E-38. Crankshaft

The crankshaft is machined from a heat-treated carbon steel forging and is carefully balanced both dynamically and statically. The crankshaft is supported by three replaceable main bearings. The front main bearing is flanged to take the end thrust of the crankshaft. A flanged section on the rear of the crankshaft acts as an oil slinger. While the crankshaft is out of the engine, handle it carefully to prevent damage to the connecting rod crankpins and the main bearing journals. Refer to Fig. 85.

E-39. Crankshaft Inspection and Repair

Clean out the drilled oil passages in the crankshaft journals with a small rifle brush making sure to get rid of all sludge or gum deposits. Blow out the passages with compressed air after cleaning. Clean the crankshaft thoroughly with a suitable cleaning solvent. Inspect the crankshaft for cracks, alignment, and condition of the crankpins and the main bearing journals. Use magnaflux equipment, if available, to check for cracks or structural flaws. Cracks, misalignment, and scored or worn journals and crankpins necessitate crankshaft repair or replacement.

Check crankshaft counterweights to be sure they are not loose.

E-40. Checking Crankshaft Alignment

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

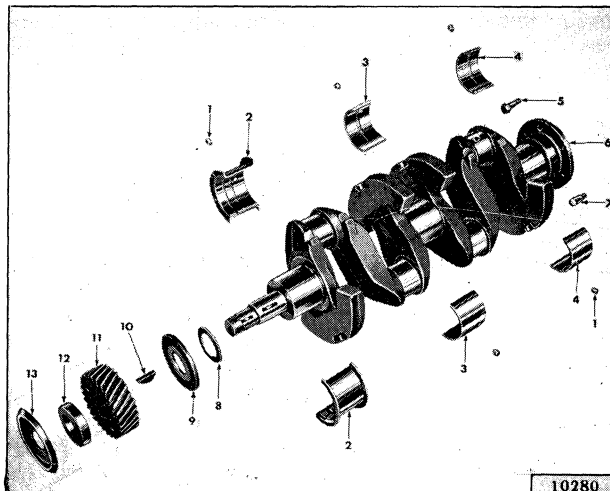


FIG. 85—CRANKSHAFT AND BEARINGS

- | | | |
|------------------|-----------------------|--------------------|
| 1—Bearing Dowel | 6—Crankshaft | 11—Crankshaft Gear |
| 2—Front Bearing | 7—Flywheel Dowel-Bolt | 12—Gear Spacer |
| 3—Center Bearing | 8—Crankshaft Shim | 13—Oil Slinger |
| 4—Rear Bearing | 9—Thrust Washer | |
| 5—Flywheel Bolt | 10—Woodruff Key No. 9 | |

E-41. Checking Main Bearing Journals

An ordinary 3" [7,62 cm.] micrometer may be used. The standard journal diameter is 2.3341" to 2.3331" [5,9286 a 5,9261 cm.] for all main bearings. Allowable taper or out-of-round of the journals is .001" [0,0254 mm.].

E-42. Checking Connecting Rod Crankpins

Check the crankpin diameters with a micrometer to ensure that they are not out-of-round or tapered more than .001" [0,0254 mm.]. The standard crankpin diameter is 1.9383" to 1.9375" [4,9233 a 4,9213 cm.].

E-43. Deleted.**E-44. Crankshaft Main Bearings**

The crankshaft rotates on three main bearings with a running clearance of .0003" to .0029" [0,0008 a 0,0103 mm.].

These bearings are positioned and prevented from rotating in their supports in the cylinder block by dowel pins. Dowel pins are used in both the center and the rear bearing caps. No dowel pins are used in the front bearing cap because the bearing has a flange. The front main bearing takes the end thrust of the crankshaft. The main bearings are of premium type which provides long bearing life. They are replaceable and when correctly installed, provide proper clearance without filing, boring, scraping, or shimming. Crankshaft bearings can be removed from this engine only with the engine out of the vehicle. Crankshaft bearings must be replaced as a complete set of three bearings, each bearing consisting of two halves. Main bearings are available in the standard size and the following undersizes:

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

The .001" and .002" undersize main bearings are for use with standard size crankshafts having slightly worn journals. The .010", .020", and .030" undersize bearings are for use with undersize crankshafts in those sizes. The .012" undersize bearings are for use with .010" undersize crankshafts having slightly worn journals. Bearing sizes are rubber stamped on the reverse side of each bearing half.

E-45. Crankshaft Main Bearing Inspection

The crankshaft journals must be carefully inspected as detailed previously in Par. E-41. Worn journals will require undersize bearings. Scored, flaked, or worn bearings must be replaced. Measure the main bearing bores in the cylinder block using a telescope gauge and micrometer. Measure the bores at right angles to the split line and at 45° to the split line. The bores should not be over .001" [0,0254 mm.] out-of-round or .001" in taper from end to end. Also, the bores should not be more than .001" oversize, considering the average diameter of the bore.

E-46. 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 .0003" to .0029" [.0008 a .0074 mm.]. With a dimension in excess of this standard running fit, a satisfactory bearing replacement cannot be made and it will be necessary to regrind the crankshaft. Install the bearing lower half and the bearing cap and draw the nuts down equally and only slightly tight. Rotate the crankshaft by hand to be sure it turns freely without drag. Pull the nuts tighter, first one then the other, a little at a time, intermittently rotating the crankshaft by hand until the recommended torque of 35 to 45 lb-ft. [4,8 a 6,2 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" [0,025 mm.] clearance is recommended for checking crankshaft main bearing clearance. The method of checking clearance is as follows:

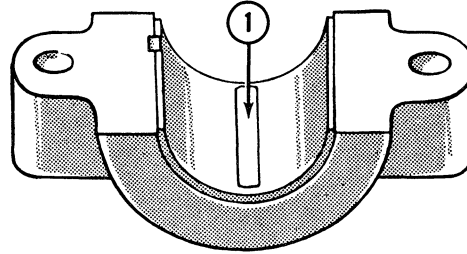
- Remove the bearing cap and carefully wipe all oil from the bearing and the journal.
- Lay a piece of "Plastigage" $\frac{1}{8}$ " [3 mm.] shorter than the width of the bearing across the journal (lengthwise of the crankshaft).
- Install the bearing and cap and tighten first one nut, then the other, 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.
- Remove the cap and measure the width of the flattened "Plastigage," using the scale printed on the edge of the envelope. The proper size "Plastigage" will accurately measure clearance down to .001".
- 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.

E-47. 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.

- Cut a piece of .001" [0,025 mm.] thick, by $\frac{1}{2}$ " [12,7 mm.] wide, feeler stock $\frac{1}{8}$ " [3 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. 86. With the

shim in this position, install the bearing and cap on the crankshaft.



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FIG. 86—SHIM STOCK IN POSITION ON MAIN BEARING

1—.001" Feeler Stock $\frac{1}{2}$ " Wide

- Tighten the bearing cap nuts, first one and then the other, a little at a time to 35 to 45 lb-ft. torque [4,8 a 6,2 kg-m.].
- 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" 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.

- 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 nuts first one, then the other, a little at a time, to the prescribed torque. The crankshaft should now turn freely without drag.

E-48. Connecting Rod Bearings

The connecting rod bearings, like the crankshaft main bearings, are of the replaceable type. When correctly installed, the bearings provide proper clearance without filing, boring, scraping, or shimming.

Main bearings with maximum wearing surfaces are obtained through the use of offset connecting rods. When the rods are installed, the offset "A" in Fig. 87 is placed away from the nearest main bearing "B".

The oil spray hole should be on the "follow" side or away from the camshaft, toward the right side of the vehicle. Because of the offset and oil spray hole, No. 1 and 2 or No. 3 and 4 connecting rods 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.

Connecting rod bearings should be replaced as a complete set. Each bearing consists of two halves. Connecting rod bearing sets are available in standard size and the following undersize:

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

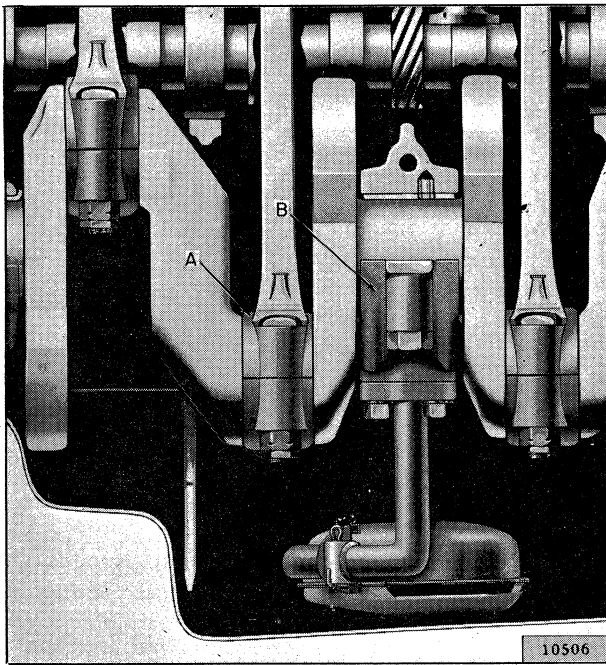


FIG. 87—CONNECTING ROD OFFSET

The .001" and .002" undersize bearings are for use with standard size crankshafts having slightly worn crankpins that do not require grinding. The .012" undersize bearings are for use with slightly worn crankshafts that have been previously ground for .010" undersize bearings.

Should it be necessary to replace the bearings due to wear, replacement of piston rings and piston pins is also recommended.

NOTE: Should it be necessary to replace a scored or burned No. 1 connecting rod bearing, see Par. E-93 regarding timing gear oil jet.

E-49. Connecting Rod Bearing Inspection

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 crankpins must be carefully inspected as detailed previously in Par. E-41. Worn crankpins will require undersize bearings. Scored, flaked, or worn bearings must be replaced.

E-50. Installing Connecting Rod Bearings

New bearings must be installed so that the oil spray hole in the upper bearing half aligns with the oil spray hole in the connecting rod. Each bearing cap must be installed to seat evenly on the connecting rod from which it was removed, and in the same position. After wiping and carefully inspecting the bearing bore in the connecting rod, install the proper bearing. 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 .003" to .0025" [0,0076 a 0,0635 mm.]. With a dimension in excess of this standard running fit, a satisfactory bearing replacement cannot be made and it will be necessary to regrind the crankshaft. 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 the recommended torque of 35 to 45 lb-ft. [4,8 a 6,2 kg-m.] is reached. If the bearings are of the correct size, and have been properly lubricated with light engine oil before installation, the connecting rod should be easy to slide 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 "Plasti-gage" or shim stock of the proper size to measure .001" [0,0254 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. E-46 or E-47. Connecting rod bearings are fitted to the same clearance as the main bearings but the torque specified for connecting rod cap bolts is different.

E-51. Connecting Rod Side Play

Check the connecting rod side play with a feeler gauge as shown in Fig. 88. The side clearance is .004" to .010" [0.1016 a 0,254 mm.].

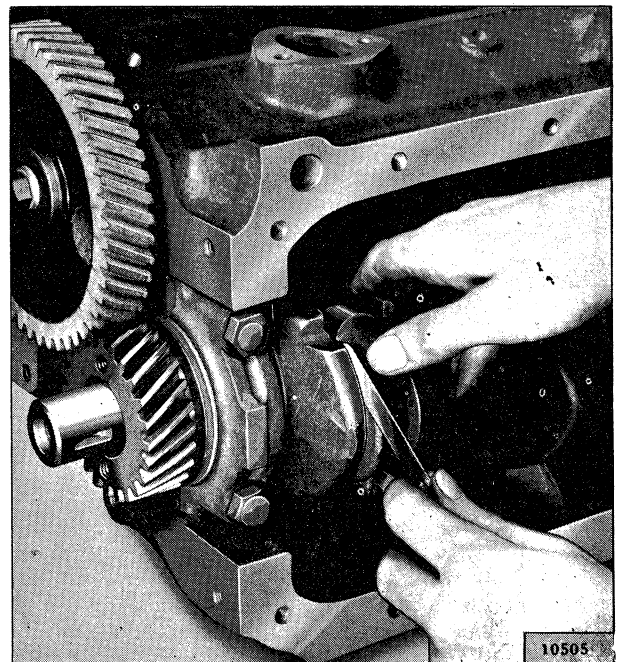


FIG. 88—CONNECTING ROD SIDE PLAY

E-52. Deleted.

E-53. Camshaft and Bearings

The camshaft is supported at four points in the cylinder block. The front is supported in a replaceable, steel-shell, babbitt-lined bearing. The bearing is pressed into place. The other three bearing surfaces are precision machined in the cylinder block. The camshaft bearings are pressure lubricated through drilled passages in the crankcase. End thrust of the camshaft is taken by a thrust plate bolted to the crankcase. The camshaft is driven by a silent helical-cut tooth timing gear at the front of the engine. A worm gear, integral with the camshaft, drives the oil pump and distributor. The fuel pump is actuated by an eccentric forged onto the camshaft.

Clean the camshaft thoroughly in cleaning solvent. Inspect all camshaft bearing surfaces to determine if they are scored or rough. The cam faces must be perfectly smooth throughout their contact face and must not be scored or worn.

E-54. Camshaft Front Bearing Replacement

Use a suitable driver to remove the camshaft front bearing from the cylinder block. To install a new bearing, align the oil hole in the bearing with the bored oil hole in the cylinder block and drive the bearing in until the front end of the bearing is flush with the front surface of the cylinder block. Make sure the oil hole is open and clear. It is not necessary to line-ream the bearing after installation because bearings for replacement are precision reamed to the finished size. Do not stake the bearing.

E-55. Camshaft End Play

End play of the camshaft is determined by running clearance between the rear face of the camshaft gear and the thrust plate and is established by the spacer thickness. The standard clearance is .004" to .007" [0,102 a 0,178 mm.] and can be measured by a dial indicator. As a general rule this clearance will change but little through wear or when a new gear is installed. To predetermine the correct end float with the gear, spacer, and thrust plate removed, measure the thickness of both the thrust plate and spacer with a micrometer. The thickness of the spacer should be approximately .006" [0,152 mm.] greater than that of the thrust plate. When this is correct and the parts are assembled and drawn tightly together by the gear retaining screw, the end play should come within standard limits.

E-56. Timing Gears and Cover

The timing gears are mounted at the front of the engine. Camshaft drive is through helical-cut timing gears; a steel gear on the crankshaft and a pressed fiber gear on the camshaft. The gears are keyed to their respective shafts. The camshaft driven gear is secured on the front end of the camshaft by means of a capscrew and a plain washer. The crankshaft gear is secured on the front end of the crankshaft by a nut threaded onto the front end of the crankshaft holding the crank-

shaft pulley, crankshaft oil slinger, and the crankshaft drive gear spacer. The timing gears are lubricated through a jet threaded into the crankcase directly above the gear contact and oil supplied through a drilled passage from the front main bearing. The timing gears are enclosed by the sealed timing cover. The oil seal in the cover bears against the hub of the crankshaft pulley. Timing gears are accessible for inspection or replacement with the engine installed in the vehicle after removing the radiator, belt drive pulley, and timing cover.

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 both gears. It is also advisable to check both the oil jet and oil passage to the crankshaft front bearing to be sure that they are clear.

E-57. Inspection and Repair

Check the general condition of both gears and inspect for evidence of excessive wear. Replace excessively worn or damaged gears. Inspect the cover and replace if bent or damaged. It is recommended that the crankshaft oil seal in the cover be replaced when the cover is removed to ensure a good seal around the crankshaft. To replace this seal with the engine in the vehicle requires removing the radiator and water pump.

E-58. Valves, Springs, and Guides

The exhaust valves seat on the top of the cylinder block with the stems extending down through replaceable valve guides. The exhaust valves are actuated by the camshaft through exhaust valve tappets. The exhaust valve springs are assembled and locked on the lower end of the exhaust valve stems. The retaining locks are the split type, which fit in a recess on the valve stems and into the taper in the valve spring retainers.

Adjustment of exhaust valves is by means of the adjusting screw threaded into the upper end of the exhaust valve tappets. An exhaust valve rotator, used as a valve spring retainer is installed on the lower end of the exhaust valve. This valve rotator, known as "Roto Cap", is a spring-loaded ball bearing device. On each lift, or opening stroke of a valve, the rotator gives the valve a slight positive clockwise rotation.

The intake valves operate in valve guides in the cylinder head and are actuated by rocker arms. The rocker arms are actuated by valve push rods and the intake valve tappets. The intake valve springs, the intake valve spring retainers, and the intake valve spring retainer locks make up the remainder of the valve operating parts. An intake valve spring retainer oil seal which encircles the upper end of the intake valve between the valve locks and the upper end of the valve guide, controls the passage of oil along the valve stem and guide.

Note: When engine trouble indicates defective valves as a possible source of trouble, also check the vacuum-pump-to-manifold vacuum line connector.

E-59. Inspection of Valves, Springs, and Guides

Clean the valves on a wire wheel, making sure that all carbon is removed from the top and the underside of the heads and that all gum and varnish deposits are removed from the stems.

Polish the valve stems with steel wool or crocus cloth. Visually inspect all valves for warpage, cracks, or excessive burning and discard if one of these conditions exists. Replace any worn, pitted, or corroded valves that cannot be cleaned with a wire brush. Replace any valves when seats are pitted, burned, or corroded so badly that they cannot be cleaned up with a light refacing on a valve refacing machine.

Replace valves with marks of scoring or abrasion visible on the stem. Replace any valves with bent stems which will be apparent when the valve is

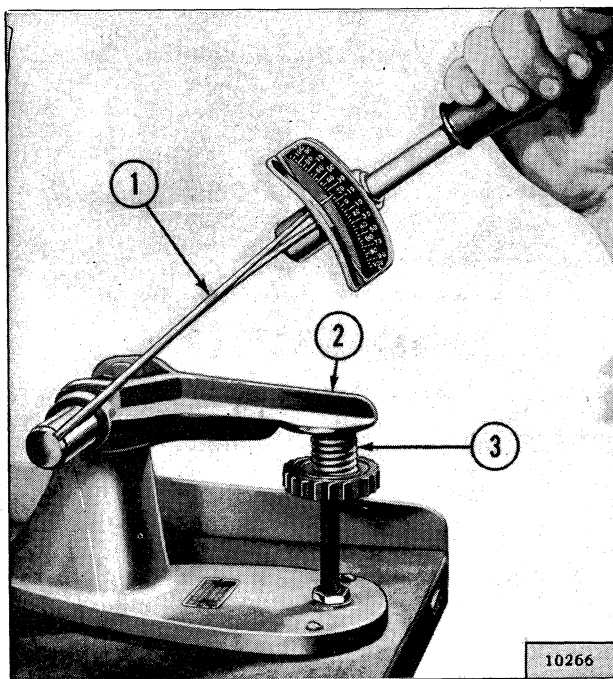


FIG. 89—TESTING VALVE SPRING

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

mounted in the valve refacing machine.

Note: Use only hard-face exhaust valves, Part No. 928342, for replacement.

Examine the stems of valves which employ the ball bearing rotators. Wear marks around the circumference of the stems indicates that the valve is rotating satisfactorily. Vertical heavy pressure areas indicate that the valve is not rotating and the valve spring retainer (Roto Cap) should be replaced if at fault. Check the diameter of the valve stem at two or three places along the length of the stem with a micrometer. The intake valve stem diameter is .3733" to .3738" [9,482 a 9,495 mm.]. The exhaust valve stem diameter is .371" to .372" [9,423 a 9,449 mm.].

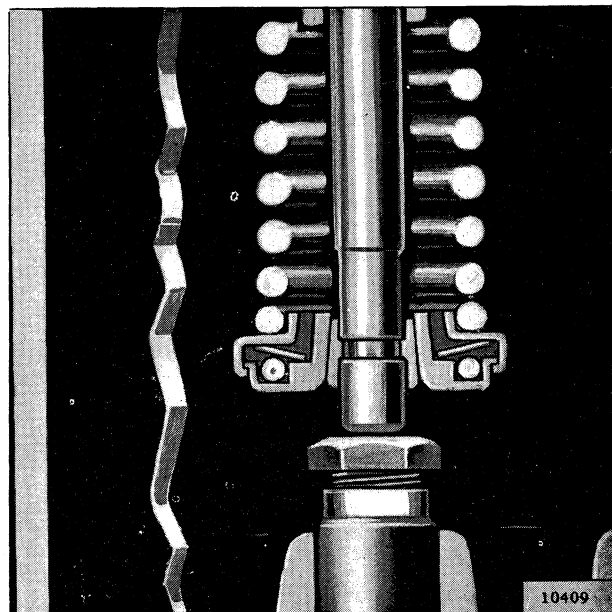


FIG. 90—VALVE WITH ROTO CAP

Note: Exhaust and intake valve springs are similar in appearance. They must not be interchanged as they have different spring characteristics.

Wash the valve springs thoroughly in solvent. Visually examine the springs and replace any that are deformed or obviously damaged. Examine for corrosion from moisture or acid etching which might develop into surface cracks and cause failure. Measure the over all free length of the springs and replace any that do not measure to standard: 1³¹/₃₂" [35,7 mm.] for intake valve springs and 2¹/₂" [63,5 mm.] for exhaust valve springs. If possible, check each valve spring in a valve spring testing fixture as shown in Fig. 89. Test each spring when compressed to the two different spring lengths given (representing valve closed and valve open spring length). If any spring fails to register spring tension equal to or greater than the minimum load limit in pounds specified for that spring length, replace the spring.

	Length	Minimum Load
Intake valve spring	1.66" [43,5 mm.]	66 lb. [29,9 kg.]
	1.40" [35,6 mm.]	140 lb. [63,5 kg.]
Exhaust valve spring	2.11" [53,6 mm.]	47 lb. [21,3 kg.]
	1.75" [44,5 mm.]	110 lb. [49,9 kg.]

Note: When using a spring checking fixture as shown in Fig. 89, it is necessary to convert the torque wrench reading which is in pounds-feet to the static pound pressure specified above according to the instructions furnished with the wrench. For example, should the torque wrench reading be 50 lb-ft. and the wrench is two feet long the static pressure of the spring will be 50 x 2 or 100 lbs.

Clean the valve guides with a standard valve guide cleaner or a wire brush. Check the valve guides in

the cylinder block. Replace valve guides which are broken or worn enough to cause excessive valve stem-to-guide clearance. See Par. E-63.

Standard intake valve clearance is .0007" to .0022" [0,01778 a 0,05588 mm.] and the exhaust valve clearance is .0025" to .0045" [0,0635 a 0,1143 mm.]. Excessive clearance between the valve stems and guides will cause improper seating and burned valves. When there is a tendency to draw oil vapor through the guide 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. Check the clearance with a suitably mounted dial indicator or 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.

E-60. Refacing Valves

Reface the valves with a valve refacer. The valve refacer manufacturer's instructions should be followed carefully to ensure a valve face concentric with the valve stem. Reface both intake and exhaust valves to an angle of 45°. Take off only the minimum of metal required to clean up the valve faces.

If the thickness of the edge of the valve head is reduced to less than $\frac{1}{32}$ " [0,8 mm.] replace the valve.

Note: Cocked or deformed valve springs or improperly installed or missing locks can be responsible for valve problems.

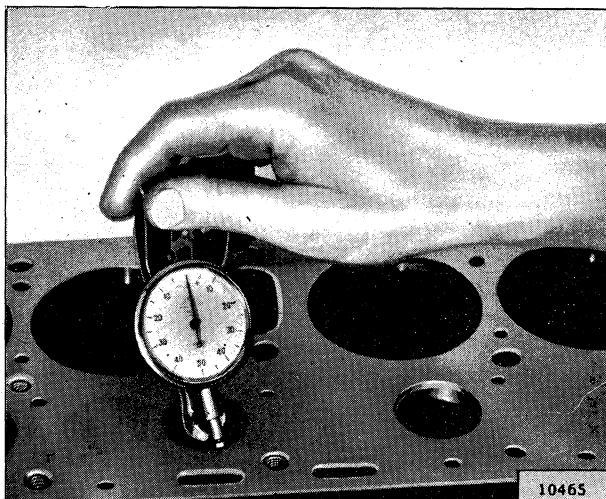


FIG. 91—GAUGING VALVE SEATS

E-61. Valve Seat Inspection and Refacing

Inspect the valve seats for cracks, burns, pitting, ridges, or improper angle. During any general engine overhaul it is advisable to reface the valve seats in both the cylinder block and head regardless of their condition. If the valve guides are to be replaced, this must be done before refacing the valve seats. Note that later engines have hardened exhaust valve seat inserts.

Valve seat inserts must be concentric with finish

ream of valve stem guides (exhaust) within .002" [0,051 mm.] total indicator reading.

When necessary to reface the valve seats, use a valve seat grinder in accordance with the grinder manufacturer's instructions. Any grinding of valve seats should be preceded by touching up the grinding stone so that their angles are accurate and the stone is not clogged. Grind each valve seat to a true 45° angle. Never grind any more than is necessary to clean up pits, grooves, or to correct the valve seat runout. Check the valve seats with a dial indicator as shown in Fig. 91 after refacing.

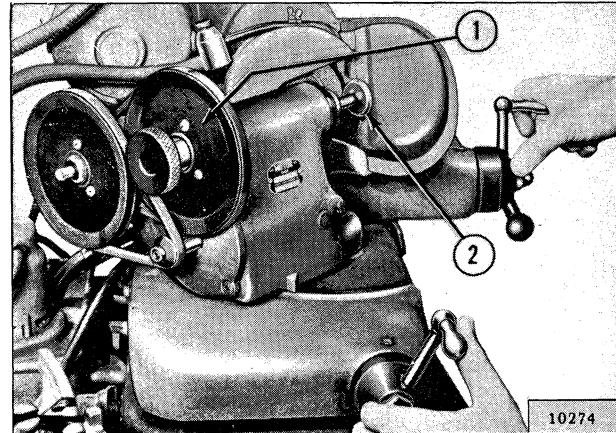


FIG. 92—REFACING VALVES

1—Valve Refacer
2—Valve

The valve seat should not be out of round more than .002" [0,051 mm.]. A simple check can be made in the absence of a dial indicator by spreading a thin coat of pencil lead or bearing-fitting blue on the valve face and then inserting the valve into the valve seat. With hand pressure, rotate the valve a quarter turn and then remove the valve and observe the transfer of blue (or pencil lead) to the valve seat. An uneven transfer will indicate an inaccurate valve and valve seat refacing operation. After the seat is ground, check its width with a seat width scale or a steel scale placed across the face of the seat. The valve seat width after refacing should measure $\frac{3}{32}$ " [2,3 mm.] and not wider than $\frac{1}{8}$ " [3,2 mm.]. Valve seat width is vital. Too wide a seat can cause seat burning as it tends to trap and hold carbon particles. Seats that are too narrow will not transfer heat to the coolant rapidly enough to keep the valves in proper operating condition. 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. Narrow the seat without changing its position in relation to the valve face by using a valve seat relief counterbore above the seat and a valve seat narrowing cutter below the seat. These operations are performed only after the valve seats have been refaced and then only when necessary. The finished valve seat should contact the approximate center of the valve face. Check by applying an extremely thin coat of pencil lead or bearing-fitting blue to the seat. Then install and rotate the valve with light pressure. Blue (or pencil marks)

will transfer to the face of the valve. If the blue is near the top edge of the valve face, lower the valve seat by using the valve seat relief counterbore. If the blue is transferred to the bottom edge of the valve face, raise the seat by using the valve seat narrowing cutter.

When the valve seat can no longer be corrected, it is advisable to investigate installing seat inserts.

E-62. Exhaust Valve Seat Insert Replacement

Hardened valve seat inserts for exhaust valves were installed in production beginning with engine serial number 4J-200614. They will seldom 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 a driver that will keep the insert in true alignment with the bore. Cool the insert and the installing tool with dry ice for 30 minutes.

Note: The insert should be sufficiently cooled to permit installation with light taps; excessive driving of the insert may cock it in the counterbore or crack the insert.

Make certain the valve seat is facing out. Drive in the insert with the tool until it bottoms in the counterbore. After installation, grind the valve seat at an angle of 45° and then check with a dial indicator as shown in Fig. 91.

E-63. Valve Guide Replacement

Damaged, loose, or worn valve guides must be replaced. Use a valve guide driver to drive out the old guides. When replacing valve guides, maximum engine performance can be secured only when the guide is positioned correctly. Driver W-238 is equipped with an adapter ring which correctly positions the guides. See Fig. 93.

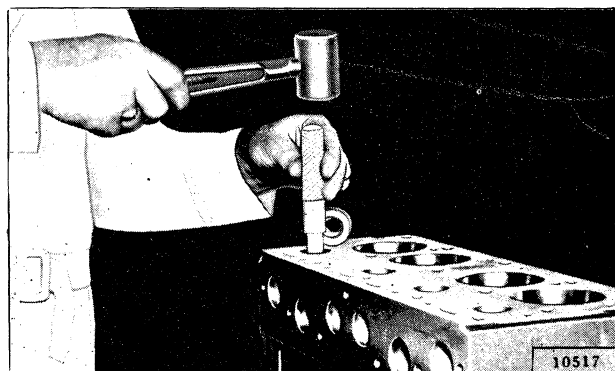


FIG. 93—VALVE GUIDE DRIVER

Start a new exhaust valve guide, blunt (nontapered) end first, into the valve guide bore in the top of the cylinder block. When properly positioned, the top end of the guide is exactly 1" [25,4 mm.] below the level of the top of the block as shown in Fig. 94. Start a new intake valve guide, tapered end first, into position from the bottom of the cylinder head. When properly positioned, the end of the guide is just flush with the end of the valve guide bore in the cylinder head as shown in Fig. 94.

Run a reamer (Tool C-38) through the new guides after they have been correctly positioned.

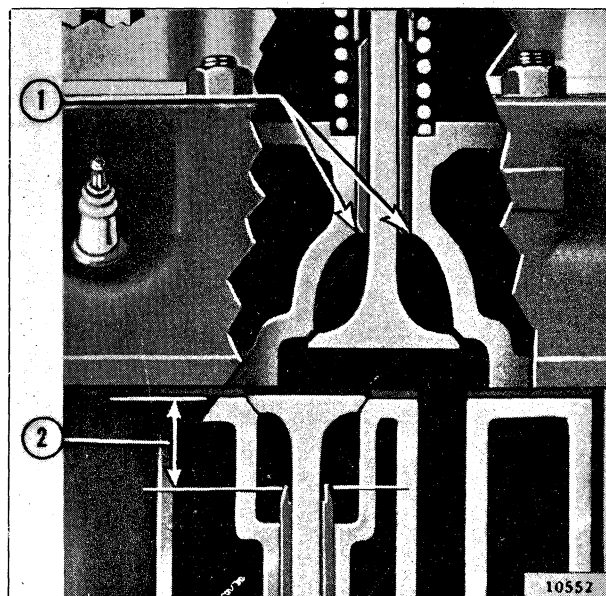


FIG. 94—VALVE GUIDE POSITIONS

1—Flush at this point 2—One Inch [25 mm.]

E-64. Tappets and Cover

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

Check the threads and fit of the exhaust valve adjusting screw in the exhaust valve tappets. The fit of a screw should be such that a wrench is required to turn it into or out of the tappet as these are of the self-locking type. Replace the worn part, either the screw or the tappet, or both, if there is looseness between the parts.

E-65. 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.

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

- 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 .0029" [0,0736 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 1/4" [6 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 the crankcase.

E-66. Floating Oil Intake

The floating oil intake is attached to the bottom of the crankcase with two screws. The float and screen causes it to ride, raise and lower with the amount of oil in the pan. This prevents water or dirt, which may have accumulated in the bottom of the oil pan, from circulating through the engine because the oil is drawn horizontally from the top

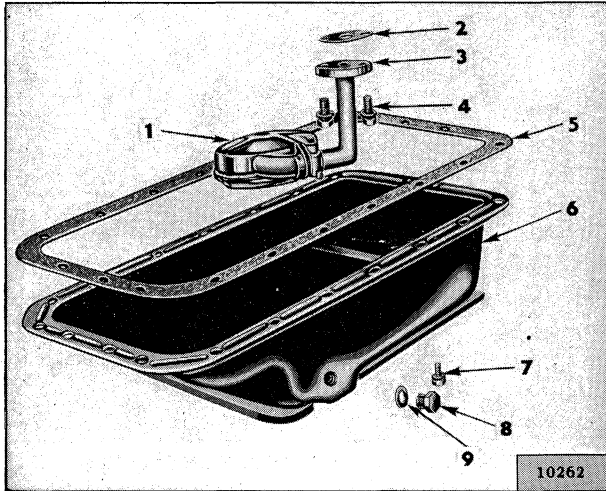


FIG. 95—FLOATING OIL INTAKE AND PAN

- 1—Oil Float
- 2—Gasket
- 3—Oil Float Support
- 4—Screw and Lockwasher
- 5—Oil Pan Gasket
- 6—Oil Pan
- 7—Bolt and Lockwasher
- 8—Drain Plug
- 9—Drain Plug Gasket

surface. Whenever removed, the float, screen, and tube should be cleaned thoroughly to remove 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 is flat. Clean both the flange and the crankcase surfaces thoroughly before installing a new gasket. Be sure the retaining screws are tight.

E-67. Oil Pump

The oil pump is located externally on the left side of the engine. In operation oil is drawn from the crankcase through the floating oil intake 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 distributor rotor 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 key on the distributor shaft with the pump shaft slot, without changing the position of the distributor rotor. Distributor can be installed only in one position as the slot and driving key are machined off-center.

The oil pump consists of an inner and outer rotor within the pump body. An oil relief valve is mounted in the pump body which controls the oil

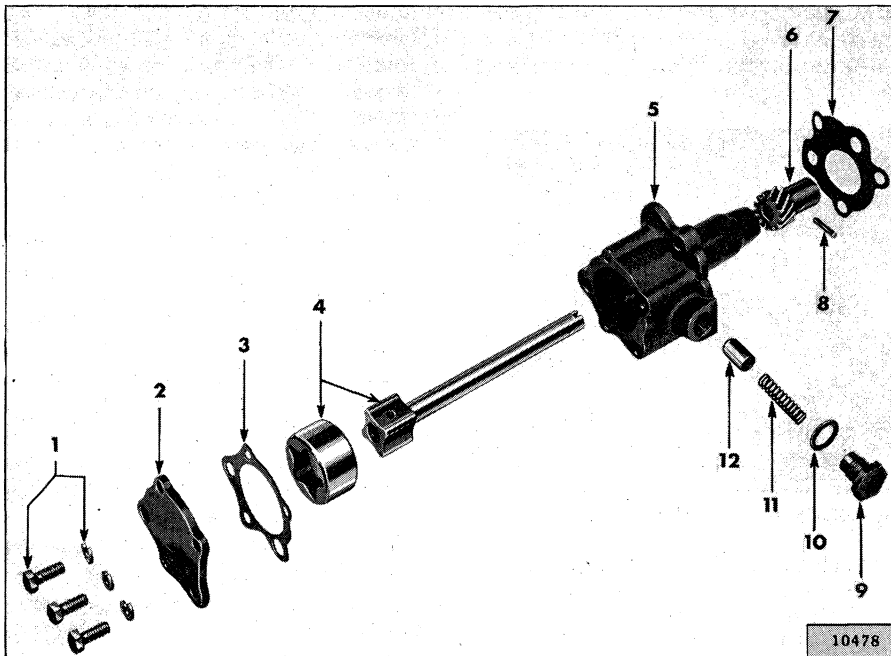


FIG. 96—OIL PUMP

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

pressure. To disassemble the pump, Fig. 96, first remove the gear which is retained by straight pin. It will be necessary to file off one end of the pin before driving it out with a small drift. By removing the cover the outer rotor and the inner rotor and shaft may be removed through the cover opening. 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. 97. This clearance should be .010" [0,254 mm.] or less.

If more, replace both rotors. Measure the clearance between the outer rotor and the pump body as shown in Fig. 98. Should this clearance exceed .012" [0,305 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 that 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" [0,025 mm.] tested with feeler gauges, Fig. 99. Measure thickness of the rotors which must be within .001" 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. The rotors should then rotate freely, proving that end float of the rotors is less than the thickness of the gasket when com-

CAUTION: The oil pressure relief spring is calibrated. Never stretch this spring to alter the relief valve pressure setting. Adjust this setting by the use of shims only. Shims are available that can be added between the retainer and the spring to increase pressure. When shims are present, removing shims will decrease pressure.

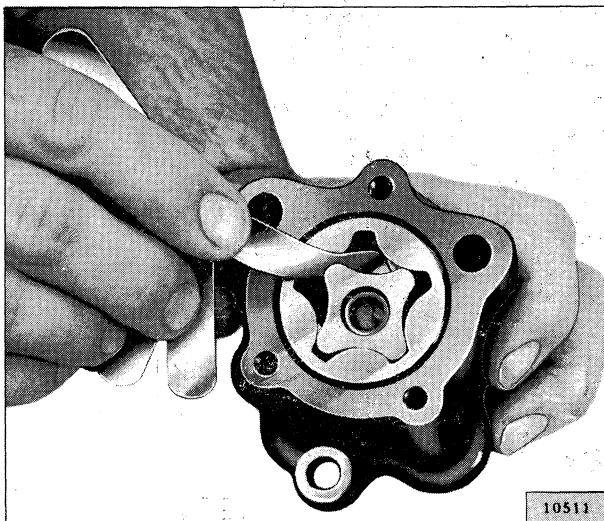


FIG. 97—CHECKING OIL PUMP ROTORS

pressed or .004" [0,102 mm.]. 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 .022" to .051" [0,559 a 1,295 mm.].

Pump output is controlled by a pressure relief valve.

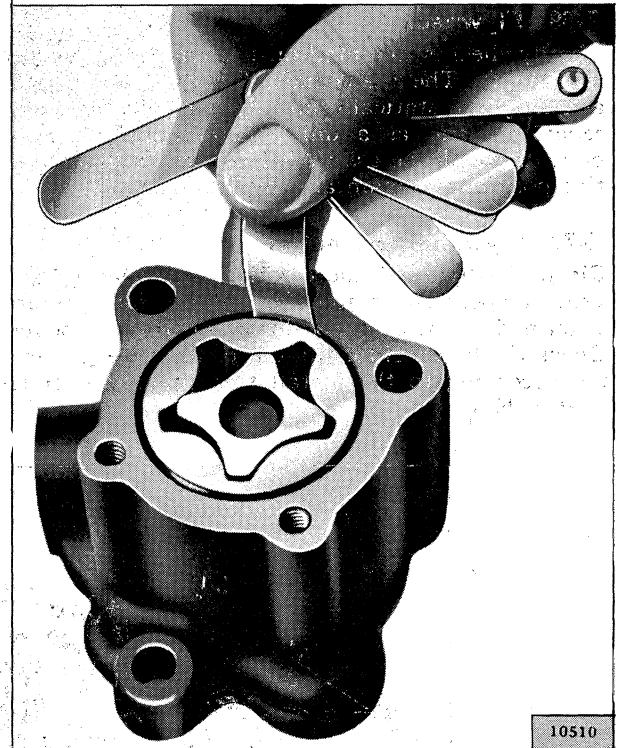


FIG. 98—CHECKING OUTER ROTOR TO OIL PUMP BODY

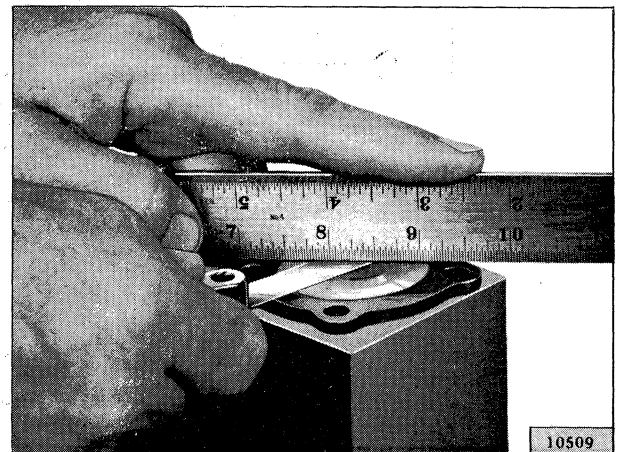


FIG. 99—CHECKING OIL PUMP COVER

This adjustment will change the pressure at higher speeds but not at idle speed. Safe minimum pressure is 6 psi. [0,4 kg-cm²] at idle, at which point the oil pressure light goes out; and 20 psi. [1,4 kg-cm²] at 2000 rpm. (32 mph. [51 kph.]).

E-68. Oil Pan

Examine the oil pan carefully for evidence of corrosion, dents, or other damage. Special attention should be given to the mounting flange to be sure of proper alignment and a tight seal at the cylinder block, oil pan, and engine front plate. Whenever the oil pan is removed, it is best to install a new oil pan gasket.

E-69. Flywheel

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

E-70. Flywheel Inspection

Clean the flywheel thoroughly with cleaning solvent. Inspect the clutch face of the flywheel for a burned or scuffed condition or rivet grooves. Check the flywheel for run-out or improper mounting according to the installation procedure given in Par. E-88.

If the inner ends of the flywheel ring gear teeth are only slightly burred or snubbed, remove the burrs and reshape the teeth using a small emery wheel. If, however, the teeth are broken, cracked, or seriously burred, the ring gear should be replaced.

E-71. Ring Gear Replacement

The ring gear is secured on the flywheel by a shrink fit. Before starting the operation of replacing the ring gear, place the new ring gear against the old gear to make certain both have the same number of teeth.

To remove the ring gear from the flywheel, drill a $\frac{3}{8}$ " [9,5 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 a range of 650°F. to 700°F. [343°C. a 371°C.] and place it on the cold flywheel, making certain that the chamfer on the teeth is on the crankshaft 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. Do not quench the ring gear; allow it to slowly air cool.

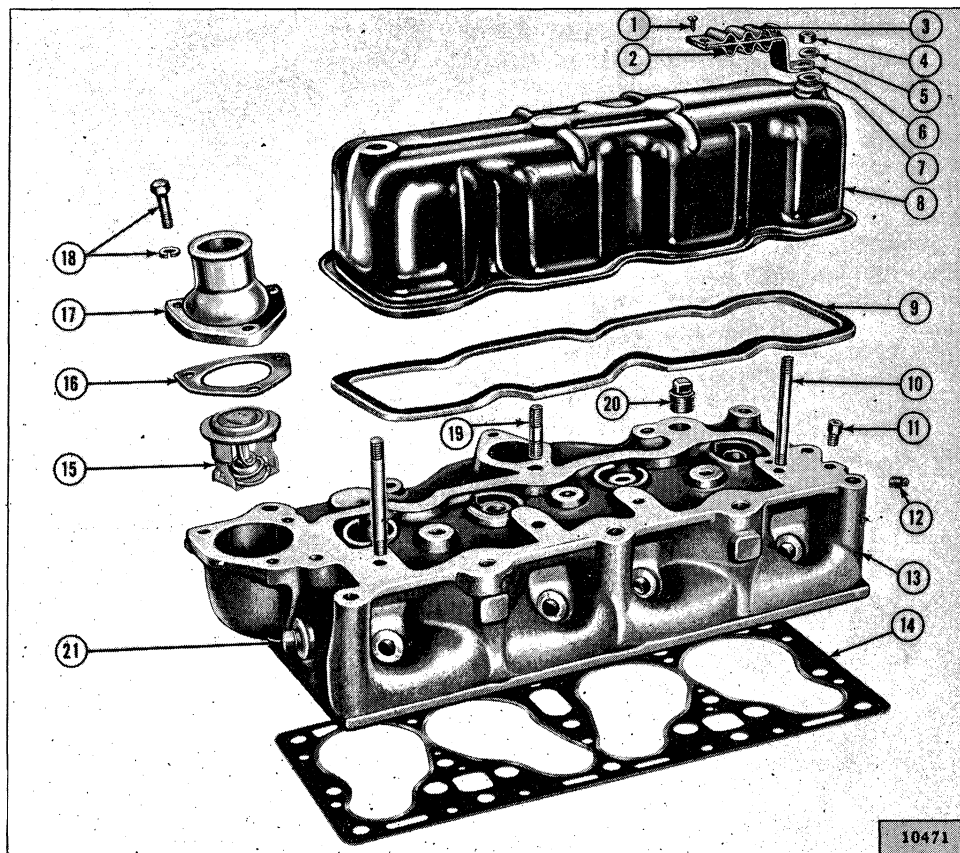


FIG. 100—CYLINDER HEAD

- | | |
|--------------------|------------------------------|
| 1—Pan Head Screw | 12—Pipe Plug |
| 2—Cable Lower Clip | 13—Cylinder Head |
| 3—Cable Upper Clip | 14—Gasket |
| 4—Nut | 15—Thermostat |
| 5—Washer | 16—Gasket |
| 6—Cable Bracket | 17—Water Outlet Fitting |
| 7—Oil Seal | 18—Screw and Lockwasher |
| 8—Rocker Arm Cover | 19—Carburetor Mounting Stud |
| 9—Gasket | 20—Pipe Plug $\frac{1}{2}$ " |
| 10—Cover Stud | 21—Pipe Plug $\frac{1}{4}$ " |
| 11—Connector | |

E-71A. Flywheel Pilot Bushing

Inspect the flywheel pilot bushing in the flywheel. For procedure on replacing the bushing, refer to Par. J-14.

E-72. Flywheel Housing

The flywheel housing, which encloses the flywheel and clutch is bolted to the engine rear plate and cylinder block. 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 engine rear end plate without evidence of warpage. The rear face must be parallel to the front face. Improper alignment may cause transmission gear disengagement. In addition, the opening in the rear of the housing, which serves as a pilot for the transmission, must be concentric with the crankshaft. The flywheel housing should be checked for alignment after it is installed on the engine. Refer to Par. E-89.

E-73. Core Hole Expansion Plug

Any evidence of coolant leakage around any of the core hole expansion plugs will require replacement of the plug. The expansion plug at the rear end of the cylinder block can be driven out with a 24" [60 cm.] length of half-inch bar stock carefully inserted through the camshaft bore in the cylinder block. The other core hole expansion plugs in the cylinder block and cylinder head can be removed by piercing the center with a sharp tool and prying them out. Before attempting to install a new plug, clean the hole thoroughly. Apply a thin coat of sealer on the new plug and install the plug with a driver.

E-74. Cylinder Head

Be sure that water passages are open and that all carbon is removed. Inspect all tapped openings. Repair any damaged threads or broken studs. Run a tap in the threaded holes to clean up rough or damaged threads. Before using a tap, squirt penetrating oil on the threads. Discard or repair cracked cylinder heads, also those warped .010" [0,254 mm.] or more over the full length of the head.

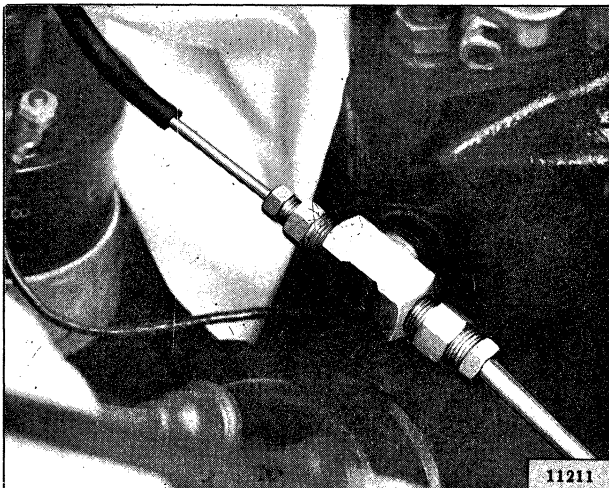


FIG. 100A—VACUUM TEE

The right side of the cylinder head has a vacuum tee positioned at a 17° angle. When installing a vacuum-operated heater, remove the 1/8" pipe plug from the tee, replacing it with a connector and vacuum tube for heater hook-up. See Fig. 100A.

E-75. Rocker Arms

The rocker arms and their related parts are mounted on the top of the cylinder head and enclosed by the rocker arm cover. The rocker arm shaft, supported in four rocker arm shaft brackets, carries the rocker arms and the rocker arm shaft springs. The intake valve adjusting screws and locknuts provide the means for adjusting these valves.

E-76. Rocker Arm Shaft Disassembly

- a. Remove the two studs in the rocker arm shaft brackets at the ends of the rocker arm shaft.
- b. Slide the rocker arm shaft brackets, the four rocker arm assemblies, and the two rocker arm shaft springs off the rocker arm shaft. Remove the two rocker arm shaft lock screws from the two remaining rocker arm shaft brackets and slide the brackets off the shaft.
- c. Insert a screwdriver under the edge of the rocker arm shaft plugs at each end of the rocker arm shaft, and pry the plugs out of the shaft.
- d. Remove the intake valve adjusting screw locknuts from each of the rocker arm valve lash adjusting screws. Remove the screws from the rocker arms.

E-77. Inspection and Repair

Run a round wire brush through the bore of the rocker arm shaft and clean out the drilled oil holes. Clean out the oil holes in the rocker arm shaft brackets, and the oil holes and grooves in the bores of the rocker arm. Inspect the diameter of the shaft at the rocker arm bearing areas. Replace the shaft if there are scores or abrasion marks along the length of the shaft. Check the shaft for alignment by rolling it across a smooth level surface. If the shaft will not roll freely, or if it rolls with a bumping motion, the shaft is out of alignment and must be replaced. Inspect the threads of the adjusting screw hole in the rocker arms and if necessary clean with a proper size tap. Replace the adjusting screw locknut or the adjusting screw if either part is damaged or deformed. Inspect the threads in the tapped hole in the top of the rocker arm shaft brackets and if necessary clean with a proper size tap. Replace the bracket if either side is worn or scored.

E-78. Assembly

- a. Install two rocker arm shaft plugs, one in each end of the shaft. Slide two rocker arm shaft brackets onto the center of the shaft. Align the tapped holes in the brackets with the drilled holes in the top of the shaft and install the rocker arm shaft lock screws, making sure the points of the screws enter the drilled holes in the shaft.
- b. Screw the intake valve adjusting screws into the rocker arms and install the locknuts.

c. The rocker arms are paired; that is, two of the arms are angled to the right and two are angled to the left. One of each type is used on each end of the rocker arm shaft. Slide a rocker arm with the adjusting screw end of the rocker arm angling away from the bracket onto the shaft so that the adjusting screw is on the same side of the shaft as the mounting hole in the bracket.

d. Temporarily secure the end bracket in place by installing a rocker arm cover stud in the tapped opening in the top of the support.

e. Assemble the parts on the opposite end of the rocker arm shaft repeating steps c and d above.

E-79. 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 covered in detail are made 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 not be required.

Mount the cylinder block in an engine repair stand. If an engine stand is not available, perform the following assembly operation in a manner designed to protect personnel against an accident and the engine and its parts against damage.

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

E-80. Install Oil Gallery Plug

Coat plug threads with a suitable sealing compound and install the plugs in the front and rear ends of the oil gallery in the cylinder block and the rear end of the cylinder head. Torque the plugs 20 to 25 lb-ft. [2,8 a 3,4 kg-m.].

There is also a pipe plug (⅛" [3,2 mm.] slotted, headless) in the opening in the main oil gallery inside the cylinder block at No. 2 cylinder and another pipe plug (⅛" square-head) in the opening

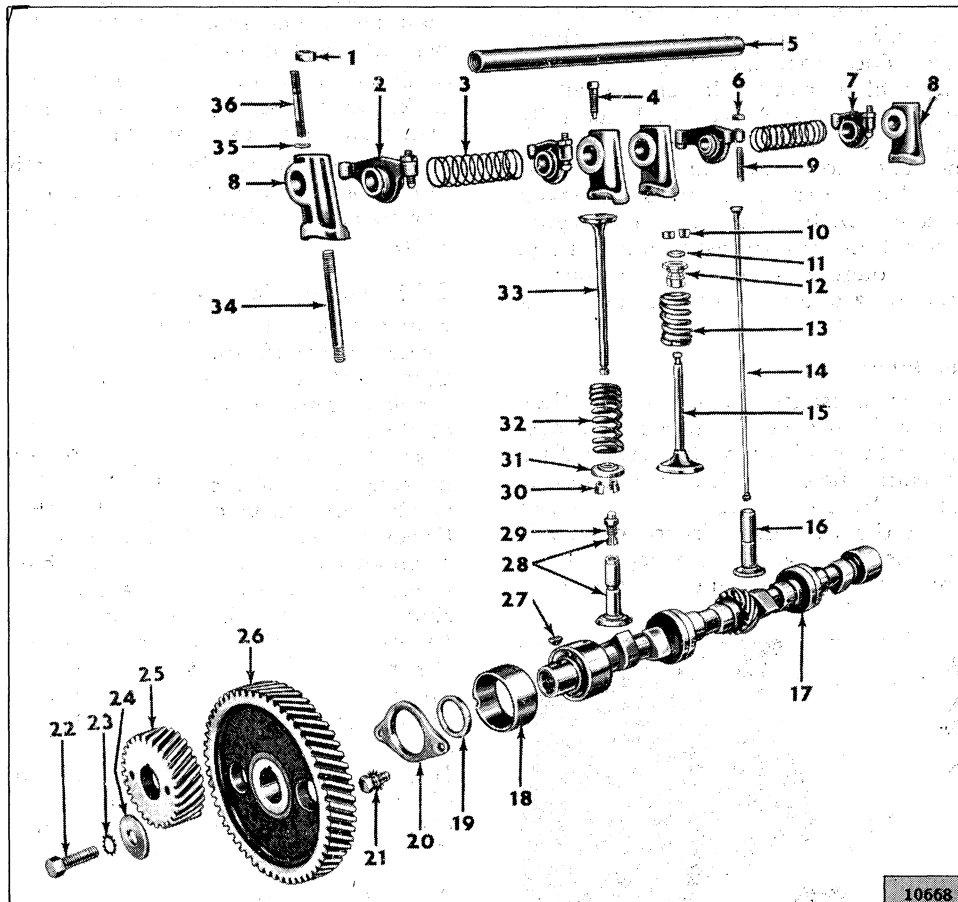


FIG. 101—VALVES, CAMSHAFT, AND TIMING GEARS

- | | | |
|---------------------------------------|---------------------------------|------------------------------|
| 1—Nut | 13—Intake Valve Spring | 25—Crankshaft Gear |
| 2—Left Rocker Arm | 14—Intake Valve Push Rod | 26—Camshaft Gear |
| 3—Rocker Arm Shaft Spring | 15—Intake Valve | 27—Woodruff Key No. 9 |
| 4—Rocker Shaft Lock Screw | 16—Intake Valve Tappet | 28—Exhaust Valve Tappet |
| 5—Rocker Shaft | 17—Camshaft | 29—Tappet Adjusting Screw |
| 6—Nut | 18—Camshaft Front Bearing | 30—Spring Retainer Lock |
| 7—Right Rocker Arm | 19—Camshaft Thrust Plate Spacer | 31—Roto Cap Assembly |
| 8—Rocker Arm Shaft Bracket | 20—Camshaft Thrust Plate | 32—Exhaust Valve Spring |
| 9—Intake Valve Tappet Adjusting Screw | 21—Bolt and Lockwasher | 33—Exhaust Valve |
| 10—Intake Valve Upper Retainer Lock | 22—Bolt | 34—Rocker Shaft Support Stud |
| 11—Oil Seal | 23—Lockwasher | 35—Washer |
| 12—Intake Valve Spring Upper Retainer | 24—Camshaft Gear Washer | 36—Rocker Arm Cover Stud |

in the oil passage directly below the oil pump intake passage. If these two pipe plugs were removed, make certain they are reinstalled in the locations described above or the counterweight of the crankshaft might strike the projecting head of the square-head plug.

E-81. Install Tappets

Turn the block upside down. Beginning at the rear end of the cylinder block, install the intake and exhaust valve tappets in the tappet bores in the cylinder block in the following order: one exhaust, two intake, two exhaust, two intake, and finally one exhaust valve tappet.

Check the tappet to bore fit of each tappet as it is installed in the block. If the stem-to-block clearance tolerance of .0005" to .002" [0,0013 a 0,0051 mm.] is exceeded install a new tappet fitting within this tolerance or ream the bore to accommodate the next oversize tappet which is available in .004" oversize.

E-82. Install Camshaft and Thrust Plate

Lubricate all camshaft bearings and cam surfaces generously with clean, light engine oil. Carefully, so not to damage or score the camshaft front bearing, install the camshaft, locating it properly in the bearings. Do not allow the rear end of the camshaft to strike sharply against the expansion plug installed in the rear end of the bore.

Install the camshaft thrust plate. Slide the thrust plate spacer onto the end of the camshaft with the beveled inner edge of the spacer facing the camshaft. If the same camshaft is being reinstalled, install any shims previously removed. These shims are placed between the camshaft shoulder and the spacer. Torque the thrust plate attaching bolts 20 to 26 lb-ft. [2,8 a 3,6 kg-m.].

End play of the camshaft is determined by running clearance between the rear face of the camshaft gear and the thrust plate. The standard clearance is .004" to .007" [0,102 a 0,178 mm.] as measured by a dial indicator. Should a check show too little end play, place a shim of suitable thickness between the camshaft shoulder and the spacer. Too much end play may be corrected by removing shims or dressing off the spacer a slight amount. See Fig. 101.

E-83. Install Crankshaft and Bearings

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

NOTE: It is possible to incorrectly install the front main bearing. The bearing is properly installed in the cap with the narrower of the two radial oil grooves toward the front edge of the cap. If this bearing is not properly installed, the oil grooves in the two halves of the bearing will not match at the parting line and premature failure of the bearing will result.

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. Torque the bolts 65 to 75 lb-ft.

[9,0 a 10,4 kg-m.] rotating the crankshaft after each bearing cap is tightened

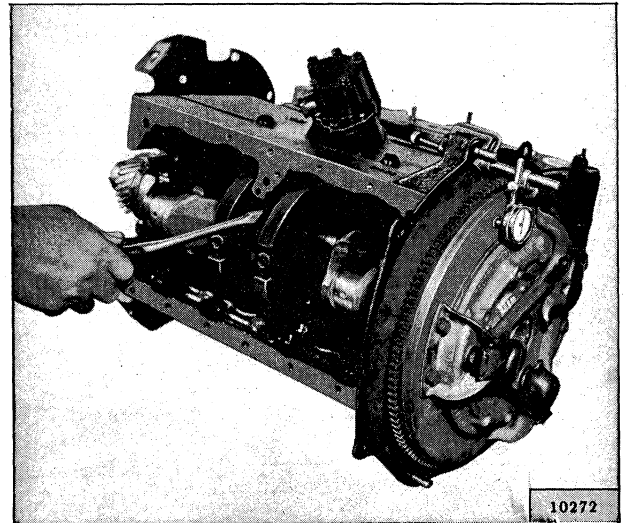


FIG. 102—GAUGING CRANKSHAFT END PLAY

E-84. Check Crankshaft End-Play

End play 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" [0,102 a 0,152 mm.] which is controlled by .002" [0,051 mm.] shims placed between the thrust washer and the shoulder on the crankshaft. Check the end play with a dial indicator as shown in Fig. 102. If clearance is incorrect, adjustment is made by adding or removing shims.

Install the thrust washer with the beveled inner edge toward the front bearing.

E-85. Install Crankshaft Timing Gear

Install the woodruff key in the longer of the two keyways on the front end of the crankshaft. Install the crankshaft timing gear on the front end of the crankshaft with the timing mark facing out, away from the cylinder block. Align the keyway in the gear with the woodruff key and then drive or press the gear onto the crankshaft firmly against the thrust washer.

E-86. Install Crankshaft Rear Bearing Seal

When installing the crankshaft rear bearing seal around the crankshaft, apply a thin coat of light cup grease to both halves of the seal except for the ends which are already treated with sealing compound. When installing the rear main bearing cap in the crankcase, place a small amount of plastic-type gasket cement on both sides and face of the cap to prevent oil leakage. Insert the rubber packings shown in Fig. 105 into the holes between the bearing cap and the case. Do not trim these packings. The packings are of a predetermined length that will cause them to protrude approximately 1/4" [6 mm.] from the case. When the oil pan is installed, it will force them tightly into the holes and effectively seal any opening between the bearing cap and the crankcase.

E-87. Install Front End Plate

Assemble the gasket to the front end plate making certain that it is positioned properly down to the bottom of the crankcase. Install the front end plate on the cylinder block and tighten in place.

E-88. Install Flywheel

Be sure the crankshaft flange and flywheel mating surfaces are clean to permit proper flywheel alignment. With the crankshaft in the cylinder block,

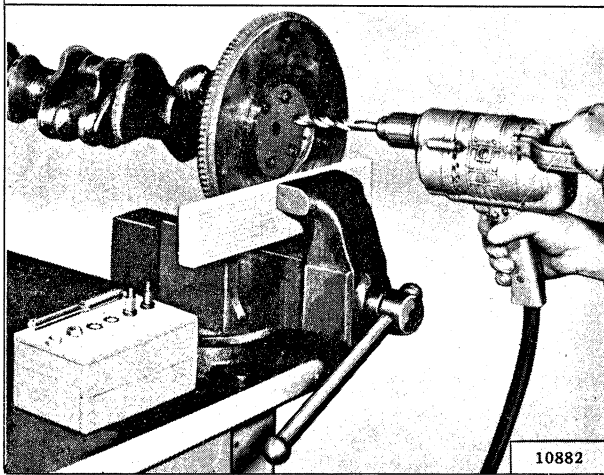


FIG. 103—DRILLING FLYWHEEL

place the flywheel on the mounting bolts in the crankshaft. When installing a new crankshaft or flywheel, replace the tapered dowel bolts with

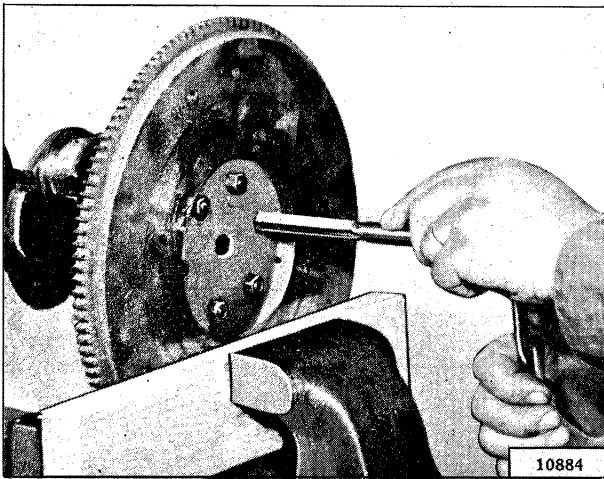


FIG. 104—REAMING FLYWHEEL

straight snug-fitting special bolts provided using Flywheel Dowel Bolt Installing Tool Kit W-231 as shown in Fig. 103 and 104. Assemble the crankshaft and flywheel in proper relation; then install the straight bolts previously used and tighten securely. Next, use the $\frac{35}{64}$ " [13,9 mm.] drill to enlarge the tapered holes. Ream the holes with the $\frac{9}{16}$ " [14,3 mm.] straight reamer and install the two special flywheel bolts with nuts and lockwashers in place of the two tapered dowel bolts

formerly used. This procedure overcomes the necessity of reaming special tapered holes. Tighten the nuts alternately and evenly until each is tightened 35 to 41 lb.-ft. [4,8 a 5,7 kg.-m.].

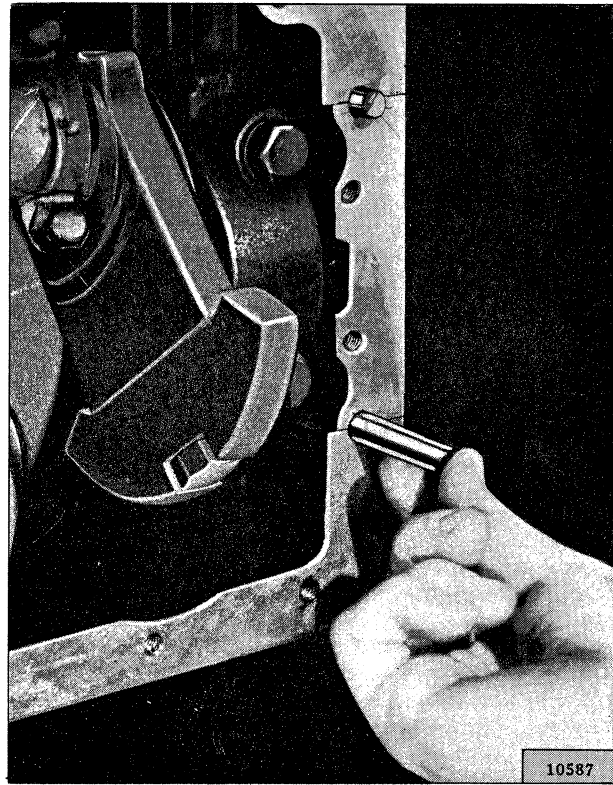


FIG. 105—REAR BEARING CAP PACKING

After installation check the run-out of the flywheel with a dial indicator attached to the engine plate as illustrated in Fig. 106. Mount the dial indicator with the contact button of the indicator resting against the clutch face of the flywheel. Set the indicator at zero and rotate the flywheel. Maximum allowable run-out is .008" [0,203 mm.] near the outer edge of the rear face of the flywheel.

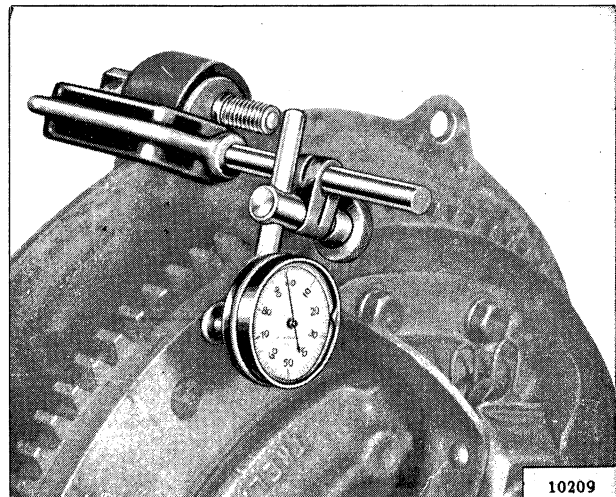


FIG. 106—CHECKING FLYWHEEL RUN-OUT

With the flywheel housing installed temporarily, the alignment can be checked with a dial indicator. Without the clutch installed on the flywheel, a dial indicator can be mounted on one of the flywheel bolts. Set the dial indicator with the button resting against the rear face of the flywheel housing. Rotate the flywheel, noting the run-out on the indicator. Maximum allowable run-out is .005" [0,127 mm.]. Relocate the dial indicator so that the button is against the side of the rear opening to check the radial run-out. Rotate the flywheel and note the run-out which should not exceed .006" [0,152 mm.].

E-89. Install Flywheel Housing

Be certain that the mating surfaces of the flywheel housing and cylinder block are clean and smooth. Place the flywheel housing in position and attach to the cylinder block and engine rear plate. The long bolts through the lugs on the engine crankcase and those below are installed with the nuts on the flywheel housing side. Install the other bolts from the rear except the screw used to attach the top side of the starting motor. Tighten securely.

E-90. Install Clutch

To install the clutch assembly with the engine out of the vehicle use a clutch plate aligning arbor. Place the clutch driven plate in position against the flywheel. Insert the arbor into the clutch driven plate and clutch shaft bushing and expand the arbor in the bushing to hold it in place. Hold the clutch pressure plate assembly in position against the clutch driven plate and install the attaching bolts and washers, tightening the bolts alternately and evenly. Remove the arbor.

E-91. Install Valves and Springs

Oil the valve stems. Insert all intake and exhaust valves in the valve guides from which they were removed.

Install one exhaust valve spring and exhaust valve spring retainer (Roto Cap) for each exhaust valve. Slip the top end of the spring onto the bottom end of the valve guide and, with a large screwdriver, snap the spring and retainer over the tappet adjusting screw. Make certain that the two closely wound coils of each spring are at the top (placed up to seat against the block.) See Fig. 107.

Turn the crankshaft as necessary to bring each exhaust valve tappet to its lowest position. Using a valve spring lifter, C-482 compress each exhaust valve spring, while holding the valve down, so that the 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. When installation of exhaust valves is complete, remove any cloths used to block the valve compartment floor openings. Install the intake valves and springs in the cylinder head placing the ends of the springs having the closed coils down against the cylinder head.

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, using Tool C-3422 position a seal ring on the valve stem just above the lock recess, then install the locks and release the spring.

Adjust the valve tappets to the proper specified clearance. Refer to Par. E-106, E-107, E-108, and specifications at the end of this section for specifications and adjustment procedure.

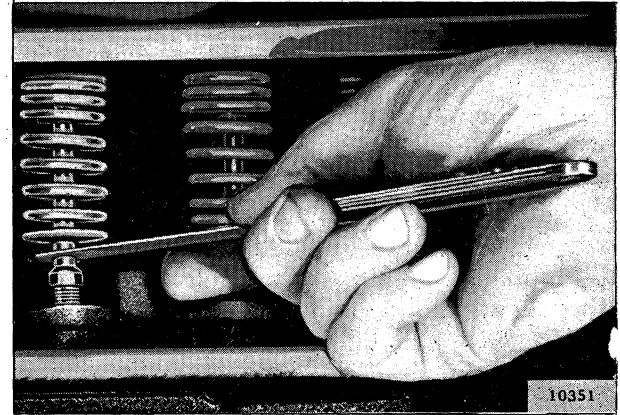


FIG. 107—VALVE TAPPETS AND SPRINGS

E-92. Install Camshaft Timing Gear

Turn the camshaft or crankshaft as necessary so that the timing marks on the two gears will be together after the camshaft timing gear is installed. Refer to Fig. 108. Install the woodruff key in the keyway on the front end of the camshaft. Start the large timing gear on the camshaft with the timing mark facing out. Do not drive on the camshaft gear, or the camshaft may dislodge the plug at the rear of the cylinder block causing an oil leak. Install the camshaft gear retaining screw and torque it 30 to 40 lb-ft. [4,1 a 5,5 kg-m.] drawing the gear onto the camshaft in the process. Standard running tolerance between the timing gears is .000" to .002" [0 a 0,051 mm.] which should be checked with a dial indicator.

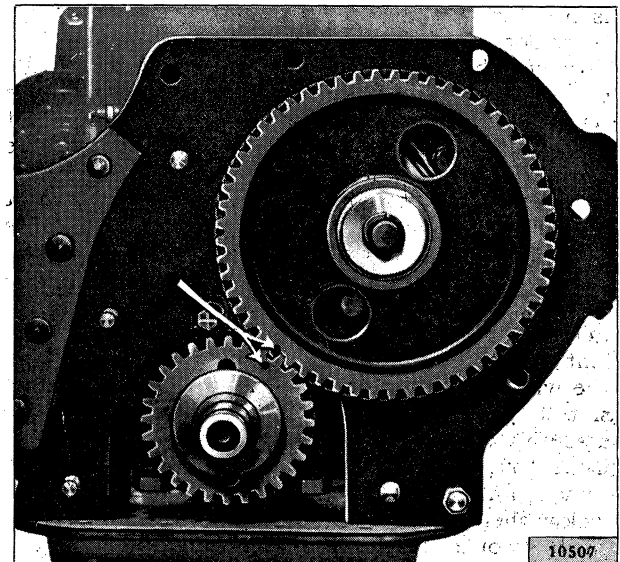


FIG. 108—TIMING GEARS

E-93. Install Timing Gear Oil Jet

Install the timing gear oil jet in the tapped hole in the front of the cylinder block. Position the oil hole in the side of the oil jet so that it will direct the oil stream against the camshaft driven gear just ahead of the point of engagement with the crankshaft drive gear.

Note: A new timing gear oil jet entered production with engine S/N 4J-250095. The earlier jet has a .070" [0,178 mm.] diameter aperture; the later jet has a .040" [0,102 mm.] aperture. The later jet reduces oil pressure variation at No. 1 connecting rod bearing. It is recommended that the .040" jet be installed in engines with serial numbers lower than above whenever it has been necessary to replace a scored or burned No. 1 connecting rod bearing.

E-94. Install Oil Pump

The oil pump is driven from the camshaft by means of a spiral (worm) gear. The distributor, in turn, is driven by the oil pump by means of a tongue on the end of the distributor shaft which engages a slot in the end of the oil pump shaft. Because the tongue and the slot are both machined off center, the two shafts can be meshed in only one position. Since the position of the distributor shaft determines the timing of the engine, and is controlled by the oil pump shaft, the position of the oil pump shaft with respect to the camshaft is important.

Turn the crankshaft to bring together the timing marks on the crankshaft and camshaft gears. See Fig. 108. Install the oil pump mounting gasket on the pump. With the wider side of the shaft on top (nearer the top of the cylinder block), start the oil pump drive shaft into the opening in the left side of the cylinder block with the mounting holes in the body of the pump in alignment with the holes in the cylinder block. Insert a long-blade screwdriver into the distributor shaft opening in the opposite side of the block and engage the slot in the oil pump shaft. Turn the shaft so that the slot is positioned at what would be roughly the nine-thirty position on a clock face.

Remove the screwdriver and, looking down the distributor shaft hole with a flashlight, observe the position of the slot in the end of the oil pump shaft to make certain it is properly positioned. Replace the screwdriver and, while turning the screwdriver clockwise to guide the oil pump drive shaft gear into engagement with the camshaft gear, press against the oil pump to force it into position. Remove the screwdriver and again observe the position of the slot. If the installation was properly made, the slot will be in a position roughly equivalent to eleven o'clock position on a clock face with the wider side of the shaft still on the top. If the slot is improperly positioned, remove the oil pump assembly and repeat the operation.

Coat the threads of the capscrews with gasket cement and secure the oil pump in place with two lockwasher-equipped capscrews installed through the body of the oil pump and into the cylinder block and one lockwasher-capscrew installed through the oil pump mounting flange.

E-95. Install Timing Gear Cover

Apply a thin coat of gasket paste to the timing gear cover. Position the gasket on the cover and carefully locate the cover on the front of the front mounting plate. Attach the cover and timing indicator and tighten the bolts.

E-96. Install Pistons and Connecting Rods

Before installing each piston and connecting rod assembly in the cylinder block, generously lubricate the entire assembly with engine oil. Space the ring gaps around the piston so that no two gaps are aligned vertically and are not located over the T-slot in the piston skirt. Insert the assembly in the correct cylinder with the connecting rod identifying number toward the camshaft side of the cylinder block. When installing each assembly, rotate the crankshaft so that the crankpin is in the down position. Fit a piston ring compressor tightly around the piston rings. Reach up from the bottom of the cylinder block and guide the end of the connecting rod over the crankshaft journal as the piston is tapped down into the cylinder bore with hammer handle.

Lubricate the connecting rod bearing surfaces generously with engine oil and install the bearing cap with the numbered side matched to the numbered side of the connecting rod. Torque the nuts evenly 35 to 45 lb-ft. [4,8 a 6,2 kg-m.]. The connecting rod cap nuts are locked with stamped nuts. Used stamped nuts should be discarded and replaced with new ones. These locking stamped nuts should be installed with the flat face toward the connecting rod nut. Turn the locking nut finger tight and then $\frac{1}{8}$ turn more with a wrench. Refer to Par. E-36 for detailed information on fitting pistons and rings in the cylinder bores.

E-97. Install Crankshaft Pulley

Align the keyway in the pulley with the woodruff key installed in the crankshaft. Drive the pulley onto the crankshaft and secure it in place with the crankshaft pulley nut. Insert a block of wood between one of the counterweights on the crankshaft and the side of the cylinder block to prevent the crankshaft from turning, then tighten the nut.

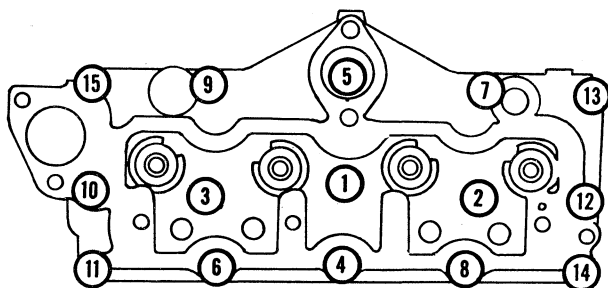
E-98. Install Oil Pan

Before installing the oil pan, make a final internal inspection particularly making certain that the inside of the cylinder block is clean. Apply a thin coat of gasket paste on the oil pan. Place the new oil pan gasket in position. Set the oil pan in position on the cylinder block and install the oil pan. Torque the attaching bolts 9 to 14 lb-ft. [1,2 a 1,9 kg-m.]. Install the oil pan drain plug and gasket and tighten the plug securely.

E-99. 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 the cylinder head and gasket are installed. Using no sealer or other compound, position the new cylinder head gasket with the crimped edges of the gasket metal down (See

Fig. 100). This gasket position allows a positive seal along the narrow surfaces of the cylinder head between the combustion chambers and eliminates the possibility of burning combustion gases reaching an asbestos portion of the cylinder head gasket. Install the cylinder head bolts. Tighten the bolts



10102

FIG. 109—CYLINDER HEAD BOLT TIGHTENING SEQUENCE

with a torque wrench to 60 to 70 lb-ft. [8,3 a 9,7 kg-m.] in the sequence shown in Fig. 109. Do not overlook installing the cylinder head bolt in the intake manifold directly under the carburetor opening.

E-100. Install Rocker Arm Assembly

a. Insert ball ends of the intake valve push rods through the cylinder head and cylinder block and seat them in the cupped head of the intake valve tappets.

b. Install the rocker-arm assembly on the four rocker-arm-mounting studs. Align the rocker arms so that the ball ends of the intake valve tappet adjusting screws fit into the cup ends of the push rods.

c. Install the four rocker-arm-attaching nuts. Thread each nut down evenly in sequence, one turn at a time, until the torque is 30 to 36 lb-ft. [4,1 a 5,0 kg-m.].

E-101. Install Spark Plugs

Clean and adjust the spark plugs, setting the electrode gaps at .030" [0,762 mm.]. Install the plugs to prevent any foreign matter entering the combustion chambers during the remaining operations. Torque the spark plugs 25 to 33 lb-ft. [3,4 a 4,6 kg-m.].

E-102. Install Manifold

If manifold studs were removed for replacement, apply sealer on the stud threads before installing a new stud.

Make certain that no foreign objects are inside the manifold and that all passages are clear. Place a new set of manifold gaskets in position on the side of the cylinder block. Then, carefully slide the manifold onto the studs and against the cylinder block being careful not to damage the gaskets. Torque all manifold attaching nuts evenly 29 to 35 lb-ft. [4,0 a 4,8 kg-m.].

E-103. Install Oil Filler Tube

When installing the oil filler 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 to prevent damage to the cap gasket seat.

E-104. Install Water Pump

Make certain that the mating surfaces of the water pump and the cylinder block are clean and smooth. Install the gasket on the flange of the pump and install the pump in position on the cylinder block. Torque the water pump attaching bolts alternately and evenly 12 to 17 lb-ft. [1,7 a 2,3 kg-m.].

E-105. Install Water Outlet Fitting

Install the thermostat and the water outlet fitting. Torque the water outlet fitting attaching bolts 20 to 25 lb-ft. [2,8 a 3,4 kg-m.].

E-106. Final Operations

Before starting the engine, adjust the exhaust valve tappets to .016" [0,4064 mm.]. Set the intake valve rocker arm adjustments close to the standard .018" [0,4572 mm.].

Start the engine and let it warm up to normal operating temperature. Then retorque all head bolts in the proper sequence.

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

Check all head bolts and the head gasket for leaks. Cement a new gasket on the rocker arm cover. Install the cover placing an oil seal then a flat washer and nut on each cover stud. Cement a new gasket on the exhaust valve cover. Install the cover and crankcase ventilation fittings using a new gasket back of the vent cover and new copper ring gaskets under the attaching screw heads. Torque the valve tappet cover nuts 7 to 10 lb-ft. [1,0 a 1,4 kg-m.].

E-106A. Compression Test

Take compression readings with a compression gauge, as shown in Fig. 22 at each cylinder while cranking the engine with the starter motor. Allow only four compression strokes at each cylinder and record only the first and fourth readings. Interpret the readings as follows:

a. When pressure quickly comes up to specified pressure and is uniform between all cylinders within 10 psi. [0,7 kg-cm²] it indicates that the engine is operating normally with satisfactory seating of rings, valves, valve timing, etc.

b. When pressure is low on the first stroke and builds up to less than specified pressure it indicates compression leakage usually attributable to rings or valves. To determine which is responsible, pour ½ oz. [15 cm³] of tune-up oil into each cylinder. Allow a few minutes for the oil to leak down past the rings. Then again test compression. If compression pressures improve over the first test, the trouble is probably worn piston rings and bores. If compression pressures do not improve, the trouble is probably caused by improper valve seating. If this condition is noticed on only two cylinders that are adjacent, there is a possible gasket leak between these cylinders. If inspection of the spark plugs from these cylinders disclosed fouling of surface cracking of electrodes, gasket leakage is probable.

c. When pressure is higher than normal it 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 to correct this trouble.

d. Reinstall the spark plugs. Torque with a wrench to proper setting.

E-107. VALVE ADJUSTMENT

Proper valve adjustment is important to prevent burning of valves and poor engine performance. This adjustment consists of obtaining a specified lash in the valve mechanism. The exhaust valve tappets and the intake valve rocker arms should be adjusted to the proper clearance with the engine cold (at room temperature). Valve clearance can be properly adjusted only when the tappet is on the heel or low portion of the cam.

E-108. Valve Adjustment Procedure

The exhaust valve tappets are adjusted by turning the adjusting screw in or out of the tappet as necessary to obtain the proper clearance. Where special wrenches can be obtained, they should be used to facilitate the adjustment. The proper clearance is .016" [0,406 mm.] between the end of the adjusting screw and the bottom of the exhaust valve.

Crank the engine over to close a valve and check the clearance with a feeler gauge. To adjust, hold the tappet with one wrench and turn the adjusting screw, with the other. Check and adjust each of the tappets in proper sequence.

Adjust each intake valve by adjusting the rocker arm screw at the push rod to obtain .018" [0,457 mm.] clearance between the rocker arm and the valve stem with tappet on the heel of the cam.

E-108A. Vacuum Check

Disconnect the vacuum line fitting from the head just below the carburetor and install the proper adapter. Connect a 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 the correct rpm. (F4-134 engine: 600 rpm.) Observe the vacuum reading and interpret as follows:

a. A steady reading from 18 to 21 inches [46 a 63 cm.] of mercury [Hg] is a normal reading indicating that valve and spark timing, valve seating, and piston ring sealing are all satisfactory.

b. A steady but below normal reading 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. A slowly fluctuating or drifting reading indicates that the idle mixture is incorrect and the cause should be looked for in the fuel system.

d. A rhythmic pulsating reading is caused by a condition affecting one or more cylinders, but not all, and indicates leaky valve, gasket blowby, restricted intake port, or an electrical miss.

e. An intermittent pulsating reading is caused by an occasional malfunction such as a sticking valve (all valves may be erratic in operation if the valve

springs are weak), or 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. A normal reading that quickly falls off (with engine running at 2000 rpm.) indicates exhaust back-pressure caused by a restriction in the exhaust system.

E-109. Check Valve Timing

To check the valve timing, carefully set the intake valve rocker arm adjustment for No. 1 cylinder to .026" [0,6604 mm.] between the rocker arm and the valve stem. Rotate the crankshaft clockwise until the piston in No. 1 cylinder is ready for the intake stroke. The intake valve opens 9° before top center (BTC). Note the distance between the "TC" and "5°" marks on the indicator on the timing gear cover and estimate the 9° before top center position. See Fig. 110. With the crankshaft in this position, timing is correct if the rocker arm is just tight against the intake valve stem. Do not overlook resetting the rocker arm adjustment to the correct running clearance.

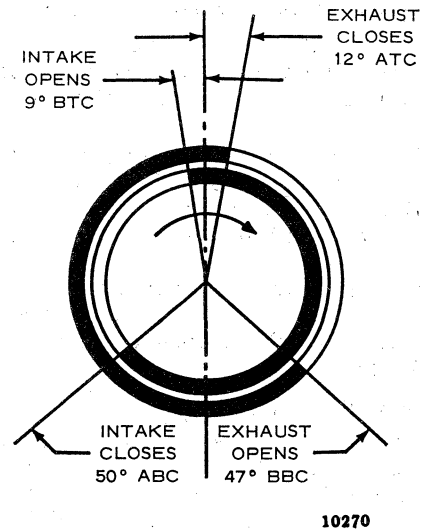


FIG. 110—VALVE TIMING

E-110. OILING SYSTEM

The engine oil pressure system is designed to provide adequate lubrication to all working parts of the engine. The gear-type oil pump is driven from the engine camshaft. The pump is provided with a floating, screened intake that prevents the circulation of any sediment that might accumulate in the oil pan. By means of this pump, the main bearing journals and crankpins are efficiently lubricated through an oil gallery and passages in the cylinder block. Oil is forced under pressure to the main bearings and through the cheeks of the crankshaft to the connecting rod bearings. Oil is also force-fed to the camshaft bearings, timing gears, and intake valve rocker arms. The oil pressure is controlled by relief valve located in the oil pump. The valve is

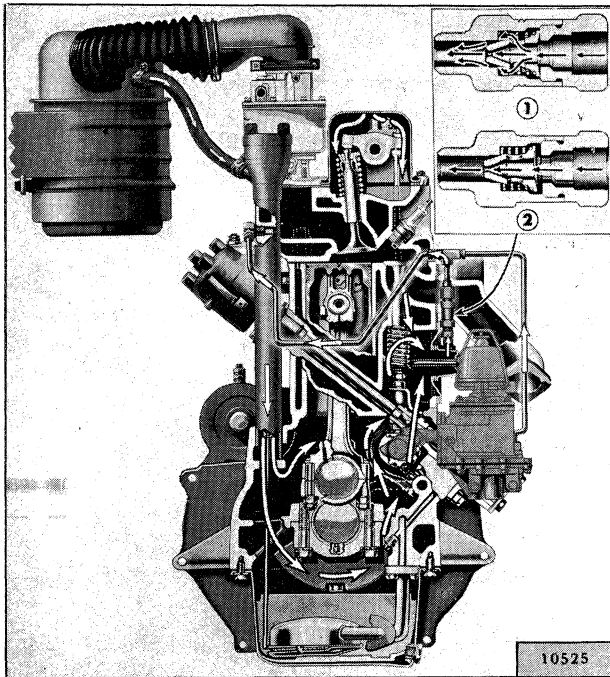


FIG. 111—CRANKCASE VENTILATION

1—Valve Open
2—Valve Closed

designed to open when excessive pressure develops in the system, relieving the pressure and returning the excess oil to the oil pan. The cylinder walls, piston pins, and tappets are supplied with oil from spurt holes in the connecting rods. A portion of the oil is continually passed through an oil filter which effectively removes any foreign matter suspended in the oil. A flanged section on the rear of the crankshaft acts as an oil slinger and, in combination with the rear main bearing upper and lower oil seal, prevents the leakage of oil from the rear end of the cylinder block. Leakage of oil from the front end of the cylinder block is controlled by the crankshaft oil slinger and the front oil seal installed in the timing gear cover. The oil pressure indicator light 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.

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-111. Positive Crankcase Ventilation

The crankcase ventilating system provides thorough, positive ventilation which reduces to a minimum the formation of sludge. The crankcase is ventilated by a sealed system. The system is actuated through a valve attached to the valve cover, which is connected by a tube to the intake manifold. Clean air is drawn into the oil filler tube through a hose from the air cleaner. Any vapors in the crankcase are carried into the manifold and burned.

Be sure there are no air leaks at the tube connections between the air cleaner and the oil filler tube, and that the oil filler tube cap gasket is in good condition. Always keep the cap locked securely in place. When tuning the engine or grinding valves, remove the control valve and clean it thoroughly. If the valve is blocked with carbon, the ventilating system will not operate and, should the valve fail to seat, it will be impossible to make the engine idle satisfactorily.

E-112. Oil Filter

The engine is equipped with a 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 filter and gasket. The filter assembly may be replaced by detaching the oil lines at the case and removing the mounting bracket.

E-113. 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
 Defective Spark Plugs—Clean or Replace
 Defective Breaker Points—Replace Points
 Incorrect Breaker Point Gap—Reset Points
 Defective Condenser or Coil—Replace
 Loose Electrical Connections—Locate and
 Tighten
 Broken Valve Spring—Replace Spring
 Broken Piston or Rings—Replace
 Defective Head Gasket—Replace Gasket
 Cracked Distributor Cap—Replace Cap

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

Burned Valves and Seats—Continued

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
 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 Cham-
 bers
 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

E-114. F4-134 ENGINE SPECIFICATIONS

MODEL:	CJ-3B, CJ-5, CJ-6	METRIC
ENGINE:		
Type.....	F-Head	
Number of Cylinders.....	4	
Bore.....	3 $\frac{1}{8}$ "	79,375 mm.
Stroke.....	4 $\frac{3}{8}$ "	111,12 mm.
Piston Displacement.....	134.2 cu. in.	2199 cm ³
Bore Spacing (center to center):		
1 and 2, 3 and 4.....	3.437"	8,729 cm.
2 and 3.....	4.938"	12,542 cm.
Firing Order.....	1-3-4-2	
Compression Ratio:		
Standard.....	7.4:1	
Optional.....	6.9:1	
Compression Pressure.....	120 to 130 psi.	8,4 a 9,2 kg-cm ²
Number of Mounting Points:		
Front.....	2	
Rear.....	1	
Horsepower (SAE).....	15.63	
Horsepower (Max Brake).....	75 @ 4000 rpm.	
Maximum Torque @ 2000 rpm.....	114 lb-ft.	15,77 kg-m.
Idle Speed.....	600 rpm	
Governor Speed (optional):		
Velocity.....	2200 to 3200 rpm.	
Centrifugal.....	1000 to 2600 rpm.	
PISTONS:		
Material.....	Aluminum Alloy	
Description.....	Cam Ground, T-slot, Tin Plated	
Length.....	3 $\frac{3}{4}$ "	9,525 cm.
Diameter (near bottom of skirt).....	3.1225" to 3.1245"	7,9311 a 7,9362 cm.
Weight.....	13.5 oz.	382,7 gr.
Clearance Limits:		
Piston-To-Cylinder Bore..... Selective Feeler Fit		
Ring Groove Depth:		
No. 1 and 2 Ring.....	.1593" to .1655"	4,046 a 4,203 mm.
No. 3 Ring.....	.1693" to .1755"	4,300 a 4,457 mm.
Ring Groove Width:		
No. 1 Ring.....	.0955" to .0965"	2,4257 a 2,4511 mm.
No. 2 Ring.....	.095" to .096"	2,413 a 2,438 mm.
No. 3 Ring.....	.1875" to .1885"	4,7625 a 4,7879 mm.
Piston Pin Hole Bore.....	.760" to .770"	19,304 a 19,558 mm.
Cylinder Bore — Standard..... 3.125" to 3.127"		
— max. out of round.....	.005"	0,1270 mm.
— max. taper.....	.005"	0,1270 mm.
— max. rebore.....	.040"	1,0160 mm.
PISTON RINGS:		
Function:		
No. 1 and 2.....	Compression	
No. 3.....	Oil	
Material:		
No. 1.....	Cast Iron, Chrome-plated Face	
No. 2 and 3.....	Cast Iron	
Width:		
No. 1 and 2.....	3 $\frac{3}{32}$ "	2,38 mm.
No. 3.....	3 $\frac{1}{16}$ "	4,76 mm.
Gap (Std. to .009 Cyl. Bore).....	.007" to .045"	0,178 a 1,143 mm.
Thickness:		
No. 1 and No. 2 Rings.....	.134" to .144"	0,3403 a 0,3657 mm.
No. 3 Ring.....	.115" to .125"	0,2821 a 0,3175 mm.
Side Clearance in Groove:		
No. 1 Ring.....	.002" to .004"	0,051 a 0,102 mm.
No. 2 Ring.....	.0015" to .0035"	0,038 a 0,088 mm.
No. 3 Ring.....	.001" to .0025"	0,025 a 0,063 mm.
PISTON PINS:		
Material.....	SAE 1016 Steel	
Length.....	2.781"	70,637 mm.
Diameter.....	.8119" to .8121"	20,6223 mm.
Type.....	Locked in Rod	
Clearance in Piston (selective fit).....	.0001" to .0003"	0,0025 a 0,0076 mm.

E-114. F4-134 ENGINE SPECIFICATIONS (Continued)

MODEL:	CJ-3B, CJ-5, CJ-6	METRIC
CONNECTING RODS:		
Material	SAE 1141 Forged Steel	
Weight	32 oz.	907 gr.
Length (center to center)	9.187"	23,33 cm.
Bearing:		
Type	Removable	
Material	Steel-backed Babbitt	
Length Over All	1.089" to 1.099"	27,661 a 27,915 mm.
Clearance Limits .....	.001" to .0019"	0,025 a 0,0483 mm.
Undersize Bearings Available .....	.001"	0,025 mm.
	.002"	0,051 mm.
	.010"	0,254 mm.
	.012"	0,305 mm.
	.020"	0,508 mm.
	.030"	0,762 mm.
End Play .....	.004" to .010"	0,102 a 0,254 mm.
Installation	From Above	
Bore:		
Upper .....	.8115" to .8125"	20,612 a 20,637 mm.
Lower	2.0432" to 2.0440"	51,8972 a 51,9176 mm.
CRANKSHAFT:		
Material	SAE 1040 Forged Steel	
End Thrust	Front Bearing	
End Play .....	.004" to .006"	0,102 a 0,152 mm.
Main Bearings:		
Type	Removable	
Material	Steel-backed Babbitt	
Clearance .....	.0003" to .0029"	0,0076 a 0,0736 mm.
Undersize Bearings Available .....	.001"	0,025 mm.
	.002"	0,051 mm.
	.010"	0,254 mm.
	.012"	0,305 mm.
	.020"	0,508 mm.
	.030"	0,762 mm.
Journal Diameter	2.3331" to 2.3341"	5,9286 a 5,9261 cm.
Bearing Length:		
Front	1.64"	41,66 mm.
No. 2	1.72"	43,69 mm.
No. 3	1.66"	42,16 mm.
Out of round and out of taper limits .....	.001"	0,025 mm.
Direction of Cylinder Offset	Right	
Amount of Cylinder Offset .....	.125"	3,175 mm.
Crankpin Journal Diameter	1.9375" to 1.9383"	49,2125 mm.
Flywheel Run Out (max.) .....	.005"	0,127 mm.
CAMSHAFT:		
Bearings:		
Material	Steel-backed Babbitt (Front only)	
Number	4	
Clearance .....	.001" to .0025"	0,025 a 0,063 mm.
Journal Diameter:		
Front	2.1860" to 2.1855"	55,518 mm.
Front Intermediate	2.1225" to 2.1215"	53,898 mm.
Rear Intermediate	2.0600" to 2.0590"	52,311 mm.
Rear	1.6230" to 1.6225"	41,217 mm.
Bearing Diameter:		
Front	2.1870" to 2.1890"	55,5498 a 55,6006 mm.
Front Intermediate	2.125" to 2.126"	53,9750 a 54,0004 mm.
Rear Intermediate	2.0625" to 2.0635"	52,3875 a 52,4129 mm.
Rear	1.625" to 1.626"	41,2750 a 41,3004 mm.
End Play .....	.004" to .007"	0,101 a 0,178 mm.
Drive:		
Type	Helical Gear	
Crankshaft Gear	Cast Iron	
Camshaft Gear	Pressed Fiber-Steel Hub	
VALVE SYSTEM:		
Valve Rotators	On Exhaust Valve	
Tappets:		
Clearance — Cold:		
Intake .....	.018"	0,461 mm.
Exhaust .....	.016"	0,406 mm.
Clearance for Timing (intake) .....	.026"	0,6604 mm.
Over All Length:		
Intake	2 $\frac{3}{4}$ "	6,98 cm.
Exhaust	2 $\frac{1}{8}$ "	7,30 cm.
Stem Diameter .....	.6245" to .6240"	15,8623 a 15,8496 mm.
Clearance in Block .....	.0005" to .0002"	0,0127 a 0,0508 mm.

E-114. F4-134 ENGINE SPECIFICATIONS (Continued)

MODEL:	CJ-3B, CJ-5, CJ-6	METRIC
VALVE SYSTEM: (Continued)		
Timing:		
Intake:		
Opens.....	9° BTC	
Closes.....	50° ABC	
Duration.....	239°	
Exhaust:		
Opens.....	47° BBC	
Closes.....	12° ATC	
Duration.....	239°	
Valve Opening Overlap.....	21°	
Valves:		
Intake:		
Material.....	SAE 5150	
Length Over All.....	4.781"	12,14 mm.
Head Diameter.....	2"	50,8 mm.
Angle of Seat.....	45°	
Stem Diameter.....	.3733" to .3738"	9,481 a 9,494 mm.
Stem-to-Guide Clearance.....	.0007" to .0022"	0,0178 a 0,0559 mm.
Lift.....	.260"	6,604 mm.
Exhaust:		
Material.....	Uniloy 21-12	
Length Over All.....	5.909"	150,089 mm.
Head Diameter.....	1.47"	37,34 mm.
Angle of Seat.....	45°	
Seat Insert Material.....	Eatonite EMS 58	
Stem Diameter.....	.371" to .372"	9,423 a 9,449 mm.
Stem-to-Guide Clearance.....	.0025" to .0045"	0,0635 a 0,1143 mm.
Lift.....	.351"	8,915 mm.
Springs:		
Intake:		
Free Length.....	1.97"	50,00 mm.
Standard:		
Pressure @ Length:		
Valve Closed.....	73 lb. @ 1.66"	33,1 kg. @ 86,7 mm.
Valve Open.....	153 lb. @ 1.40"	69,4 kg. @ 35,7 mm.
Service Minimum:		
Pressure @ Length:		
Valve Closed.....	66 lb. @ 1.66"	29,9 kg. @ 86,7 mm.
Valve Open.....	140 lb. @ 1.40"	63,5 kg. @ 35,7 mm.
Exhaust:		
Free Length.....	2½"	63,5 mm.
Pressure @ Length:		
Standard:		
Valve Closed.....	53 lb. @ 2.109"	24 kg. @ 53,5 mm.
Valve Open.....	120 lb. @ 1.750"	54,3 kg. @ 44,4 mm.
Service Minimum:		
Valve Closed.....	47 lb. @ 2 ⁷ / ₆₄ "	21,3 kg. @ 53,5 mm.
Valve Open.....	110 lb. @ 1 ³ / ₄ "	49,9 kg. @ 44,4 mm.
LUBRICATION SYSTEM:		
Type of Lubrication:		
Main Bearings.....	Pressure	
Connecting Rods.....	Pressure	
Piston Pins.....	Splash	
Camshaft Bearings.....	Pressure	
Tappets.....	Splash	
Timing Gears.....	Nozzle	
Cylinder Walls.....	Nozzle	
Oil Pump:		
Type.....	Internal Rotor	
Drive.....	Camshaft Gear	
Minimum Safe Oil Pressure:		
At Idle.....	6 psi.	0,4 kg-cm ²
At 2000 rpm. (35 mph.).....	20 psi.	1,4 kg-cm ²
Relief Valve Opens.....	40 psi.	2,8 kg-cm ²
Normal Oil Pressure.....	35 psi. @ 2000 rpm.	2,4 kg-cm ² @ 2000 rpm.
Oil Pressure Sending Unit.....	Electric	
Oil Intake.....	Floating	
Oil Filter System.....	Partial Flow	



FUEL SYSTEM

Contents

SUBJECT	PAR.	SUBJECT	PAR.
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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 or commercial fuel system cleaners will dissolve gum formation. In extreme cases it will be necessary to disassemble and clean the fuel system. In most cases, however, a good commercial fuel system solvent used in accordance with the manufacturer's instructions or one pint [0,6 ltr.] of acetone placed in the fuel tank with about one gallon [4,5 ltr.] of gasoline will dissolve any deposits as it passes through the system with the gasoline.

F-2. Carburetor

● Models CJ-2A, CJ-3A

Model CJ-2A is equipped with Carter carburetor, model 596S. Model CJ-3A is equipped with Carter carburetor, model 636SA. Both of these carburetors are basically the same and many parts are interchangeable. The differences between the two carburetors are mostly external and obvious and the service procedures given below will apply to both carburetors.

These carburetors are of the plain tube type, Fig. 113, with a throttle operated accelerator pump and economizer device. The carburetor is a precision instrument designed to deliver the proper fuel and air ratios for all engine speeds. By proper cleaning and replacing all worn parts, the carburetor will function correctly.

The carburetor may be divided into five circuits: float circuit, low-speed circuit, high-speed circuit, pump circuit, and choke circuit.

By treating each circuit separately, the diagnosing of trouble and the repair of the carburetor is made much simpler.

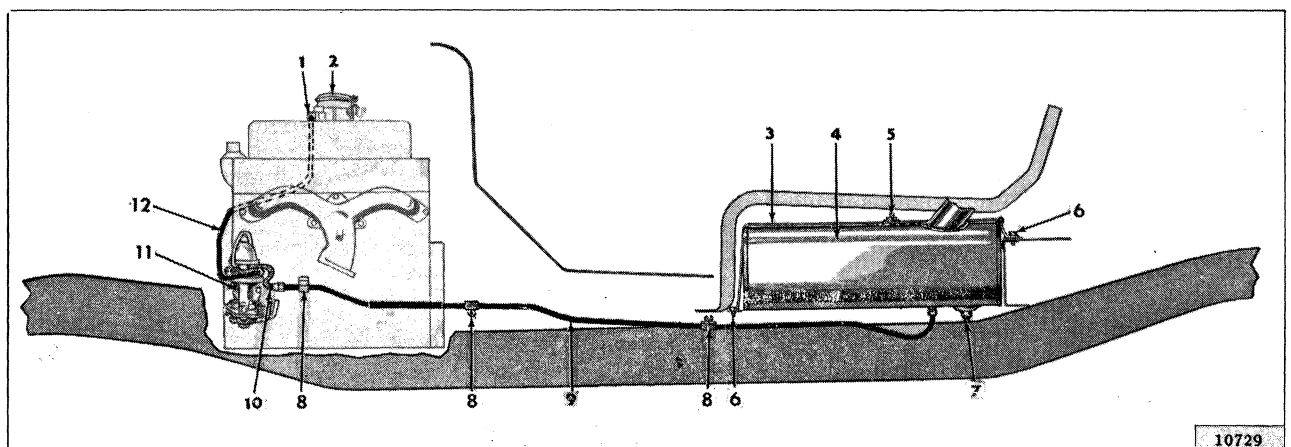


FIG. 112—FUEL SYSTEM—MODELS CJ-3B, CJ-5, CJ-6

- | | | |
|-----------------------------|--------------------------------|----------------------------|
| 1—Elbow | 5—Fuel Gauge Tank Sending Unit | 9—Fuel Line |
| 2—Carburetor | 6—Screw and Lockwasher | 10—Line-to-Pump Connection |
| 3—Fuel Tank Hold Down Strap | 7—Pipe Plug | 11—Fuel and Vacuum Pump |
| 4—Fuel Tank | 8—Clip | 12—Pump-to-Carburetor Tube |

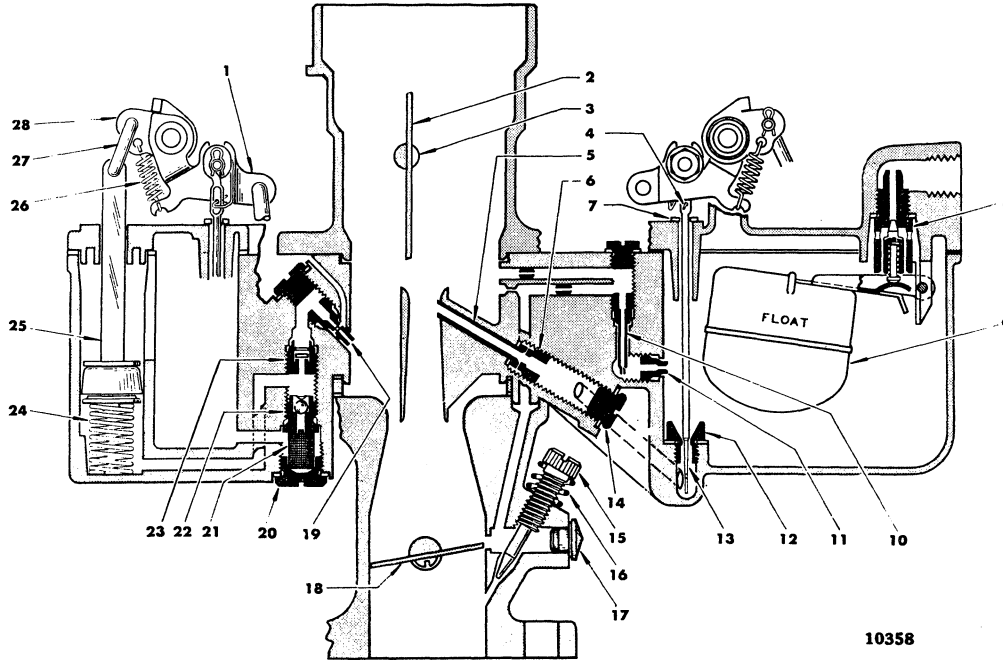


FIG. 113—CARTER CARBURETOR—MODELS CJ-2A, CJ-3A

- | | | |
|--------------------------------|-----------------------------------|--------------------------|
| 1—Pump Operating Lever | 10—Low Speed Jet | 19—Pump Jet |
| 2—Choke Valve | 11—Idle Well Jet | 20—Pump Jet Strainer Nut |
| 3—Choke Shaft and Lever | 12—Metering Rod Jet and Gasket | 21—Pump Jet Strainer |
| 4—Metering Rod Spring | 13—Metering Rod | 22—Intake Ball Check |
| 5—Nozzle | 14—Nozzle Passage Plug and Gasket | 23—Discharge Disc Check |
| 6—Nozzle Retaining Plug | 15—Idle Adjustment Screw | 24—Pump Plunger Spring |
| 7—Metering Rod Disc | 16—Idle Adjustment Screw Spring | 25—Pump Plunger and Rod |
| 8—Needle, Pin, Spring and Seat | 17—Idle Port Rivet Plug | 26—Pump Arm Spring |
| 9—Float and Lever | 18—Throttle Valve | 27—Pump Connecting Link |
| | | 28—Pump Arm and Collar |

F-3. Float Circuit

The float circuit Fig. 114, is important because it controls the heights of the fuel level in the bowl and

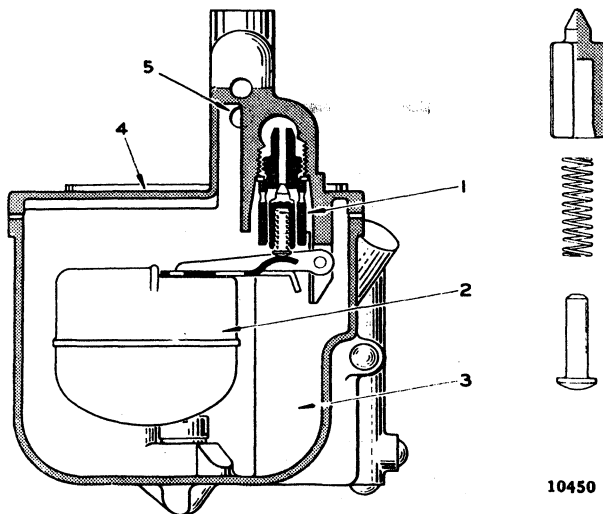


FIG. 114—FLOAT CIRCUIT

- 1—Needle Valve Seat Assembly
- 2—Float and Lever Assembly
- 3—Float Bowl
- 4—Float Bowl Cover
- 5—Vent

nozzle. If the fuel level is too high, it will cause trouble in both the low and high speed circuits.

The float bowl acts as a reservoir to hold a constant supply of fuel. The level of the fuel in the bowl is controlled by the float and lever assembly, float bowl cover, and the needle valve seat assembly.

F-4. Low-Speed Circuit

The idle or low speed circuit, Fig. 115, controls the supply of fuel to the engine for idle speeds and light load operation up to approximately 20 miles [32 km.] per hour. It supplies a small amount of fuel through the entire operating range, gradually decreasing as speed is increased above 20 miles [32 km.] per hour.

During idle and low speed operation of the engine, fuel flows from the float bowl through the idle well jet and the low speed jet to the point where it combines with a stream of air entering through by-pass. The combining of the fuel with the air atomizes or breaks up the fuel into a vapor.

This mixture of air and fuel continues on through the economizer until it begins to pass the point where it is further combined with a stream of air coming in through the lower air bleed. This mixture of fuel and air then flows downward to the idle port chamber and thence into the engine and also

through the idle adjusting screw seat just below. This mixture is richer than the engine requires but when mixed with the air coming past the throttle valve a combustible mixture of the right proportion for idle speeds is formed.

The idle port is slotted so that, as the throttle valve is opened it will not only allow more air to come in past it, but it will also uncover more of the idle port allowing a greater quantity of fuel and air mixture to enter the intake manifold.

When the idle speed position of the throttle is fixed at 8 miles per hour [12.9 k.p.h.], it leaves enough

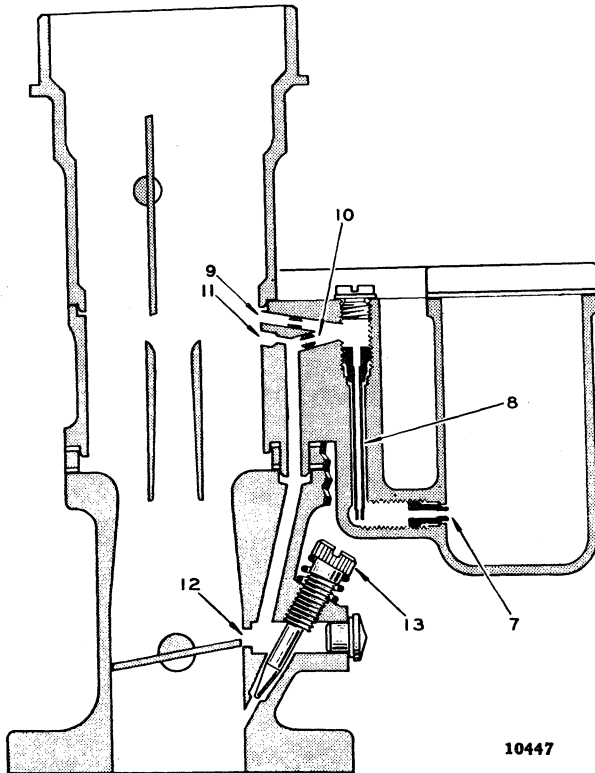


FIG. 115—LOW-SPEED CIRCUIT

- | | |
|-----------------|-------------------------|
| 7—Idle Well Jet | 11—Lower Air Bleed |
| 8—Low Speed Jet | 12—Idle Port |
| 9—By-pass | 13—Idle Adjusting Screw |
| 10—Economizer | |

of the slotted port as reserve to cover the range in speed between idle and the time when the high speed system begins to cut in.

The idle adjusting screw varies the quantity of the idle mixture.

F-5. High-Speed Circuit

The high-speed circuit, Fig. 116, cuts in as the throttle is opened wide enough for a speed of about 20 miles per hour [32 k.p.h.]. The velocity of the air flowing down through the carburetor throat creates a pressure slightly less than atmospheric pressure at the tip of the main nozzle. Since the fuel in the float bowl is acted upon by atmospheric pressure, the difference in pressure between the two points causes fuel to flow from the bowl through the metering jet and out the main nozzle into the throat of the carburetor.

At higher speeds the area of the opening between the metering jet and the metering rod governs

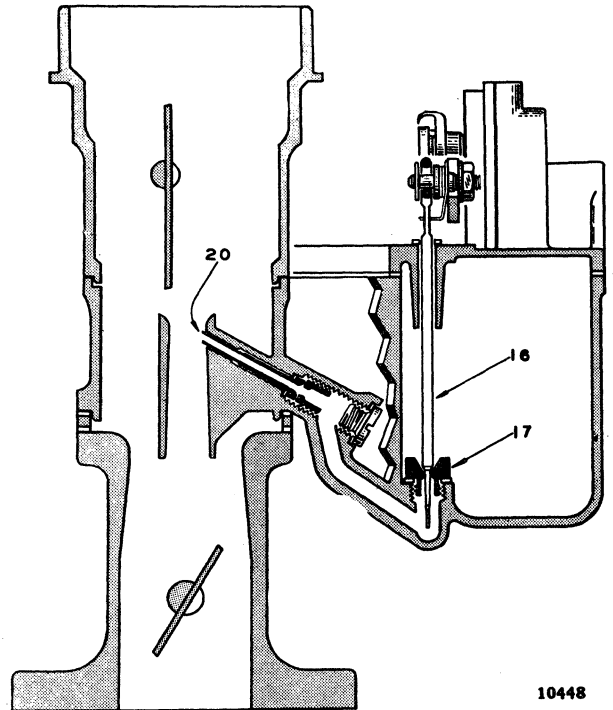


FIG. 116—HIGH-SPEED CIRCUIT

- | | | |
|-----------------|-----------------|----------------|
| 16—Metering Rod | 17—Metering Jet | 20—Main Nozzle |
|-----------------|-----------------|----------------|

the amount of fuel entering the engine. At wide open throttle only the smallest section of the rod is in the jet.

F-6. Accelerating Pump Circuit

As the accelerator pedal is depressed, the pump plunger and lever are forced downward. This forces fuel from the cylinder, closing intake ball check valve, Fig. 117, and opening discharge ball check valve passing the fuel into the throat of the carburetor through pump jet.

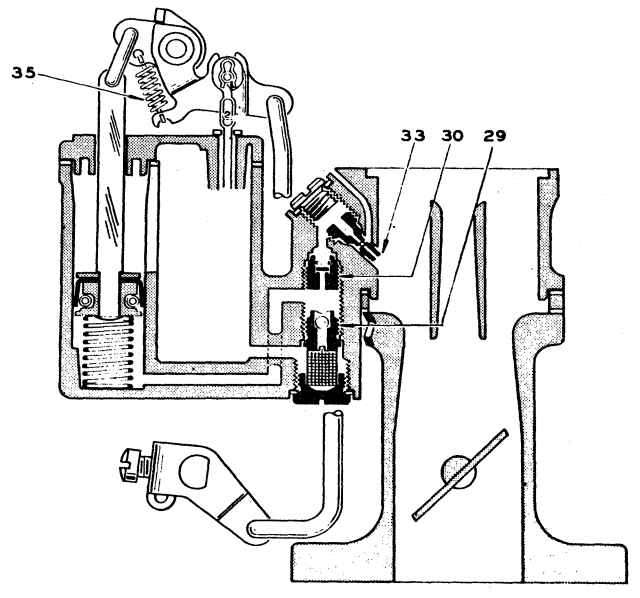


FIG. 117—PUMP CIRCUIT

- | | |
|-------------------------------|--------------------|
| 29—Intake Ball Check Valve | 33—Pump Jet |
| 30—Discharge Ball Check Valve | 35—Pump Arm Spring |

Pump action is prolonged by the pump arm spring because the hole in the pump jet restricts the flow of fuel while it is being forced out by the pump. The prolonging of the pump discharge gives the fuel in the high speed circuit sufficient time to flow fast enough to satisfy the demands of the engine.

As the accelerator pedal is allowed to return to its original position, the pump plunger is lifted upward. This creates a reduced pressure in the pump cylinder which opens intake ball check valve and closes discharge ball check valve thereby drawing in a new charge of fuel from the bowl.

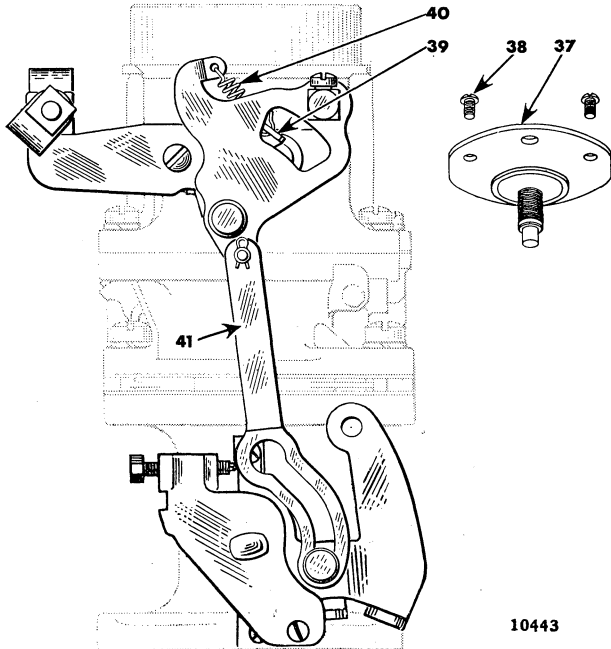


FIG. 118—CHOKE CIRCUIT

- 37—Choke Valve
- 38—Screw
- 39—Choke Shaft and Lever Assembly
- 40—Choke Operating Lever and Spring

F-7. Choke Circuit

This circuit, Fig. 118, is used only in starting and warming up the engine, by restricting the amount of air allowed to enter the carburetor thereby producing a richer mixture. It consists of a choke shaft and lever assembly choke operating lever and spring choke valve and screws.

F-8. SERVICING AND ADJUSTMENT

F-9. Float Circuit

If the float is loaded with fuel or if the holes for the pins are worn, the carburetor will flood. Poor action of the float needle will occur if the lip of the float bracket is worn. In this event, it should be smoothed with emery cloth.

The needle and seat may leak because of wear, damage or sticking and will cause the carburetor to flood. Needles and seats are available only in matched sets. Never replace the needle without replacing the seat.

To determine the float level, Fig. 119, first turn the bowl cover gasket around and with the cover in position as shown, the float by its own weight should rest at $\frac{3}{8}$ " [9,525 mm.] (as indicated by the gauge).

To change the float level press down with a screw driver on the brass lip of the float, holding up on the float while assembled to the cover of the carburetor. Bending the lip in this way allows it to retain its curvature which is necessary for the correct operation of the float valve.

Be sure the spring and pin in the valve are in position and that the spring has not been stretched.

F-10. Low-Speed Circuit

In the low speed circuit, Fig. 115, it will be found that the fuel does not come through the main metering jet, but through the idle well jet, and the low speed jet the openings of which are carefully calibrated. If they are damaged they should be replaced. The jets should always be tightly seated. The by-pass and air bleed holes must be clear. Carbon deposits which may form in the throat of the carburetor might restrict the air bleed holes to the extent that insufficient air will be supplied to mix the fuel before it reaches the idle port.

This condition will usually be indicated if it is necessary to screw the idle mixture adjusting screw, in closer than the minimum limit of $\frac{1}{2}$ turn. If the condition is bad, a rolling idle may continue even after the idle mixture adjusting screw is screwed entirely in against the seat. The air bleed holes may be cleaned with a soft copper wire.

The idle port must be kept clean and unrestricted. If it is damaged the engine will not perform properly at low speeds and a new body flange will be required.

A letter "C" enclosed by a circle is stamped on the face of the throttle valve. When the valve is installed in the carburetor, this side should be toward the idle port, and facing the intake manifold as viewed from the bottom.

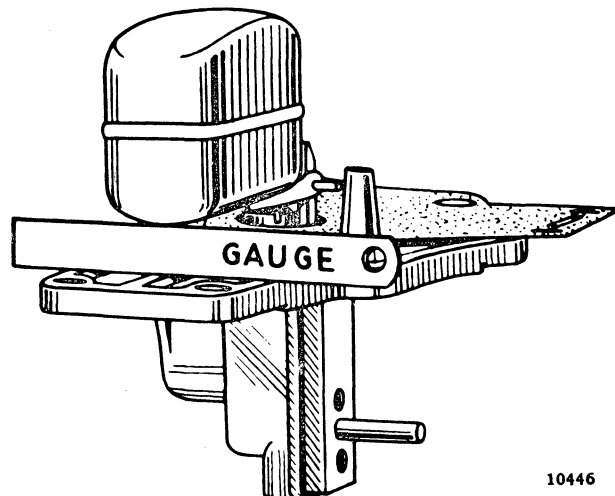


FIG. 119—FLOAT LEVEL SETTING

To properly center the valve in the throat of the carburetor, the screws should be started in the shaft, and then with the valve tightly closed (throttle lever adjusting screw backed out) it should be tapped lightly. This will centralize the valve in the carburetor throat. Pressure should then be maintained with the fingers until the screws are tightened.

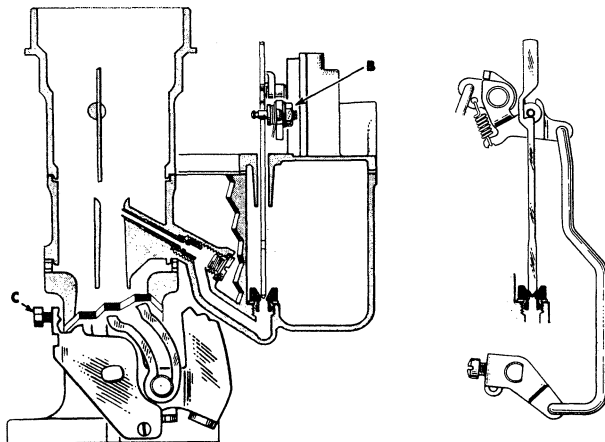
If the carburetor throat is restricted with carbon deposit it will be necessary to open the throttle wider than the correct opening to obtain the proper engine idle speed. Opening the throttle more than this amount in order to obtain the proper idle will then uncover more of the slotted idle port than was intended. This will result in leaving an insufficient amount of the idle port as a reserve to cover the period between idle and 20 miles [32 km.] per hour, where the high speed system begins to cut in. A flat spot on acceleration will result. Clean by scraping with emery cloth.

F-11. High-Speed Circuit

It is rarely necessary to remove the main nozzle, Fig. 116. It can usually be cleaned by removing the plug and blowing it out with compressed air. If it is damaged and requires replacing, make sure, upon installation that only one gasket is between the nozzle and the seat.

If the carburetor has been in service for a long time or has been tampered with, it may be found that the metering rod is improperly adjusted or worn. A worn metering rod will have the effect of a rich mixture above 20 miles per hour [32,2 k.p.h.]. If the metering rod is worn, the metering rod jet will also be worn and both should be replaced. Before adjusting the metering rod adjust the accelerating pump stroke, for the pump stroke adjustment will change the metering rod setting.

To adjust the metering rod, back out throttle lever adjusting screw "C", Fig. 120, and close the throttle tight. Using gauge T-109-26, Fig. 120, (supplied by Carter Carburetor Co.) loosen nut "B" and move pin until it seats in the notch of the gauge. Tighten the nut securely. Remove the gauge and install metering rod with disc, and connect the spring through hole in the metering rod.



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FIG. 120—METERING ROD GAUGING

To check the setting, note the position of the operating pin in the eye of the metering rod. It should just clear within the top of the eye (clearance not to exceed $\frac{1}{64}$ " — .397 mm.) when the metering rod is seated and the throttle stop screw set for proper engine idle.

F-12. Accelerating Pump Circuit

If the pump plunger is worn, sticks or if the spring under the leather has lost its tension, replace the plunger assembly, Fig. 113.

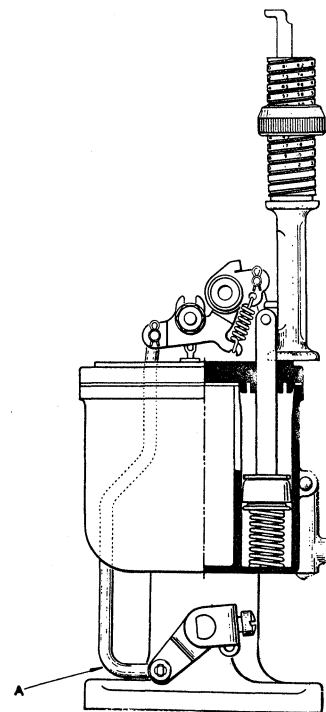
If the pump intake check valve, Fig. 117, leaks part of the pump discharge will be forced back through the valve into the float bowl, preventing a sufficient amount of fuel to be discharged from the jet. If the valve can not be cleaned with compressed air, it must be replaced.

If the pump discharge check valve leaks, air will be drawn into the pump cylinder on the up stroke of the plunger. This gives an insufficient discharge of fuel into the throat of the carburetor on acceleration causing a flat spot. If the valve can not be cleaned with compressed air, to prevent leakage, it must be replaced.

If the accelerating pump arm spring is weak or damaged, it will cause poor acceleration.

If the hole in the accelerating pump jet is too large, the accelerating charge will be allowed to pass too fast and will make the mixture too rich. An enlarged jet must be replaced. A loose jet gives the same effect. A clogged jet will cause a flat spot on acceleration.

To adjust the pump stroke, pump gauge T-109-117C (supplied by Carter Carburetor Co.) should be used. First back out the throttle adjusting screw



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FIG. 121—PUMP TRAVEL GAUGING

"C", Fig. 120, to fully close the throttle. To measure the stroke, place the gauge on top of the bowl cover, Fig. 121, open the throttle wide and measure to the top of the pump plunger rod. Close the throttle tight and measure again. The difference, which is the pump stroke, should be $\frac{17}{64}$ " [6,747 mm.]. To adjust the stroke bend the throttle connector rod at "A". **IMPORTANT:** Always set the pump stroke before setting the metering rod. If set afterwards the metering rod will be thrown out of adjustment.

If the throttle connector rod and throttle shaft arm assembly are worn, it will allow the throttle valve to be opened by the accelerator pedal before the pump jet begins to discharge fuel, resulting in a flat spot. Replace all worn parts because the operation of the metering rod is also affected.

F-13. Choke Circuit

The choke connector link connects the choke and throttle levers and opens the throttle slightly when the choke valve is closed, thus insuring quick starting and freedom from stalling during the warm up period.

F-14. Carburetor

● Models CJ-3B, CJ-5, CJ-6, DJ-3A

Current production models CJ-3B, CJ-5, and CJ-6 have a Carter YF-938SD carburetor superseding the earlier YF-938SC, YF-938SA, or YF-938S models.

Note: Conversion kits for changing earlier models to SD models are available. See Par. F-27. It is recommended that when a carburetor is converted that a tag be fashioned stamped with the new model number and installed under one of the air horn screws. Look for such a tag to determine if the carburetor has previously been converted.

The carburetor for model DJ-3A is a Carter model YF-2392S. Carburetors listed above are all in the same YF series and have only minor differences. Descriptions and repair procedures given in the following paragraphs apply equally to all YF-series carburetors. YF-series carburetors employ manual and vacuum control of the metering rod and accelerator pump.

The carburetor controls and vaporizes the fuel through five separate circuits: float circuit, low-speed circuit, high-speed circuit, choke circuit, and accelerating-pump circuit. A description of the function and operation of each circuit provides an over all description of the carburetor.

For identification, the series designation is stamped on the body under the name Carter and the model designation is stamped on a flange protruding from the body.

Note: When checking for carburetor icing causes, also check the vacuum-pump-to-manifold vacuum line connector.

F-15. Float Circuit

The float circuit, Fig. 122, 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.

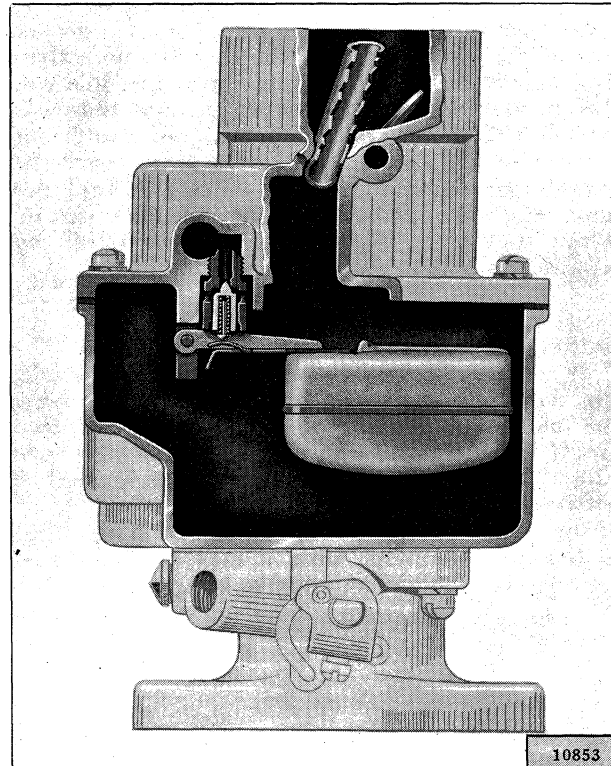


FIG. 122—FLOAT CIRCUIT

F-16. Float Adjustment

Correct float level setting is required for accurate metering of fuel in both low- and high-speed jets. To set the float, remove and invert the bowl cover. Remove the bowl cover gasket. Allow the weight of the float to rest on the needle and spring. Be sure there is no compression of the spring other than the weight of the float. Adjust the level by bending the float arm lip that contacts the needle (not the arm) to provide specified clearance between the float and cover.

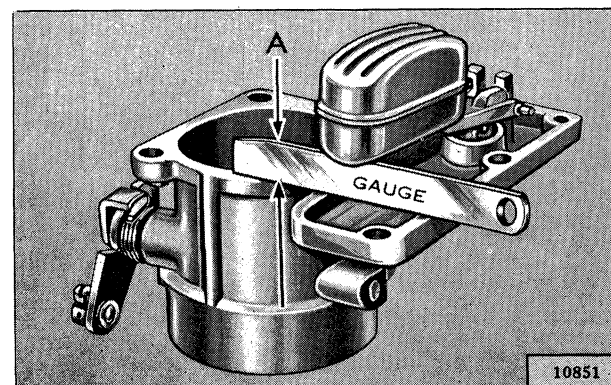


FIG. 123—FLOAT LEVEL GAUGING

Specified clearances:

- CJ-3B, CJ-5, CJ-6..... $\frac{5}{16}$ " [7,93 mm.]
- DJ-3A..... $\frac{9}{32}$ " [7,14 mm.]

This clearance, shown as A in Fig. 123, can be measured by a gauge.

Use these Carter Gauges:

- CJ-3B, CJ-5, CJ-6.....T109-107
- DJ-3A.....T109-126

F-17. Low-Speed Circuit

Fuel for idle and early part-throttle operation is metered through the low-speed circuit. The low-speed circuit is illustrated in Fig. 124. Liquid fuel enters the idle well through the metering rod jet. Low-speed jet measures the amount of fuel for

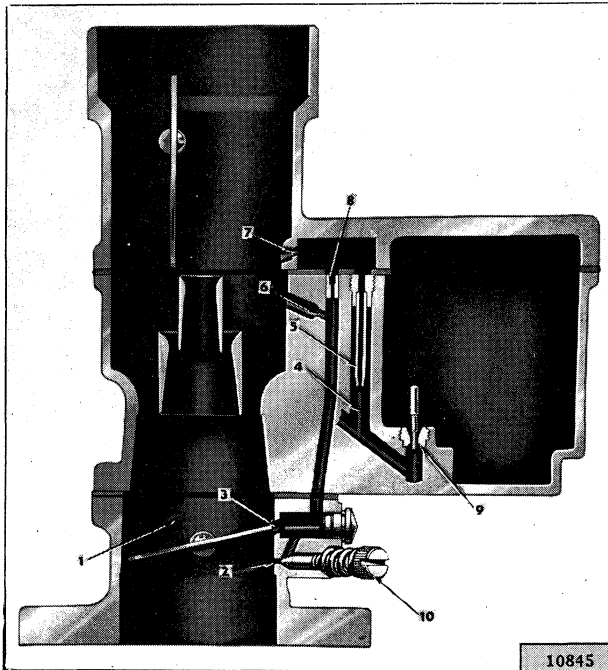


FIG. 124—LOW-SPEED CIRCUIT

- | | |
|------------------------------|--------------------------|
| 1—Body Flange | 6—Idle Air Bleed |
| 2—Idle Adjustment Screw Port | 7—Air By-pass |
| 3—Idle Port | 8—Economizer |
| 4—Idle Well | 9—Metering Rod Jet |
| 5—Low Speed Jet | 10—Idle Adjustment Screw |

idle and early part-throttle operation. Air-by-pass, economizer, and idle air bleed 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 and idle adjustment screw port.

F-18. Idle Adjustment

Turn screw, Fig. 124, $\frac{3}{4}$ to $1\frac{3}{4}$ turns for normal opening on the CJ-3B, CJ-5, CJ-6. Turn screw 1 to $2\frac{1}{2}$ turns for normal opening on the DJ-3A carburetor. For richer mixture, turn this screw out; for leaner mixture, turn this screw in. Do not idle the engine below 600 rpm. By-pass, economizer, idle port, idle adjustment screw port, and bore of throttle body flange must be clean and free from carbon. Obstructions at any of these points will cause poor low-speed performance. A worn or damaged idle adjustment screw or low-speed jet should be replaced.

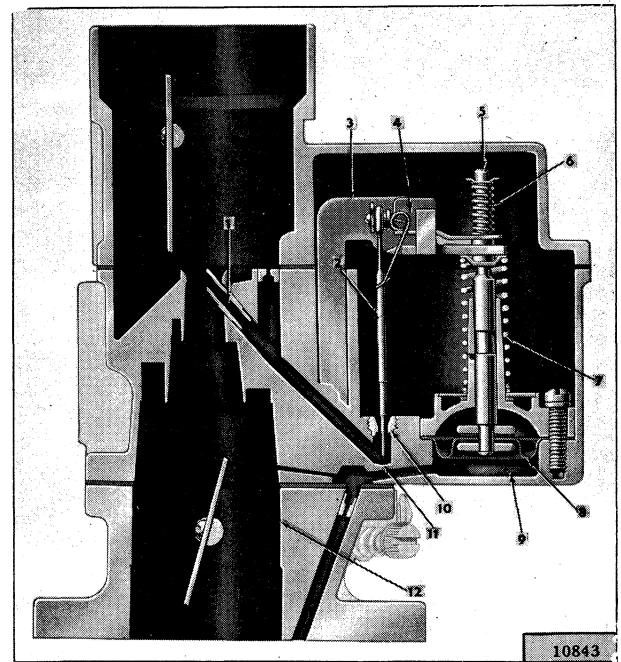


FIG. 125—HIGH-SPEED CIRCUIT

- | | |
|-----------------------------|-------------------------|
| 1—Nozzle | 7—Pump Diaphragm Spring |
| 2—Metering Rod | 8—Diaphragm Assembly |
| 3—Pump Lifter Link | 9—Chamber |
| 4—Metering Rod Arm Assembly | 10—Metering Rod Jet |
| 5—Diaphragm Shaft | 11—Carburetor Casting |
| 6—Upper Pump Spring | 12—Carburetor Bore |

F-19. High-Speed Circuit

Fuel for part-throttle and full-throttle operation is supplied through the high-speed circuit shown in Fig. 125. A metering rod and metering rod jet control the amount of fuel admitted through the nozzle for high-speed operation. The lower end of the metering rod is calibrated in size to accurately meter the fuel required. As the rod is automatically raised and lowered in the jet, 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. During part-throttle operation, vacuum in chamber pulls diaphragm down, holding metering arm assembly against pump lifter link. Movement of the metering rod is controlled by the pump lifter link which is attached to the carburetor throttle shaft. At all times vacuum in the chamber is strong enough to overcome the tension of pump diaphragm spring. Upper pump spring serves as a bumper upon deceleration and as a delayed action spring upon acceleration. Under any operating condition, when the pump diaphragm spring overcomes vacuum in the chamber, the metering rod will move toward the wide throttle (power) position.

Note: Nozzle is pressed in and should not be removed.

F-20. Metering Rod Adjustment

Check metering rod adjustment each time the carburetor is reassembled. Before adjustment is made, be sure that the flat of metering rod arm is parallel to the flat of pump lifter link as shown

(Fig. 125.) With the throttle valve seated in carburetor bore, press down on the upper end of diaphragm shaft until the diaphragm bottoms in the vacuum chamber. The metering rod should now seat on casting with the metering rod arm flat against the pump lifter link. If the metering rod does not seat on the casting (check by pressing downward on metering rod) or seats before the metering rod arm makes flat contact with the pump lifter link, make adjustment by bending the lip on the metering rod arm.

F-21. 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 offset-spring loaded to prevent over-choking during the starting warm-up period. When the choke valve is moved to a closed position for starting, the fast idle connector rod A in Fig. 126 revolves the fast idle link B. This action 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.

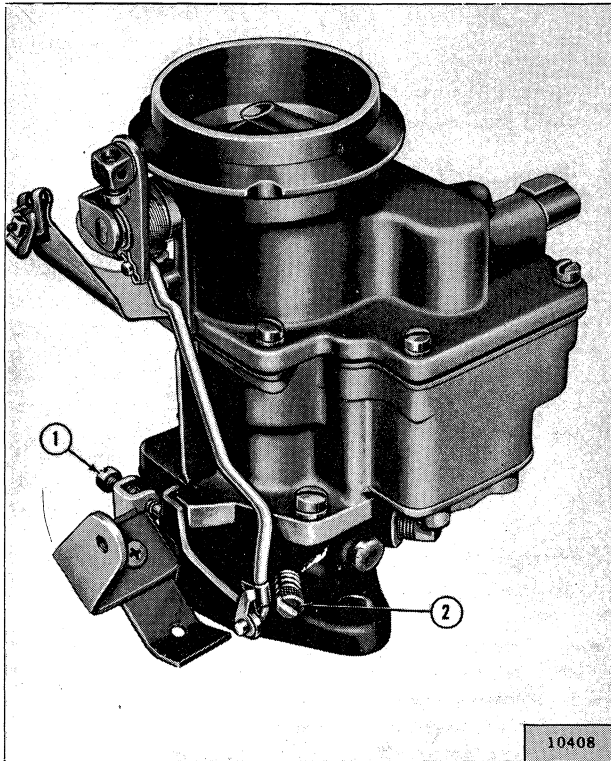


FIG. 126—FAST IDLE ADJUSTMENT

F-22. Fast Idle Adjustment

With the choke held in wide open position, lip A (Fig. 126) on the fast-idle rod should contact the boss on the body casting. Adjust by bending the fast-idle link at offset B.

F-23. Accelerating Pump Circuit

The accelerating pump circuit shown in Fig. 127 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

at all times when the engine is running. Lower and more uniform vacuum is provided by vacuum restriction and vacuum bleed passage. When the diaphragm is in its maximum down position at low throttle resulting from high vacuum in chamber the chamber above the diaphragm is full of fuel which has been admitted through intake passage. When the throttle is opened, vacuum drops in the chamber and the diaphragm is initially forced upward by the spring on the diaphragm shaft. The upward motion is picked up by accelerator pump lifter which is connected to the throttle. This movement forces fuel from the chamber above the diaphragm through discharge pump check valve and discharge pump jet. 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 to be available for the next cycle of operation.

Note: The pump jet (see insert drawing in Fig. 127) projecting into the air stream is permanently pressed into the carburetor body and should not be removed. Also, carburetor design makes it impossible to adjust the pump stroke.

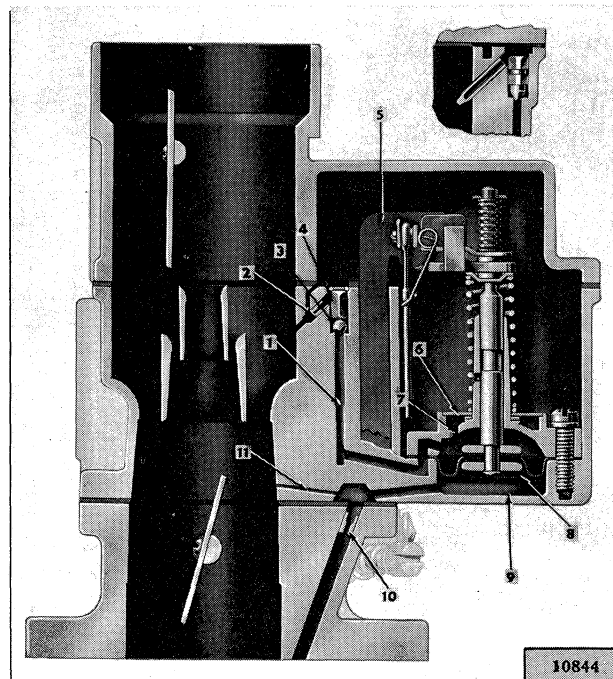


FIG. 127—ACCELERATING PUMP CIRCUIT

- | | |
|-------------------------|---------------------------|
| 1—Pump Fuel Passage | 7—Intake Passage |
| 2—Discharge Pump Jet | 8—Diaphragm |
| 3—Pump Check Valve Ball | 9—Vacuum Chamber |
| 4—Ball Check Weight | 10—Vacuum Restriction Jet |
| 5—Pump Lifter Arm | 11—Vacuum Bleed Passage |
| 6—Filter Screen | |

F-24. Accelerating Pump Maintenance

If engine acceleration is unsatisfactory, remove the pump diaphragm and check the diaphragm for wear or damage. Then remove the pump check retainer ring located directly above the pump check weight and pump ball check. Pump ball check must seat properly as a leak will cause poor acceleration

performance. Inspect and replace all worn or damaged parts. Clean and blow out all passages with compressed air. Note that when testing the pump for discharge volume with the carburetor off the engine, only half of the maximum pump capacity will be discharged. When the engine is operating, vacuum controls the balance of discharge.

F-25. Carburetor Disassembly

Refer to Fig. 128.

- a. Pry pin spring and clevis clip free and remove fast-idle connector rod (43).
- b. Remove air horn and bowl cover attaching screws and lockwashers. Remove choke tube clamp assembly.

- c. Remove air horn assembly and gasket.
- d. Remove ball check valve retainer ring. Invert the unit and tap lightly to remove ball check valve retainer and ball check valve.
- e. Loosen the screw locking the throttle shaft arm to the throttle shaft. Remove the throttle shaft arm and pump connector link.
- f. Remove diaphragm housing screws. Entire assembly can now be lifted out of the body. This assembly can easily be disassembled and reassembled if necessary.
- g. Carefully remove pump intake strainer housing using tip of knife blade.
- h. With the air horn in an upside-down position, remove pin and float. Invert the air horn and catch needle pin and needle pin spring.

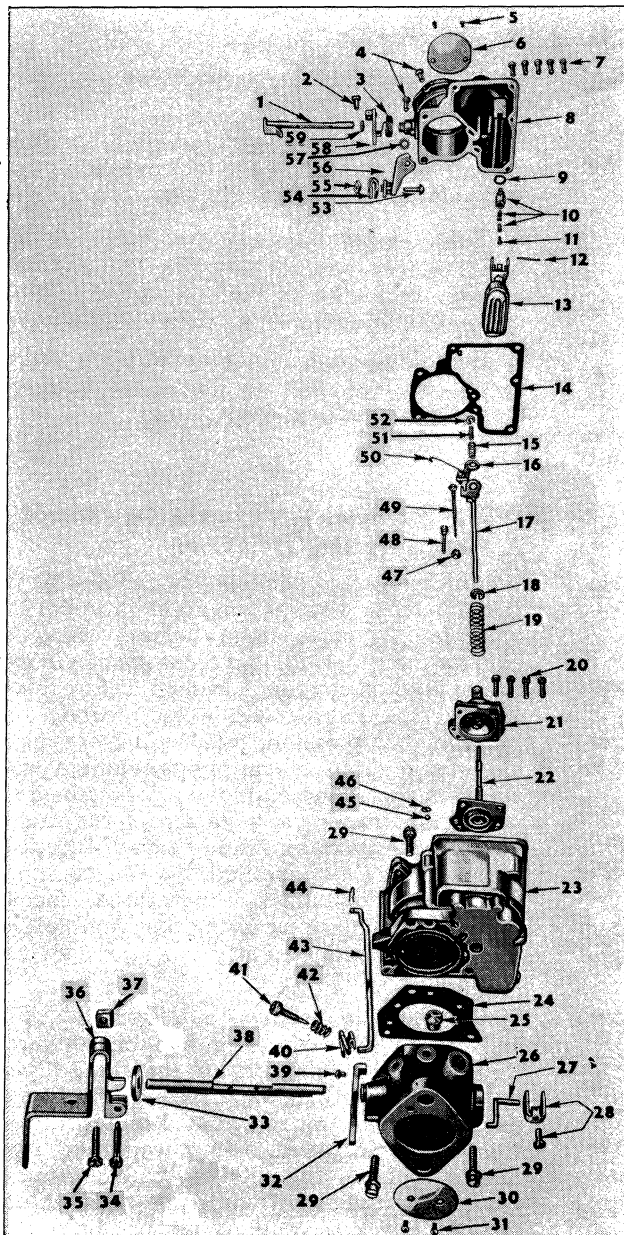


FIG. 128—CARBURETOR INDEX

- 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 Pin
- 13—Float
- 14—Gasket
- 15—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—Pump Link Connector
- 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—Ball Check Valve
- 46—Ball Check Valve Retainer Ring
- 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

i. Remove metering rod jet. Remove low-speed jet.

Note: Do not remove pressed-in parts such as nozzle, pump jet, or antipercolator air bleed.

j. Remove body flange attaching screws, body flange assembly, and gasket.

k. Remove idle-adjustment screw, spring, idle port rivet, throttle lever assembly, washer, fast idle arm, throttle plate screws, throttle plate, and throttle shaft.

l. Remove throttle shaft seal by prying out seal retainer.

Note: Do not remove pressed-in vacuum passage orifice.

m. Remove choke valve screws and choke valve. Unhook choke spring and slide shaft from housing.

n. Wash all parts in carburetor cleaning solution and blow out passages with compressed air. Do not immerse diaphragm or seals in cleaning solution. Inspect all parts for wear or damage. Always use new gaskets when reassembling.

F-26. Carburetor Assembly

To expedite reassembly, it is advisable to group all related parts by the circuit to which they belong.

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.

Note: 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.

Note: No gasket is 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 arm assembly. Install throttle shaft arm assembly on throttle shaft guiding connector link in pump lifter link hole.

CAUTION: Linkage must not bind in any throttle position. If binding occurs, loosen clamp screw in throttle arm, adjust slightly, then retighten screw.

m. Install pump check disc, disc retainer, and lock ring.

n. Install metering rod and pin spring. Connect metering rod spring.

o. Check and if necessary correct metering rod adjustment. Follow procedure of Par. F-20.

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 the carburetor.

q. Set float level to specifications. Follow procedure of Par. F-16.

r. Install air horn gasket and air horn assembly. Install attaching screws, 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 the valve by tapping lightly, then hold in place with fingers when tightening screws.

t. Install fast-idle connector rod with offset portion of rod on top and pin spring on outside. Install fast-idle connecting rod spring.

F-27. Correcting Acceleration Flat Spot

• Models CJ-3B, CJ-5, CJ-6

Using Carburetor Models 938-S, 938-SA, 938-SC
 Inasmuch as a flat spot on acceleration or low speed stumble can come from causes other than carburetor malfunction, it is recommended that engine tuning be thoroughly checked before attempting any actual carburetor work. Make sure that ignition, compression, and timing are correct and that fuel pump is supplying enough gas. Also, the F-head engine employs a water-heated intake manifold. Proper vaporization of the fuel depends on correct intake manifold temperature. Since this temperature is controlled by the cooling system thermostat, include an operational check of the thermostat when diagnosing the stumble. Operating temperatures consistently below 155°F. can cause stumble.

If the stumble persists, a YF-938-S, YF-938-SA, or YF-938-SC carburetor can be converted to a YF-938-SD carburetor by installing Special Kit 924161, consisting of a pump discharge check needle, a metering rod, and a metering rod jet. If this kit is installed, the pump discharge check needle replaces the original ball, weight, and retainer and the small wire-type retainer used with the ball check assembly must not be reinstalled.

When installing the kit, check the size of the pump discharge jet, No. 2, Fig. 129. Early production YF-938S and YF-938SA carburetors have a .025" [0,635 mm.] jet installed. If the carburetor being converted has a .025" jet it must be opened up to .031" [0,787 mm.] by running a No. 68 drill through the jet as shown in Fig. 129. The jet must be drilled as it is a pressed in part and cannot be replaced.

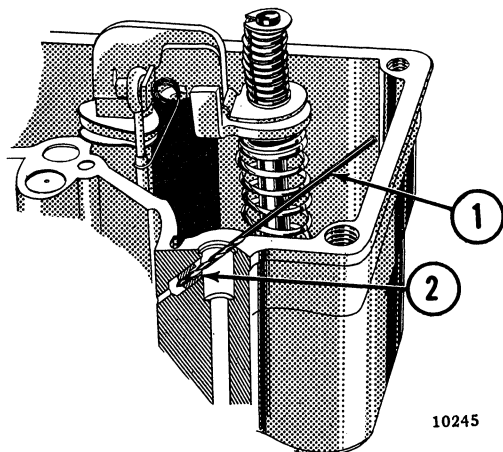


FIG. 129—DRILLING CARBURETOR JET

- 1—Drill (#68 size)
- 2—Accelerator Pump Discharge Jet

Upon completing the installation of the conversion kit, mark or tag the carburetor to indicate that it is a YF-938SD.

F-28. Steep-Grade Carburetor Kit

In the field where a CJ-3B or CJ-5 equipped with Carter carburetor 938-S is required to idle on steep slopes, flooding of the carburetor sometimes results. A steep-grade carburetor kit is available that will allow satisfactory idle operation under this condition. This kit (W.M. #94481, Carter #75-960U) contains a metering rod, a metering rod jet, and a plug.

To install this kit, replace the standard metering rod and metering rod jet with those contained in the kit. Place the small brass plug in the accelerator pump well. **Exert finger pressure only** when installing this plug. Forcing the plug in too far will damage the accelerator jet. Make certain the metering rod and float level are set to specifications. Set idle at 600 rpm.

When reworking the carburetor to include this steep-grade kit, check to determine if the seal (Carter #121-172) and retainer (Carter #136-152) are installed. If these parts are not present, they should be installed.

F-29. Fuel Pump

- Models CJ-2A, DJ-3A

Fig. 130 illustrates the pump used on the Models CJ-2A and DJ-3A. The rotation of the camshaft eccentric operating rocker arm pivoted at the

rocker arm pin pulls the link and diaphragm assembly downward about 1/4" [6,35 mm.], against spring pressure which creates a vacuum in pump chamber to provide the suction stroke.

On the suction stroke of the pump, fuel from the tank enters inlet into sediment bowl and passes through strainer and inlet valve into pump chamber. On the return stroke spring pressure pushes the diaphragm upward forcing fuel from chamber through outlet valve and out through outlet to the carburetor.

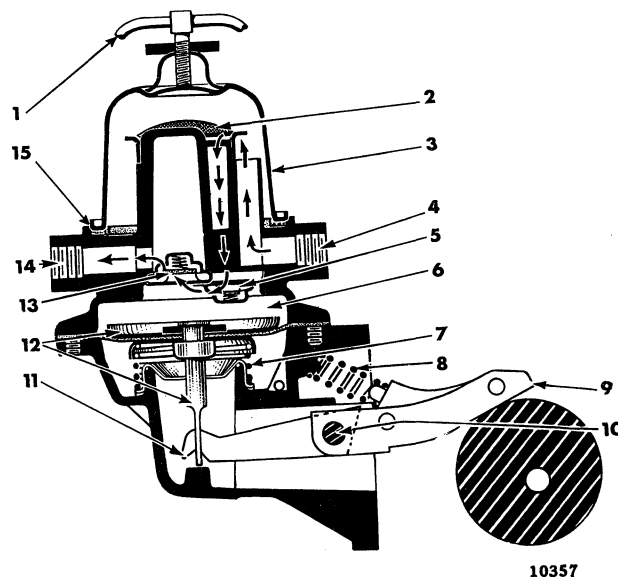


FIG. 130—FUEL PUMP—CJ-2A, DJ-3A

- | | |
|--------------------------|---------------------------|
| 1—Strainer Bail and Seat | 9—Rocker Arm |
| 2—Filtering Screen | 10—Rocker Arm Pin |
| 3—Bowl | 11—Rocker Arm Link |
| 4—Fuel Inlet | 12—Diaphragm and Pull Rod |
| 5—Inlet Valve | 13—Outlet Valve |
| 6—Pump Chamber | 14—Fuel Outlet |
| 7—Diaphragm Spring | 15—Body Screw |
| 8—Rocker Arm Spring | |

When the carburetor bowl is full, the float in the carburetor closes the needle valve, thus creating a pressure in pump chamber. This pressure will hold diaphragm assembly down against spring pressure where it will remain inoperative until the carburetor requires more fuel and the needle valve opens. The rocker arm spring is merely for the purpose of keeping the rocker arm in constant contact with the eccentric.

The diaphragms are manufactured of several layers of specially treated cloth which is impervious to fuel.

The fuel pumps have a large reservoir and fluctuation chamber. The sediment bowls are clamped to the pump assemblies, making it a simple matter to clean out any sediment. Each valve assembly is a self-contained unit made up of a valve cage, a fiber valve and a valve spring. The valve assemblies are held in place by a valve retainer permitting easy and speedy removal of the assemblies.

F-30. Disassembly

To disassemble the pump, release the thumb nut holding clamp of sediment bowl and remove the bowl. Remove strainer from the center tower, remove cork gasket, remove the six screws holding the cover flange to the pump body. Scratch a line across the two castings to assure reassembly in the same position. Lift off the top cover and remove the rocker arm spring which holds the rocker arm against the camshaft eccentric.

To unhook the diaphragm pull rod from the rocker arm link, press down and away from the rocker arm side of the pump. Remove the oil seal and the washer.

Remove the two screws holding the inlet and outlet valve retainers and remove the retainers.

Wash all parts thoroughly in cleaning solution and examine them for wear or damage.

F-31. Assembly

Install the oil seal (rubber cup) on body followed by the stud washer and spring which fits under the

diaphragm assembly. Hold the rocker arm down, press down and put the diaphragm assembly in place. Install inlet valve assembly with new gasket. The inlet valve is installed in the body with the spring facing down. Install the outlet valve assembly with the outlet valve spring up. Install the valve retaining plate and two screws. Assemble the upper and lower housings with the marks in alignment. Install the six screws and tighten them evenly. Install rocker arm spring. Install a new bowl gasket, filter screen and bowl tightening into place with thumb nut.

F-32. Fuel and Vacuum Pump

• Model CJ-3A

Model CJ-3A is equipped with a combination fuel and vacuum pump. The servicing of both the fuel and vacuum units is outlined below.

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

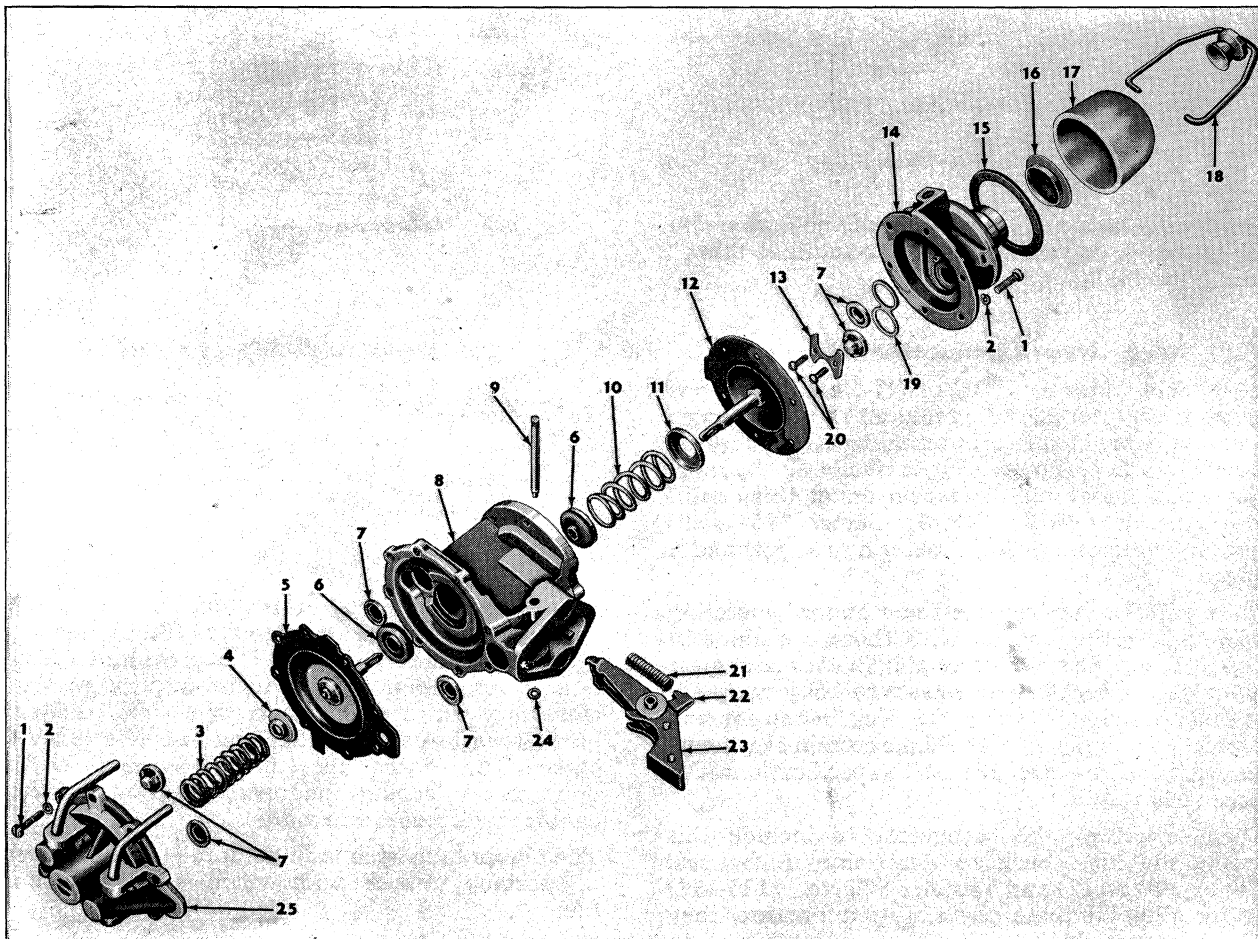


FIG. 131—FUEL AND VACUUM PUMP CJ-3B, CJ-5, CJ-6

- | | | |
|---------------------|--------------------------|----------------------|
| 1—Cover Screw | 9—Rocker Arm Pin | 18—Bail |
| 2—Lockwasher | 10—Fuel Diaphragm Spring | 19—Gasket |
| 3—Diaphragm Spring | 11—Oil Seal Retainer | 20—Screw |
| 4—Spring Seat | 12—Diaphragm and Rod | 21—Rocker Arm Spring |
| 5—Diaphragm and Rod | 13—Valve Retainer | 22—Link Spacer |
| 6—Oil Seal | 14—Cover | 23—Rocker Arm |
| 7—Valve Assembly | 15—Gasket | 24—Washer |
| 8—Body | 16—Screen | 25—Body |

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.

Model CJ-3A has a cover plate and filtering screen which is attached to the top of the pump by a cap screw. The screen should be cleaned at least twice yearly to prevent trouble due to a blocked screen or water freezing. The screen should be washed and dried and then cleaned with a stiff brush. When reassembling the cover plate make certain that the cork gasket is not broken; reverse it and position it flat on the seat, then install the cover plate and tighten the cap screw securely. After cleaning, start the engine and carefully inspect the cover plate for leakage.

F-33. Disassembly

Remove the cover plate, gasket, and screen. Mark the two castings with a file to ensure positioning in the same relation upon assembly. Remove the screws attaching the fuel cover to the pump body. Remove the cover, diaphragm, and spring. Remove rocker arm pin, 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-34. 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 cover plate and secure them firmly with the cover plate screw.

F-35. Fuel Pump Testing

Correct fuel pump pressure is essential to satis-

factory 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.

To check fuel pump pressure, connect a pressure gauge into the fuel line at the carburetor with a T-fitting. At 1800 rpm. engine speed, the pressure should not exceed $4\frac{3}{4}$ psi. [0,33 kg-cm²] maximum.

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 $10\frac{1}{2}$ " [26,67 cm.] of mercury at 1800 rpm. engine speed.

F-36. Vacuum Pump

The operation and function of the vacuum pump are similar to the pump described in Par. F-42.

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-37. 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-38. 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-39. Fuel Pump

• Models CJ-3B, CJ-5, CJ-6

The double-action fuel pump consists of a metal body, a rubber diaphragm, rocker arm, valves, springs, gaskets, and a glass sediment bowl complete with strainer. The metal pump body provides a working housing for the diaphragm, lever, valves, and springs. The fuel pump is mounted on the left side of the engine and is actuated by an eccentric on the camshaft. An air dome is cast into the metal cover to relieve the carburetor needle valve and the fuel pump diaphragm of excessive pressure when the carburetor needle valve is closed.

Tracing pump operation from the beginning, the camshaft eccentric forces the diaphragm up, overcoming spring pressure. This action creates a partial vacuum in the pump chamber. Fuel from the main tank is forced into the low-pressure pump chamber through the open disc valve. Incoming fuel supplies the force necessary to open the valve, which is a one-way check valve. As the engine camshaft continues to rotate, spring pressure forces the diaphragm downward as the pump rocker arm follows the camshaft eccentric to its low spot. The downward action of the diaphragm closes the intake valve and forces fuel to the carburetor

reservoir through the pump outlet valve. Both intake and outlet valves are one-way check valves opened and closed by fuel flow. No mechanical components are required in the control of valve operation.

Fuel is delivered to the carburetor only when the float needle is off its seat. When the fuel level in the carburetor bowl is high enough for the float to force the needle against its seat, pressure backs up to the fuel pump air dome and causes the diaphragm to stop pumping. In this position, the pump is said to be balanced because the pressure in the pump-to-carburetor line equals that of the diaphragm spring. In this way, fuel from the pump to the carburetor is always under pressure. The carburetor uses fuel, causing the float to drop and pull the carburetor needle valve off its seat. Pressure in the pump immediately drops as fuel is delivered to the carburetor reservoir. Almost instantaneously the diaphragm again starts operating to pump more fuel. The diaphragm can start and stop many times in each mile of vehicle operation, but the pump actuating linkage is always in operation while the engine is running. The fuel pump incorporates a pulsator and pulsator chamber to dampen the effect of pump pressure pulsations on the carburetor needle valve. This prevents high fuel level in the reservoir that would result from the needle being jarred away from its seat. Also, operating economy

would be affected because a high fuel level usually results in an over-rich mixture.

The actuating linkage has its own spring to ensure continuous contact of the lever to the camshaft eccentric.

This fuel pump has a sediment bowl and filtering screen which is attached to the top 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

Remove the cover plate, gasket, and screen or bowl clamp, sediment bowl, gasket and screen if so equipped. Mark the two castings with a file to ensure positioning in the same relation upon assembly. Remove the screws attaching the fuel cover to the pump body. Remove the cover, diaphragm, and spring. Remove rocker arm pin,

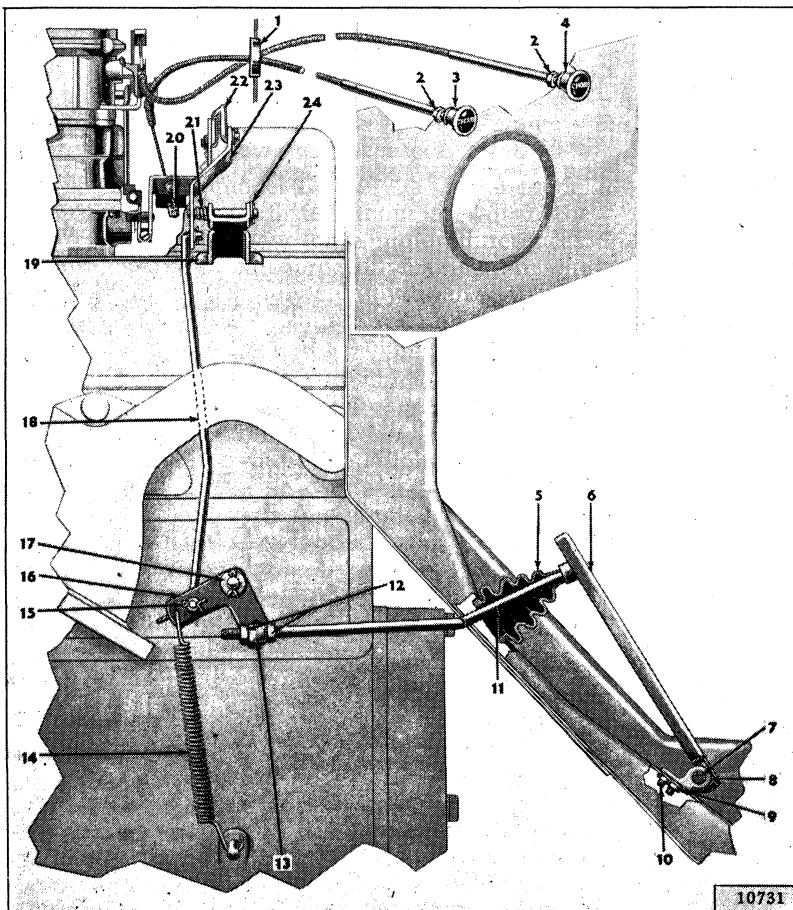


FIG. 132—ACCELERATOR LINKAGE—CJ-3B, CJ-5, CJ-6

- 1—Grommet
- 2—Nut and Lockwasher
- 3—Throttle Control
- 4—Choke Control
- 5—Treading Rod Seal
- 6—Accelerator Treadle
- 7—Treading Hinge Pin
- 8—Treading Hinge
- 9—Nut and Lockwasher
- 10—Screw
- 11—Accelerator Rod
- 12—Nut
- 13—Adjusting Block
- 14—Retracting Spring
- 15—Cotter Pin
- 16—Lower Bellcrank
- 17—Washer
- 18—Bellcrank Link Rod
- 19—Bracket
- 20—Throttle Wire Stop
- 21—Bellcrank Spring
- 22—Rod
- 23—Upper Bellcrank
- 24—Washer

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rocker arm, and rocker arm spring. Remove the valve plate screw and separate the valve plate retainer, valve gaskets, and valves.

Clean all parts in 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. Refer to Par. F-43 for fuel pump testing.

F-41. Assembly

Refer to Fig. 131

Install the valve gaskets, valves, valve retainer and secure them with the valve retainer screws. 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 six attaching screws. Do not draw the screws up tight. Install rocker arm spring, rocker arm pin washers, rocker arm and rocker arm pin. With rocker arm positioned on the diaphragm rod, draw

the six pump body screws up evenly and securely. Install the filter screen, cork gasket and sediment bowl and secure them firmly with the thumb screw on the bowl clamp.

F-42. Vacuum Pump

● Models CJ-3B, CJ-5, CJ-6

The double-action fuel pump resembles two single-action pumps placed one above the other. A single fuel pump rocker arm actuates the two separate diaphragms. One diaphragm is part of the fuel delivery pump and operates as described in Par. F-39. The other diaphragm is part of the vacuum pump and operates as described here.

As the actuating lever forces the diaphragm upward against spring pressure, air is forced through the outlet port into the engine's intake manifold. On the return stroke, spring pressure forces the diaphragm downward, creating a partial vacuum and opening the inlet valve. In this manner, air is pumped out of the windshield wiper motor and into the intake manifold. When the wiper motor is shut off, manifold vacuum holds the diaphragm against its spring so that the full motion of the actuating lever is not accompanied by a complete up-and-down motion of the diaphragm.

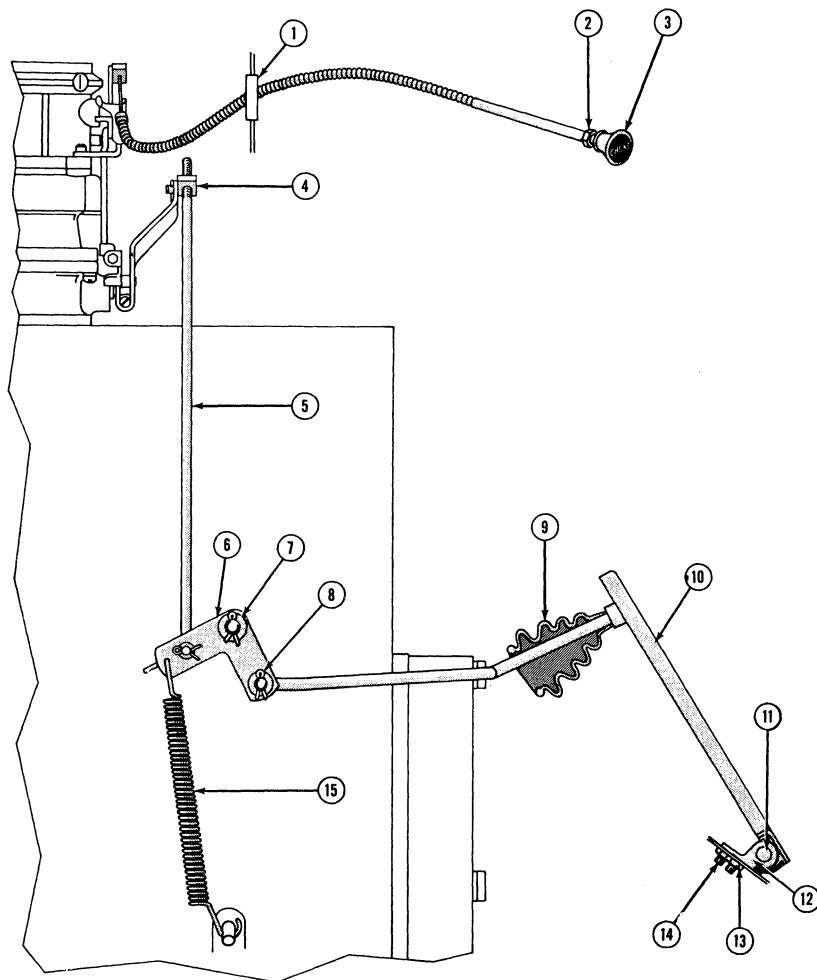


FIG. 133—ACCELERATOR LINKAGE—DJ-3A

- 1—Bushing
- 2—Nut and Lockwasher
- 3—Choke Control
- 4—Adjusting Block
- 5—Rod
- 6—Bell Crank
- 7—Plain Washer
- 8—Cotter Pin
- 9—Seal
- 10—Treadle
- 11—Pin
- 12—Hinge
- 13—Nut and Lockwasher
- 14—Screw
- 15—Spring

When the windshield wiper motor is turned on, but manifold vacuum is greater than the vacuum created by the booster pump, air flows from the wiper motor through both valves of the vacuum booster. As manifold vacuum drops off as a result of the engine operating under low speed and high load, the vacuum created by the vacuum booster will be greater than engine intake manifold vacuum and the pump will operate the wiper motor when the wiper control switch is turned on.

Refer to Fig. 131.

Remove the eight cover attaching screws and lockwashers, and remove the cover, diaphragm spring and spring seat. Detach the diaphragm rod from the rocker arm and remove the diaphragm. The valve assemblies are pressed into the cover and body and lightly staked. They may be removed with the point of a knife blade. If installing new valves be sure the inlet and outlet valves are correctly positioned and stake them lightly with a small punch.

Assemble the vacuum pump in the reverse order of disassembly, drawing the cover attaching screws up evenly and tightly.

F-43. Fuel Pump Testing

Four tests are presented in following paragraphs to test for proper operation of the fuel pump. In addition, check the following:

a. Check for secure mounting of the fuel pump. The rocker arm may be working the entire pump up and down, rather than just the pump diaphragms.

b. Remove and clean the fuel sediment bowl.

c. Check all fuel lines.

F-44. Volume Check

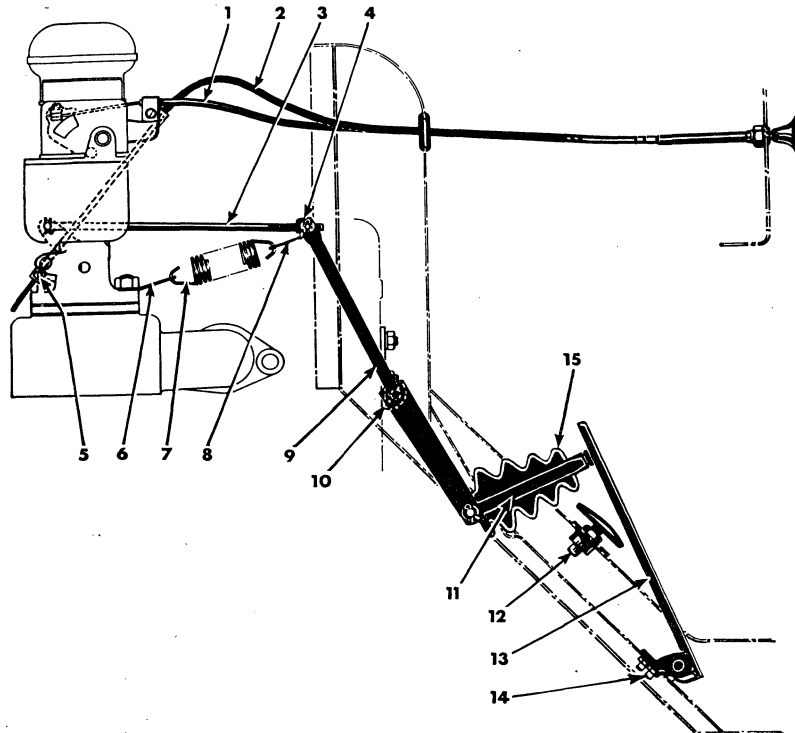
To measure fuel pump capacity (amount of fuel delivered in a given time) disconnect the pump-to-carburetor line at the carburetor end. Place the open end of the line in a suitable container. Start the engine and operate at normal idle speed. Delivery should be one quart U.S. [1 ltr.] within one minute.

F-45. Pressure Check

To measure fuel pump pressure (force of fuel delivery) disconnect the pump-to-carburetor line at the carburetor end. Plug a pressure gauge and T-fitting into the open end of this line and into the carburetor. Start the engine and operate at normal idle speed. Pressure should be $2\frac{1}{2}$ to $3\frac{3}{4}$ psi. [0,716 a 0,264 kg-cm²] at 1800 rpm. and at 16" [406 mm.] above the outlet.

F-46. Vacuum Check

To measure fuel pump vacuum (pull of the pump at the inlet side) disconnect the pump-to-fuel-tank



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FIG. 134—ACCELERATOR LINKAGE—CJ-2A, CJ-3A

- | | |
|--------------------------|--------------------------|
| 1—Choke Control | 8—Retracting Spring Clip |
| 2—Throttle Control | 9—Shaft and Lever |
| 3—Adjusting Rod | 10—Cross Shaft Lever |
| 4—Adjusting Rod Block | 11—Connection Link |
| 5—Throttle Wire Stop | 12—Foot Rest |
| 6—Retracting Spring Clip | 13—Accelerator Treadle |
| 7—Retracting Spring | 14—Pedal Hinge |

line at the fuel pump. Attach a vacuum gauge to the fuel pump inlet. Start the engine, accelerate to specified speed, and hold this engine speed while taking a gauge reading. Permissible gauge reading is 8" [203 mm.] of mercury [Hg] at 1200 rpm. and 10½" [267 mm.] at 1800 rpm.

F-47. Vacuum Booster Check

To test the condition of the vacuum booster pump, disconnect both inlet and outlet lines at the pump. Attach a vacuum gauge to the windshield wiper connection at the pump. Start the engine, accelerate to 2000 rpm., and hold this engine speed while taking a gauge reading. Permissible gauge reading is 10" to 14" [254 a 356 cm.] of mercury [Hg].

F-48. 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.

F-49. Accelerator 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. On Models CJ-3B, CJ-5 and CJ-6 adjustment is made at the adjusting block, Fig. 132. Loosen the lock nuts, and adjust the length of the accelerator rod so that when the carburetor throttle valve is wide open the accelerator treadle will just strike the toe board. After correct adjustment is made tighten both lock nuts firmly.

On Models CJ-2A and CJ-3A, adjust the linkage, as described above, at the adjusting block, Fig. 134. On Model DJ-3A, adjust the linkage at the adjusting block, Fig. 133.

F-50. Fuel Tank Straps

Models CJ-3B, CJ-5, CJ-6

The fuel tanks are wider and the hold-down straps longer beginning with the following production serial numbers:

CJ-3B 57348-43965 and on

CJ-5 57548-77001 to -77882; 57548-77983 and on

CJ-6 57748-14359 and on

This change also eliminated the crimped portion of the fuel tank upper flange. To have the old straps accommodate a new replacement tank, crimp the flanges of the new tank at the strap point. Also, where the new longer straps are used with the old style tank, add an extra piece of anti-squeak between strap and tank.

F-51. Fuel Tank Cap

A pressure type fuel tank filler cap is used on all models. This is necessary to prevent fuel leakage from the cap vent opening when the vehicle is on a side slope. Two spring loaded relief valves which open when venting is required are built into the cap. The pressure valve opens at 1½ to 2½ pounds per sq. in. [.105 to .176 kg/sq. cm.] and the vacuum valve at ¾ pounds [.053 kg/sq. cm.]. Should the pressure valve fail to open, pressure in the tank may force fuel by the carburetor inlet valve causing flooding. Failure of the vacuum valve may prevent flow of fuel to the carburetor. Should the valves fail to vent install a new cap.

F-52. SERVICE DIAGNOSIS

Symptoms	Probable Remedy
Excessive Fuel Consumption:	
Tires improperly inflated.....	Inflate
Brakes drag.....	Adjust
Engine operates too cold.....	Check thermostat
Heat control valve inoperative.....	Check thermostatic spring
Leak in fuel line.....	Check all connections
Carburetor float level high.....	See "Carburetor" section
Accelerator pump not properly adjusted.....	Adjust
Leaky fuel pump diaphragm.....	Replace
Loose engine mountings causing high carburetor fuel level.....	Tighten
Ignition timing slow or spark advance stuck.....	See "Distributor" section
Low compression.....	Check valve tappet clearance
Air cleaner dirty.....	Remove and clean
Engine Hesitates on Acceleration:	
Accelerator pump does not function perfectly.....	Replace piston and rod or adjust
Carburetor float level.....	Adjust
Spark plugs.....	Replace or clean and adjust
Low compression.....	Check valves
Distributor points—dirty or pitted.....	Replace
Weak condenser or coil.....	Replace
Carburetor jets restricted.....	Remove and clean
Excessive engine heat.....	See "Engine" section
Engine Stalls—Won't Idle:	
Improper condition of carburetor.....	See "Carburetor" section
Low speed jet restricted.....	Remove and clean
Dirty fuel sediment bowl screen.....	Remove and clean
Air cleaner dirty.....	Remove and clean
Leaky manifold or gasket.....	Replace
Fuel pump diaphragm porous.....	Replace
Loose carburetor.....	Tighten flange nuts
Water in fuel.....	Drain and clean system
Improper ignition.....	See "Distributor" section
Spark plugs.....	Clean and adjust
Valves sticking.....	Grind valves

F-53. FUEL SYSTEM SPECIFICATIONS

MODEL:	CJ-2A, CJ-3A	Metric
Fuel Tank:		
Capacity.....	10½ gals.	39,75 ltr.
Location.....	Under Driver's Seat	
Fuel Pump:		
Make.....	AC	
Model (CJ-2A).....	153886	
(CJ-3A).....	1539353	
Pressure (CJ-2A).....	4½ lbs.	0,316 kg-cm ²
(CJ-3A).....	2½-3¼ lbs.	0,176 a 0,264 kg-cm ²
Carburetor:	Carter	
CJ-2A.....	596S	
CJ-3A.....	636SA	
Flange.....	1"	[25,4 mm.]
Primary Venturi.....	1½"	[8,731 mm.]
Main Venturi.....	1"	[25,4 mm.]
Float Setting.....	¾"	[9,525 mm.]
Fuel Intake Needle Seat.....	No. 53 Drill	
Low Speed Jet Tube.....	.029"	[0,7366 mm.]
Idle Well Jet.....	No. 61 Drill	
Idle Screw Seat.....	No. 46 Drill	
Main Nozzle Discharge Jet.....	.096"	[2,43 mm.]
Metering Rod.....	No. 75-547	
Jet Size.....	.070"	[1,77 mm.]
Setting Gauge.....	T-109-26	
Accelerating Pump:		
Discharge Jet.....	No. 73 Drill	
Intake Ball Check.....	No. 40 Drill	
Discharge Check.....	No. 40 Drill	
Relief Passage.....	No. 42 Drill	
Stroke.....	1¼"	[6,747 mm.]
Stroke Setting Gauge.....	T-109-117C	
Air Cleaner:		
Make.....	Oakes-Donaldson	
Model.....	613300 E653	
Type.....	Oil Bath	
Oil Capacity.....	1¼ pts.	[0,591 ltrs.]

F-53. FUEL SYSTEM SPECIFICATIONS—(Continued)

MODEL:	CJ-3B, CJ-5, CJ-6	METRIC	DJ-3A	METRIC
Fuel Tank:				
Capacity.....	10½ gal.	38,75 ltr.	12 gal.	45 ltr.
Location.....	Under Driver's Seat		Right Side of Body Rear Panel	
Fuel Pump:				
Make.....	AC		AC	
Model.....	5594032		1539716	
Type.....	Camshaft		Camshaft	
Pressure @ 1800 rpm.....	2½ to 3¾ lb.	0,176 a 0,264 kg-cm ²	4¾ lb. max.	0,33 kg-cm ² max.
Vacuum @ 1800 rpm.....	10½" Hg	26,67 cm.	10½" Hg	26,67 cm.
Fuel Filter:				
Type.....	None		Filter Spool	
Location.....			Inside Fuel Tank	
Carburetor:				
Make.....	Carter		Carter	
Model.....	YF-938 SD		YF-2392 S	
Flange Size.....	1¼"	3,17 cm.	1¼"	3,17 cm.
Primary Venturi.....	1½"	8,73 mm.	1½"	8,73 mm.
Secondary Venturi.....	1½"	17,46 mm.	1½"	17,46 mm.
Main Venturi.....	1¼"	3,17 cm.	1¼"	3,17 cm.
Float Setting.....	5/16"	7,93 mm.	9/32"	7,14 mm.
Gasoline Intake Needle Seat.....	No. 48 (.076") drill	1,93 mm.	No. 48 (.076") drill	1,93 mm.
Low Speed Jet Tube:				
Jet Size.....	No. 70 (.028") drill	0,711 mm.	No. 68 (.031") drill	0,787 mm.
By-Pass.....	No. 56 (.0465") drill	1,181 mm.	No. 56 (.0465") drill	1,181 mm.
Idle Bleed.....	No. 56 (.0465") drill	1,181 mm.	No. 56 (.0465") drill	1,181 mm.
Economizer.....	No. 54 (.055") drill	1,397 mm.	No. 54 (.055") drill	1,397 mm.
Idle Well to Bowl Bleed.....	No. 73 (.024") drill	0,609 mm.		
Idle Port.....	.184" x .030"	5,67 x 0,76 mm.	.170" x .030"	4,312 x 0,762 mm.
Lower Port:				
(For Idle Adjustment Screw).....	.0615" to .0655" dia.	1,56 a 1,66 mm.	.053" to .057" dia.	1,346 a 1,447 mm.
Set Idle Adjustment Screw.....	¾ to 1¾ turns open		½ to 2 turns open	
Main Nozzle Anti-Percolator				
Well Vent in Plug.....	No. 74 (.0225") drill	0,571 mm.	.0276" dia.	0,701 mm.
Metering Rod.....	.07325" x .0655" x .057" x .04725"	1,860 x 1,663 x 1,447 x 1,200 mm.	.0735" x .062" x .044"	1,866 x 1,574 x 1,117 mm.
Metering Rod Jet.....	.0935" dia.	2,375 mm.	.096" dia.	2,438 mm.
Accelerating Pump:				
Pump Jet.....	No. 68 (.031") drill	0,787 mm.	No. 72 (.025") drill	0,635 mm.
Intake Passage.....	No. 72 (.025") drill	0,635 mm.	No. 72 (.025") drill	0,635 mm.
Discharge Check Seat.....	No. 42 (.0935") drill	2,375 mm.		
Vacuum Restriction.....	No. 55 (.052") drill	1,320 mm.	No. 55 (.052") drill	1,320 mm.
Vacuum Passage (Diaphragm Bleed).....	No. 65 (.035") drill	0,889 mm.	No. 65 (.035") drill	0,889 mm.
Vacuum Spark Port.....	.054" to .056" dia.	1,371 a 1,422 mm.	.054" to .056" dia.	1,371 a 1,422 mm.
Air Cleaner:				
Type.....	Oil Bath		Wire Gauze	
Make.....	Donaldson		AC	
Model.....	FAE OG 5351		155254B	
Oil Capacity.....	1¼ pt.	0,591 ltr.		

EXHAUST SYSTEM

G-1. Models CJ-2A, CJ-3A, DJ-3A

On L-head engines, the exhaust and intake manifolds form one unit which is mounted on the left side of the engine. A valve is mounted in the exhaust section of this unit which, when open, directs the exhaust gases around the intake riser to assist in vaporizing the fuel when the engine is cold, thereby aiding in warming up the engine and reducing engine oil dilution. It also minimizes the use of the carburetor choke control.

When the engine is cold, the counterweight lever closes the valve and directs the hot exhaust gases against the intake riser to assist in vaporizing the fuel. As the engine warms up, the thermostatic spring expands and opens the valve sending the exhaust gas directly into the exhaust pipe. Note that the thermostatic spring is assembled to rest on top of stop No. 14 in Fig. 135, on Models CJ-2A, CJ-3A, and DJ-3A.

The manifold heat control valve must operate freely without binding or excessive play. Each time the valve bushings are lubricated, proper operation of the valve should be checked.

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.].

G-2. Models CJ-3B, CJ-5, CJ-6

On F-head 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

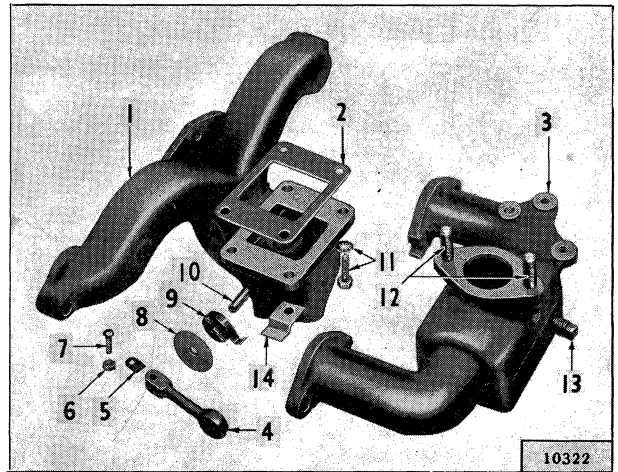


FIG. 135—MANIFOLDS AND HEAT CONTROL VALVE—DJ-3A

- | | |
|--------------------|------------------------|
| 1—Exhaust Manifold | 8—Washer |
| 2—Gasket | 9—Spring |
| 3—Intake Manifold | 10—Shaft |
| 4—Lever | 11—Bolt and Lockwasher |
| 5—Key | 12—Stud |
| 6—Nut | 13—Plug |
| 7—Screw | 14—Stop |

heat from the cooling system to the intake riser and assists in vaporizing the fuel when the engine is cold.

With this construction, there is no heat control valve on the F-head engine and the only function of the exhaust manifold is to gather and direct the exhaust gases into the exhaust pipe.

When assembling the manifold, Fig. 136, to the cylinder block new gaskets should be installed and

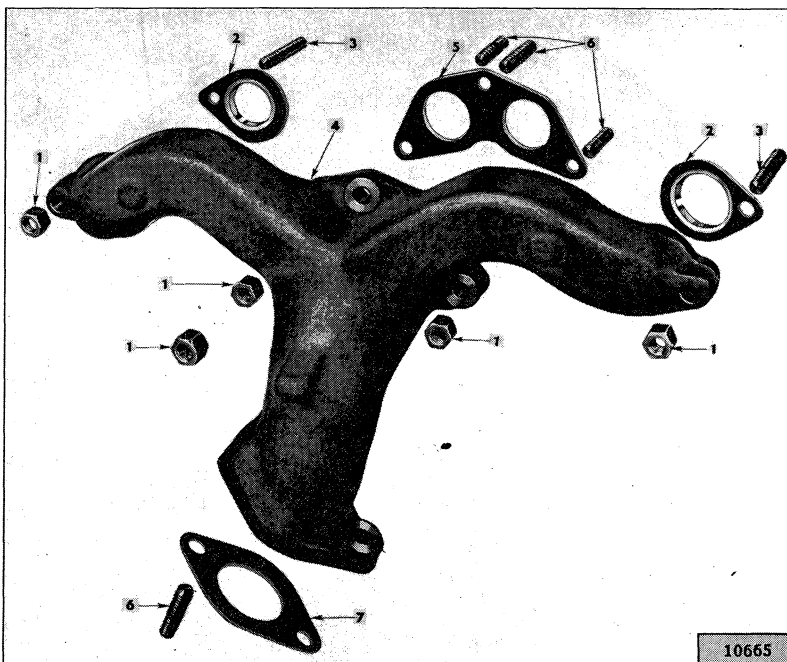


FIG. 136—EXHAUST MANIFOLD CJ-3B, CJ-5, CJ-6

- | |
|-----------------|
| 1—Stud Nut |
| 2—End Gasket |
| 3—Stud |
| 4—Manifold |
| 5—Center Gasket |
| 6—Stud |
| 7—Gasket |

COOLING SYSTEM

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Antifreeze	H-14	Heat Indicator	H-9
Antifreeze Chart	H-17	Hoses	H-8
Cooling System		Pressure Cap	H-4
Draining	H-3	Radiator	H-6
Filling	H-2	Thermostat	H-7
Cylinder Block	H-5	Water Pump	H-10
Fan Belt	H-15		

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.

It is recommended that the cooling system be flushed and checked for leaks twice a year, preferably in the fall before antifreeze is added and in the spring when the antifreeze is drained.

Reverse flushing will aid greatly in removing rust and scale, especially when used with a flushing solution. A cleaning solution should be used to loosen the rust and scale before reverse flushing the cooling system.

Flushing is accomplished through the system in a direction opposite to the normal coolant flow. This action causes the water to get behind the corrosion deposits and force them out. To do this, remove the upper and lower radiator hoses. Then attach a drain hose at the top of the radiator. Attach a new piece of hose to the radiator outlet at the bottom and insert the flushing gun. Connect the water hose to the flushing gun to a water outlet and the air hose to an air line. Turn on the water and when the radiator is full, apply the air in short blasts, allowing the radiator to fill between blasts. Continue this flushing operation until the water runs clear through the top hose.

With the thermostat removed, attach a leadaway hose to the water hose inlet. Also attach a length of new hose to the water outlet connection at the top of the engine. Turn the water on and fill the water jacket and then apply air in short blasts. Continue this flushing until the water runs clear. Also do the hot water heater. Remove heater water outlet hose from heater core. Remove inlet from engine connections. Insert flushing gun and flush heater core. Care must be taken when applying air pressure to prevent damage to the core.

H-2. Filling Cooling System

To fill the cooling system, remove the fill cap and fill the tank to the top. Replace the cap and run the engine at medium speed for approximately one minute. Remove the cap and recheck the coolant

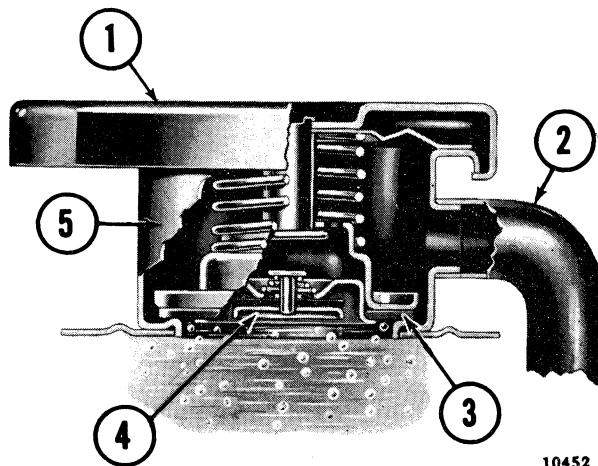
level. Add more coolant if necessary to bring the level back to the top of the tank. If the cooling system is filled when the engine is cold, recheck the coolant level after the engine has warmed up. This will ensure that the thermostat has opened allowing complete cooling system circulation.

Always correct any cooling system leaks before installing antifreeze. A corrosion inhibitor should be used in the cooling system to prevent the formation of rust and scale. A quality-brand antifreeze containing a corrosion inhibitor should be used. When the antifreeze is drained in the spring, a corrosion inhibitor should be added with the water.

H-3. Draining 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 of the cylinder block. Remove the radiator cap to break any vacuum that may have developed.

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.



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FIG. 138—RADIATOR PRESSURE CAP INSTALLED

- 1—Pressurized Cap
- 2—Overflow Tube
- 3—Pressure Seal
- 4—Vacuum Release Valve
- 5—Radiator Neck

H-4. Radiator Pressure Cap

All models are now equipped with pressure caps which reduce evaporation of cooling solution and make the engines more efficient by permitting slightly higher operating temperatures. When operating properly, the pressure cap permits pressure build-up in the cooling system during periods of severe heat load. This pressure increases the boiling point of the coolant and thus reduces overflow losses. The effectiveness of the cap is limited by its opening pressure and the boiling point of the coolant. The pressure cap employs a spring-loaded, rubber-faced pressure seal which presses against a seat in the radiator top tank. Spring pressure determines the opening pressure of the valve. A typical pressure cap is shown in Fig. 138.

Note: If a new cap is required, always install a cap of the same type and pressure rating specified. It should never be altered or replaced by a plain cap.

A vacuum release valve is employed to prevent undesirable vacuum build-up when the system cools down. The vacuum release valve is held against its seat under light spring pressure. Vacuum in the system is relieved by the valve which opens at $\frac{1}{2}$ to 1 psi. [0,035 a 0,07 kg-cm²] vacuum.

Although the mechanism of the pressure cap requires no maintenance, the cap should be inspected periodically for cleanliness and freedom of operation. The pressure cap gasket and radiator filler neck seat should also be inspected to be sure they are providing a proper seal. If the rubber face of the valve is defective, a new cap should be installed. Filler neck reseating tools are commercially available to correct minor defects at the surface of the seat. Follow instructions of the reseating tool manufacturer.

CAUTION: Use extreme care in removing the radiator pressure cap. In overheated systems, the sudden release of pressure can cause a steam flash and this flash, or the loosened cap can cause serious personal injury.

To remove the radiator pressure cap when the engine coolant temperature is high or boiling, place a cloth over the pressure cap and turn counter-clockwise about $\frac{1}{4}$ turn until the first (pressure release) stop is reached. Keep the cap in this position until all pressure is released. Then, push cap down and turn still further until cap can be removed. To install the pressure cap, place it in position and turn it clockwise as far as it will go.

H-5. Cylinder Block

Any coolant leaks at the engine block water joints are aggravated by pump pressure in the water jacket and by pressure developed in the cooling system when the pressure cap is in place. Small leaks showing up only as moist spots often cannot be detected when the engine is hot except by the appearance of rust, corrosion, and dye stains where leakage evaporated. Also, expansion and contraction of the engine block resulting from extreme temperature changes can aggravate leaks. For these reasons, when checking for coolant leaks in-

spect the block when it is cold and while the engine is running.

A leaking drain cock that cannot be closed should be replaced. Leaking core-hole expansion plugs should be replaced.

If tightening gasketed joints will not correct leakage, install new gaskets. Use a sealing compound where recommended.

H-6. Radiator

Maintenance of the radiator consists of keeping the exterior of the radiator core clean, the interior free from rust and scale, and the radiator free from leaks. The exterior of the radiator core should be cleaned and the radiator inspected for leaks each 1000 miles [1,600 km.] of normal service of the vehicle. If the vehicle is subjected to considerable off-the-road operation, this interval should be each 1000 miles or 30 days, whichever interval occurs first. Cleaning should be performed by blowing out with air stream or water stream directed from the rear of the radiator. A visual inspection is not sufficient as the accumulation of small particles of foreign material on core surfaces can restrict cooling without closing the core openings.

Radiator leakage occasionally results from corrosion perforation of the thin metal but most leakage results from mechanical failure of soldered joints when too much strain has been put on the joint. Fractures occur most often at the joint where the radiator inlet and outlet pipes are attached to the tanks. When the seams break, the entire soldered joint is exposed and can corrode, but breakage rather than corrosion is the primary cause of seam leakage. Examine the radiator carefully for leaks before and after cleaning. Cleaning may uncover points of leakage already existing but plugged with rust. White, rusty, or colored leakage stains indicate previous radiator leakage. These spots may not be damp if water only or methyl-alcohol-base antifreeze is in the cooling system since such coolants evaporate readily. An ethylene-glycol-base antifreeze shows up existing leaks as it does not evaporate.

When the pressure cap opens, the sudden surge of vapor or liquid must blow out through the overflow pipe. If the overflow pipe is dented or clogged, the pressure caused by obstruction may cause damage to the radiator or hose connections in the cooling system. To remove clogging material, run a flexible wire through the overflow pipe.

H-7. 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 operation. Automatic control of engine operating temperature is provided by a water flow control thermostat installed in the water outlet on top of the L-head engine cylinder head and at the front of the F-head engine cylinder head. The thermostat is a heat-operated valve. It should always be maintained in working order and the vehicle should never be driven without one installed



as there would then be no control of engine temperature. The temperature at which the thermostat opens is preset and cannot be altered. The standard thermostat on the CJ-3B, CJ-5, CJ-6, and DJ-3 is designed to start opening at 165°F. [74°C.] and be fully open at 188°F. [86°C.]. The optional high-temperature thermostat is designed to start opening at 180°F. [82°C.] and be fully open at 202°F. [94°C.]. The standard thermostat on the CJ-2A and CJ-3A is designed to start opening at 150°F. [66°C.] and be fully open at 170°F. [78°C.].

Note: Whenever a high-temperature thermostat is installed (one having a start-to-open rating of at least 180°F. [82°C.]) the only antifreeze recommended for the cooling system is ethylene-glycol base (so-called "permanent").

When the thermostat is not operating properly, the engine may run too hot or too cold. Overheating may damage the thermostat so that its valve will not function properly. Rust can also interfere with thermostat operation. To test the thermostat, place it in water heated approximately 25°F. [17°C.] above the temperature stamped on the thermostat valve. Submerge the bellows completely and agitate the water thoroughly. The valve should open fully. Next, place the thermostat in water heated approximately 10°F. [11°C.] below the temperature stamped on the thermostat valve. Submerge the bellows completely and agitate the water thoroughly. The valve should close completely. If the thermostat fails either of these tests, it should be replaced with a new one of the same type and rating.

H-8. Radiator Hoses and Heater Hoses

Air, heat, and water deteriorate radiator and heater hoses in two ways: by hardening or cracking which destroys flexibility and causes leaks; by softening and swelling which produces lining failure and hose rupture. Examine hoses spring and fall for possible need of replacement or tightening. If hoses are collapsed, cracked, or indicate a soft condition on the inside they should be replaced.

Correct installation of a new heater hose is important to prevent contact between the hose and the exhaust manifold. The molded curved end of the hose connects to the hot water intake of the heater; the flexible end to the hot water valve on top of the cylinder head.

When installing hose, clean the pipe connections and apply a thin layer of nonhardening sealing compound. Hose clamps should be properly located over the connections to provide secure fastening. The pressurized cooling system pressure can blow off improperly installed hoses.

On a vehicle with belt-driven governor installed, inspect to see that the belt is not cutting into the radiator hoses. If this condition should be found to exist, clamp the hose or hoses involved away from any possible interference with the governor belt.

H-9. Heat Indicator

The unit used on Models CJ-2A, 3A and early 3B is of the Bourdon or hydrostatic type and is connected by means of a capillary tube to an expansion plug mounted in the cylinder head water jacket.

Should this unit become inoperative, it should be replaced as it is not practical to either repair or adjust it. The heat indicator on late Models CJ-3B, DJ-3A, CJ-5 and CJ-6 is operated electrically and is connected by a single wire to a sealed bulb sending unit mounted in the right rear of the cylinder head.

H-10. Water Pump

Refer to Fig. 139.

The water pump on these models is a centrifugal impeller type of large capacity to circulate water in the entire cooling system. The double row ball bearing Fig. 139, 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 are retained in the water pump body by the bearing retaining wire. The water seal bears against the ground seat on the pump body and the inside of the impeller, maintaining a constant pressure against both and preventing water leakage. A drain hole in the bottom of the pump body precludes any water seepage past the seal from entering the bearing.

The impeller and the pulley hub are pressed on the shaft under high pressure.

H-11. Water Pump Inspection

Check the water pump for leaks, and excessive end play or looseness of the shaft in the pump. A quick way to check is to work the fan blades up and down by hand. If any play is noticed, this indicates that the bearings are rough. Rough bearings should be checked to see if the water pump should be replaced or rebuilt.

H-12. Water Pump Disassembly

- a. Remove the fan belt, fan blades, and fan pulley.
- b. Remove the bolts attaching the water pump to the block. Remove the pump.
- c. Remove the bearing retainer spring Fig. 139.
- d. Remove the pump impeller and pulley with a suitable puller.
- e. Remove the pump seal, bearing and shaft, and bearing slinger.

H-13. Assembling Water Pump

Before assembling the water pump, examine water seal seat in the pump body and should it be rough, install a new pump body.

To reassemble the unit, insert the long end of the shaft into the pump body from the front end until the outer end of the bearing is flush against the front end of the pump body. Position the seal, washer, and pump seal on shaft flush against the ground seat in the water pump body. 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. Support the assembly on the impeller end of the shaft and press the pulley hub on the shaft until the shaft end is flush with the pulley hub. Move the shaft in the pump body to align the retaining

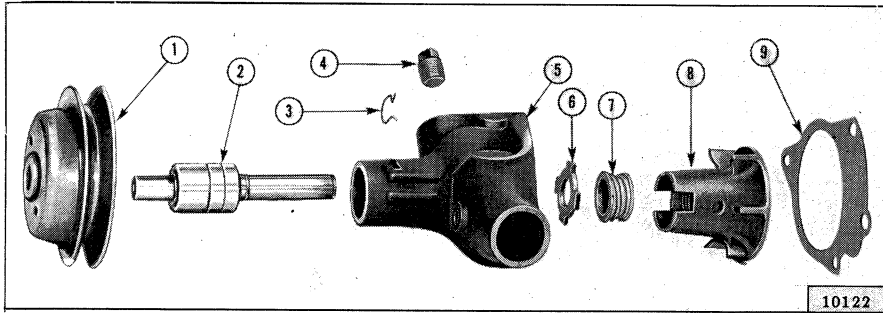


FIG. 139—WATER PUMP

- 1—Fan and Pump Pulley
- 2—Bearing and Shaft
- 3—Bearing Retainer Spring
- 4—Pipe Plug
- 5—Pump Body
- 6—Seal Washer
- 7—Pump Seal
- 8—Impeller
- 9—Gasket

wire grooves in the bearing and pump body and place the bearing retaining wire in position.

H-14. Antifreeze Solutions

Refer to antifreeze chart, Par. H-17.

When water freezes it expands approximately 9% in volume. When water, confined in a cooling system, freezes it exerts tremendous pressures causing serious damage. To prevent freezing, antifreeze is added to the water which lowers the freezing point of the coolant. The two antifreezes commonly used today have either a methanol or ethylene glycol base, and contain corrosion inhibitors. Methanol is usually cheaper than ethylene glycol and slightly less quantity is needed for the same protection. However, methanol will evaporate with the water when the vehicle is operated at warmer temperatures, and must be replaced. Ethylene glycol will not evaporate at normal operating temperatures, and any evaporation losses need only be replaced with water. Methanol solution is injurious to vehicle finishes. Should any be spilled on the vehicle, it should be washed off immediately with a good supply of cold water without wiping or rubbing. Under ordinary conditions, ethylene glycol is not injurious to vehicle finish. A table in the specifications data at the end of this section gives the protection obtained by the addition of various amounts of both methanol and ethylene glycol. Antifreeze should be drained and discarded in the spring, the cooling system flushed and refilled with water and a corrosion inhibitor. In the fall, a fresh filling of antifreeze should be used. Although the old antifreeze has freeze protection, the corrosion inhibitors in the antifreeze are no longer effective in protecting the cooling system from corrosion.

Before installing antifreeze, inspect the cooling system to be sure it is clean, leak-proof, 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 of the overflow pipe to allow for expansion when hot. 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.

H-15. Fan Belt

The fan and generator are belt driven by a V-belt. The drive of the V-belt is on the sides of the V. A

fan belt that is too tight will cause rapid wear of the generator and water pump bearings. If the belt is too loose, it may slip preventing the water pump from properly cooling the engine or the generator from properly charging the electrical circuit. The fan belt is properly adjusted when it can be deflected 1/2" [13 mm.] with strong thumb pressure applied midway between the fan and generator pulleys. Check this adjustment and inspect the condition of the fan belt at each engine lubrication period. It is good preventive maintenance to replace a badly frayed, worn, or cracked fan belt before it breaks in operation.

To replace the fan belt, loosen the attaching bolts at each generator brace-to-engine mounting and pivot the generator toward the engine to gain slack needed to install the new belt. Remove the old belt. Position the new belt over the fan pulley, over the crankshaft pulley, then over the generator pulley. Pull the generator away from the engine until belt tension is firm. Then tighten the generator mounting bolts and check the tension as indicated above. Reset the generator as necessary for correct belt tension. Finally, torque the generator mounting bolts 25 to 35 lb-ft. [3,4 a 4,8 kg-m.].

H-15A. Engine Overheating

An engine will not be damaged by high coolant temperatures unless the coolant boils. The pressurized cooling system used on these vehicles raises the boiling point of the coolant. The following table lists the boiling point of water and anti-freeze solutions at atmospheric pressure and at 4 1/2 and 7 pounds pressure as used in these cooling systems.

System Pressure	Methyl Alcohol	Water	Ethylene Glycol
None	179°F. [91,5°C.]	212°F. [100°C.]	223°F. [106,1°C.]
4 1/2 psi. [0,32 kg-cm ²]	190,5°F. [87,9°C.]	225°F. [107,1°C.]	236,5°F. [113,5°C.]
7 psi. [0,5 kg-cm ²]	197°F. [91,5°C.]	231,5°F. [110,7°C.]	243,5°F. [117,3°C.]

The antifreeze solutions listed protect to -20°F. [-28,9°C.]. Should overheating be encountered, and the fault is believed to be in the cooling system, check for the following:

- a. Proper coolant level. See Filling Cooling System Par. H-2.
- b. Poor air flow. Check for dirty radiator core. (See Radiator Par. H-6). Check for faulty belt pulley operation, worn or loose fan belt, or damaged fan. Clean, repair, replace or adjust as necessary.
- c. Foaming coolant. Check for air leaks at water pump, hose connection and filler cap. Tighten, repair or replace as necessary.

d. Surging or "after boil." Check pressure cap and replace if valves or gasket are faulty. Install lower temperature thermostat, if necessary.

e. External leaks. Check the following for leaks: Hoses and clamps, water pump, radiator, head gasket, core plugs and drain cocks, as well as the cylinder head or block for cracks.

f. Internal leaks. Check for faulty head gasket, cracked cylinder head or block.

g. Poor coolant flow. Check hose condition, water pump, fan belt, and repair or replace as necessary. Inspect block for rust or scale, and clean and flush the system, if necessary.

h. Be sure a thermostat is installed. See Thermostat Par. H-7.

i. Check the temperature gauge.

H-15B. Heater

Early production vehicles are equipped with manual-operated fresh air heaters. The heater controls are operated manually through Bowden cables.

Late production vehicles are equipped with vacuum-operated fresh air heaters that are operated by and identified by push buttons.

H-15C. SERVICE DIAGNOSIS

Symptoms	Probable Remedy
Overheating:	
Lack of coolant	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.	

H-16. COOLING SYSTEM SPECIFICATIONS

	Under Hood	Metric
Radiator Cap:		
Location.....	Under Hood	
Relief Valve Pressure:		
CJ-2A, CJ-3A.....	4½ psi.	0,32 kg-cm ²
CJ-3B, CJ-5, CJ-6, DJ-3A.....	7 psi.	0,5 kg-cm ²
Vacuum Valve Release.....	½ to 1 psi.	0,04 a 0,07 kg-cm ²
Circulation Thermostat:		
Type.....	Choke	
Standard:		
Starts to Open:		
CJ-2A, CJ-3A.....	150°F.	65,5°C.
CJ-3A, CJ-5, CJ-6, DJ-3A.....	165°F.	74°C.
Fully Open:		
CJ-2A, CJ-3A.....	170°F.	78°C.
CJ-3A, CJ-5, CJ-6, DJ-3A.....	188°F.	86°C.
Optional High Temperature:		
Starts to Open:		
CJ-3A, CJ-5, CJ-6, DJ-3A.....	180°F.	82°C.
Fully Open:.....	202°F.	94°C.
Water Pump:		
Type.....	Centrifugal	
Drive.....	V-Belt	
Bearing.....	Ball	
Radiator:		
Type:		
Model:		
CJ-2A.....	Tube & Fin	
CJ-3A.....	Cellular	
CJ-3B.....	Cellular	
CJ-5, CJ-6.....	Tube & Fin	
DJ-3A.....	Cellular	
Cooling System Capacity:		
Without Heater.....	11 qt.	10,5 ltr.
With Heater.....	12 qt.	11,5 ltr.
Fan:		
Number of Blades.....	4	
Spacing.....	90°	
Diameter.....	15"	38 cm.
Ratio Fan-to-Crankshaft:		
Early CJ-3A.....	1.83 to 1	
All Others.....	1.19 to 1	
Bearing.....	Water Pump	
Drive Belt:		
Angle of V:		
CJ-2A.....	42°	
CJ-3A.....	45°	
CJ-3B, CJ-5, CJ-6, DJ-3A.....	38°	
Length:		
CJ-2A.....	42 ¹¹ / ₃₂ "	108 cm.
CJ-3A.....	44"	112 cm.
CJ-3B, CJ-5, CJ-6, DJ-3A.....	42 ⁵ / ₈ "	102 cm.
Width.....	1 ¹¹ / ₁₆ "	17

H-17. ANTIFREEZE CHART

ANTIFREEZE			PROTECTION TO TEMPERATURE SHOWN			
Quarts U.S.	Quarts Imperial	Liters	Methyl Alcohol		Ethylene Glycol	
			Fahr.	Cent.	Fahr.	Cent.
11-Quart System						
2	1 ² / ₈	2	13°	10,5°	18°	- 7,2°
3	2 ¹ / ₂	2 ³ / ₄	0°	-17,7°	8°	-13,3°
4	3 ¹ / ₈	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 ³ / ₈	.....	.....	-47°	-43,8°
12-Quart System						
2	1 ² / ₈	2	15°	- 9,5°	15°	- 7,2°
3	2 ¹ / ₂	2 ³ / ₄	3°	-16,1°	10°	-12,2°
4	3 ¹ / ₈	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 ³ / ₈	-50°	-45,5°	-3 ⁴ / ₈ °	-36,6°

ELECTRICAL SYSTEM

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Battery	I-2	Horn	I-76
Bendix Folo-Thru Drive	I-60	Ignition Switch	I-63
Bendix Starter Drive	I-58	Ignition System	I-3
Current-Voltage Regulator	I-22	Ignition Timing	I-13
Directional Signals	I-77	Indicators and Gauges	I-65
Distributor	I-4	Lighting System	I-66
Distributor Cap	I-5	Main Light Switch	I-67
Distributor Condenser	I-7	Overrunning Clutch Drive	I-59
Distributor Governor Mechanism	I-9	Spark Plugs	I-14
Distributor Points	I-8	Starting Motor	I-44
Distributor Rotor	I-6	Starting Motor Armature	I-53
Fuel Gauge	I-64	Starting Motor Brush Holders	I-55
Generator	I-15	Starting Motor Brushes	I-51
Generator Armature	I-18	Starting Motor Commutator	I-47, I-52
Generator Brush Holders	I-20	Starting Motor Field Coils	I-54
Generator Field Coils	I-19	Starting Switch	I-62
Head Lamp Aiming	I-73	Stop Light Switch	I-69

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 always interchangeable and a replacement item of the correct voltage rating must be secured. Refer to Par. I-70. 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. In the following paragraphs will be found information about the battery, distributor, coil, generator, voltage regulator and starting motor. These units with the connecting wires, make up the engine electrical system. The wiring diagram will show the different circuits of the engine electrical system and the various units which make up those circuits. With plastic-covered wiring harnesses use only rubber-insulated wiring clips.

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. At each 1000 miles [1.600 km.], or when the vehicle is lubricated, check the battery condition with a hydrometer and check the electrolyte level in each cell. At each

10,000 miles [16.000 km.], clean and inspect the battery as outlined below.

Note: Do not allow flames or sparks to be brought near the vent openings of the battery since hydrogen gas may be present in the battery and might explode.

Note: The liquid in the battery (electrolyte) is a solution of sulphuric acid which, on contact, can injure skin or eyes, or damage clothes. If it is spilled on the skin or spattered in the eyes, promptly flush it away with quantities of clear water only. If the acid is spilled on clothes, wet it thoroughly with a weak solution of ammonia, or with a solution of sodium bicarbonate or baking soda.

Note: When installing a battery, make sure the negative terminal is grounded. Reverse polarity in the ignition system can cause an otherwise top performing engine to become rough and sluggish.

Battery Inspection

a. Check the specific gravity of the electrolyte in each cell of the battery. A hydrometer reading of 1.260 indicates that the battery is fully charged. If the reading is 1.225 or below, the battery needs recharging. If one or more cells is 25 "points" (.025) or more lower than the other cells, this indicates that the cell is shorted, the cell is about to fail, or there is a crack in the battery partition in the case. Unless the battery is repaired or replaced, battery trouble will soon be experienced.

b. Check the electrolyte level in each cell, add distilled water to maintain the solution $\frac{3}{8}$ " [9.5 mm.] above the plates. Avoid overfilling. Replace the filler caps and tighten securely. It is important

to keep the electrolyte level above the plates at all times because plates that are exposed for any length of time will be seriously damaged.

c. Check the wing nuts on the hold-down frame for tightness. Tighten them only with finger pressure, never with pliers or a wrench. Excessive pressure could damage the battery case.

d. Clean the battery terminals and cable connectors. Prepare a strong solution of baking soda and water and brush it around the terminals to remove any corrosion that is present. The cell caps must be tight and their vents sealed to prevent cleaning solution entering the cells. After cleaning, coat the terminals with heavy grease.

e. Inspect the battery cables and replace if badly corroded or frayed. Check tightness of terminal screws to ensure good electrical connections. Check the tightness of the negative ground cable connection at the frame to ensure a good ground connection.

f. Load test the battery. Connect a voltmeter across the battery. Run the starting motor for 15 seconds. If the voltage does not drop below 5 volts on a 6-volt battery, or 10 volts on a 12-volt battery, the battery is satisfactory. If the voltage falls below the figures given, yet the specific gravity is above 1.225, the condition of the battery is questionable.

g. Be sure the engine ground strap connection, Fig. 140, is tight at both connections. If these connections are loose or dirty, hard starting or failure to start may result.

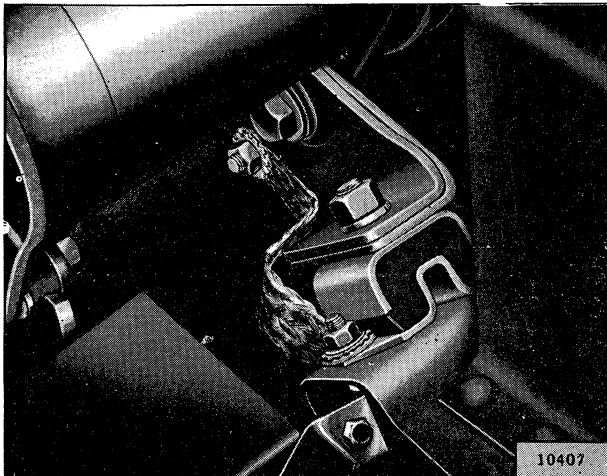


FIG. 140—ENGINE GROUND STRAP

I-3. Ignition System

Note: Although Auto-Lite equipment is standard on 'Jeep' vehicles, at the start of 1954 production a few 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 de-

rived 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 follow each other in sequence of firing order. To accomplish this the following units are required:

- a.** The battery, which supplies the electrical energy;
- b.** 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;
- c.** 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;
- d.** The spark plugs, which provide the gap in the engine cylinders;
- e.** The wiring, which connects the various units;
- f.** The ignition switch, which controls the battery current when it is desired to start or stop the engine.

I-4. Distributor

The distributor is mounted on the right side of the engine and is operated by a coupling on the oil pump shaft, see Fig. 71, which is driven by a spiral gear on the camshaft. The spark advance is fully automatic, being controlled by built-in centrifugal weights. While some parts of the distributor may be checked or replaced with the unit mounted on the engine, it is best to periodically remove it for a thorough check. Information covering the parts which can be serviced without removal is given below.

I-5. 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-6. Rotor

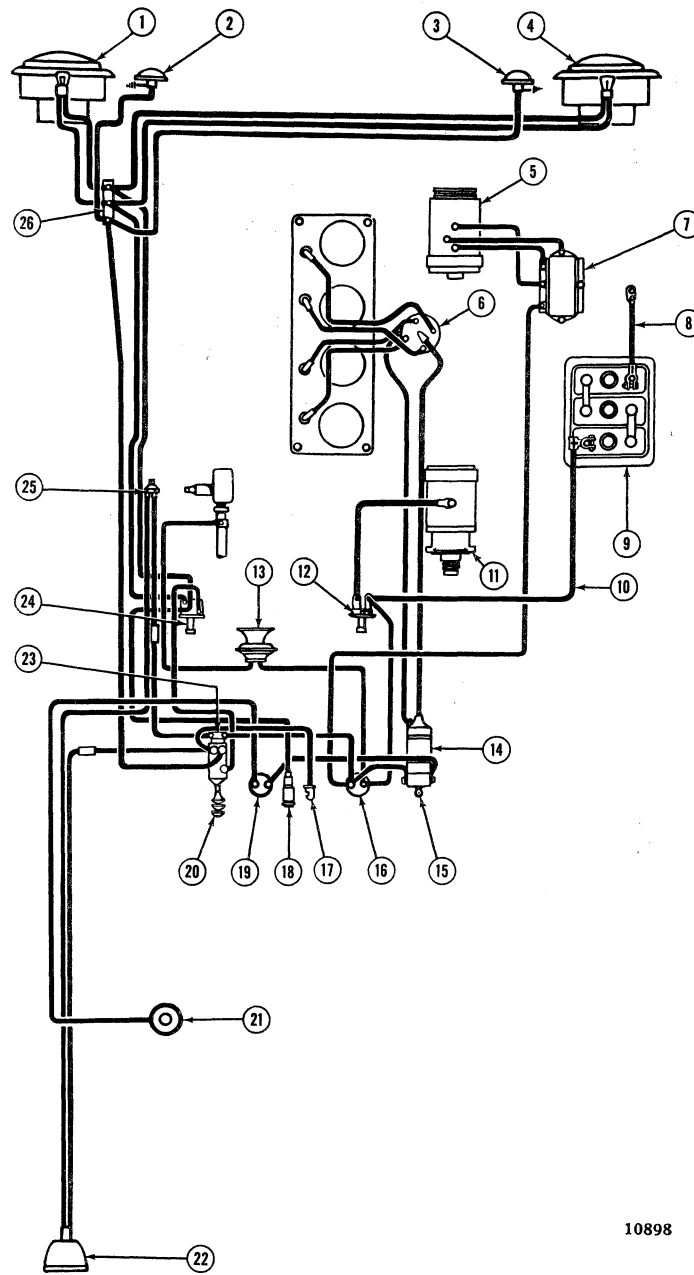
Inspect the rotor for cracks or evidence of excessive burning at the end of the metal strip.

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-7. 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

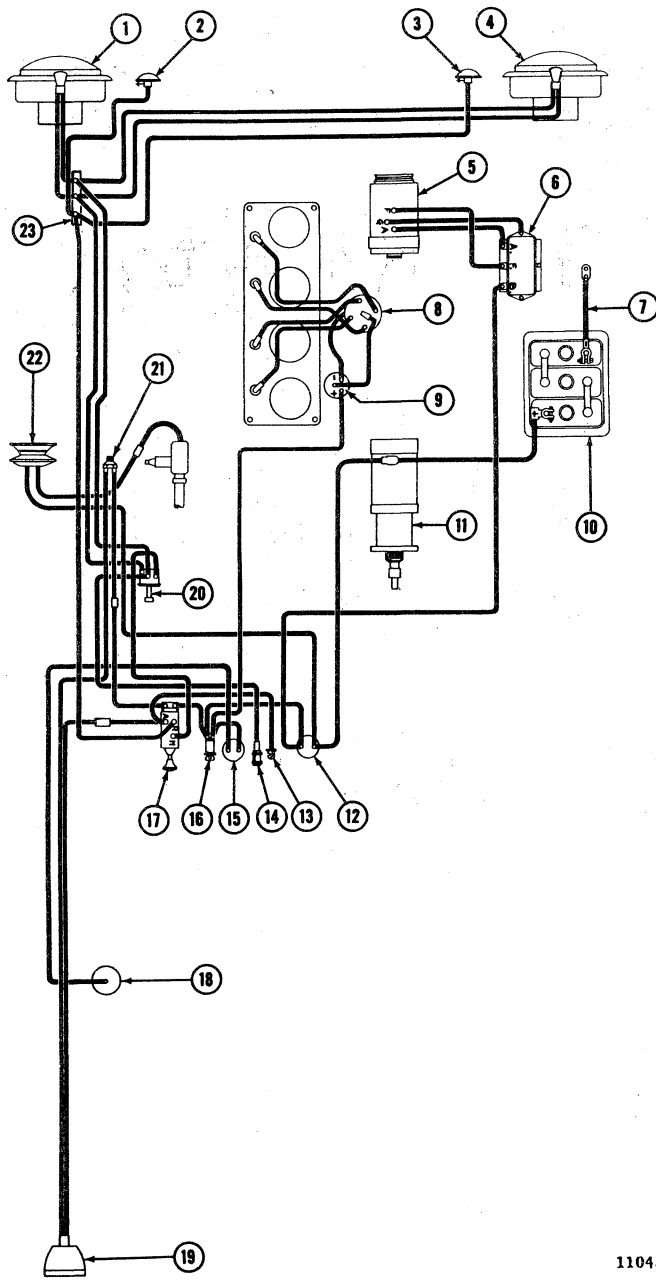
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FIG. 141—WIRING DIAGRAM—MODEL CJ-2A

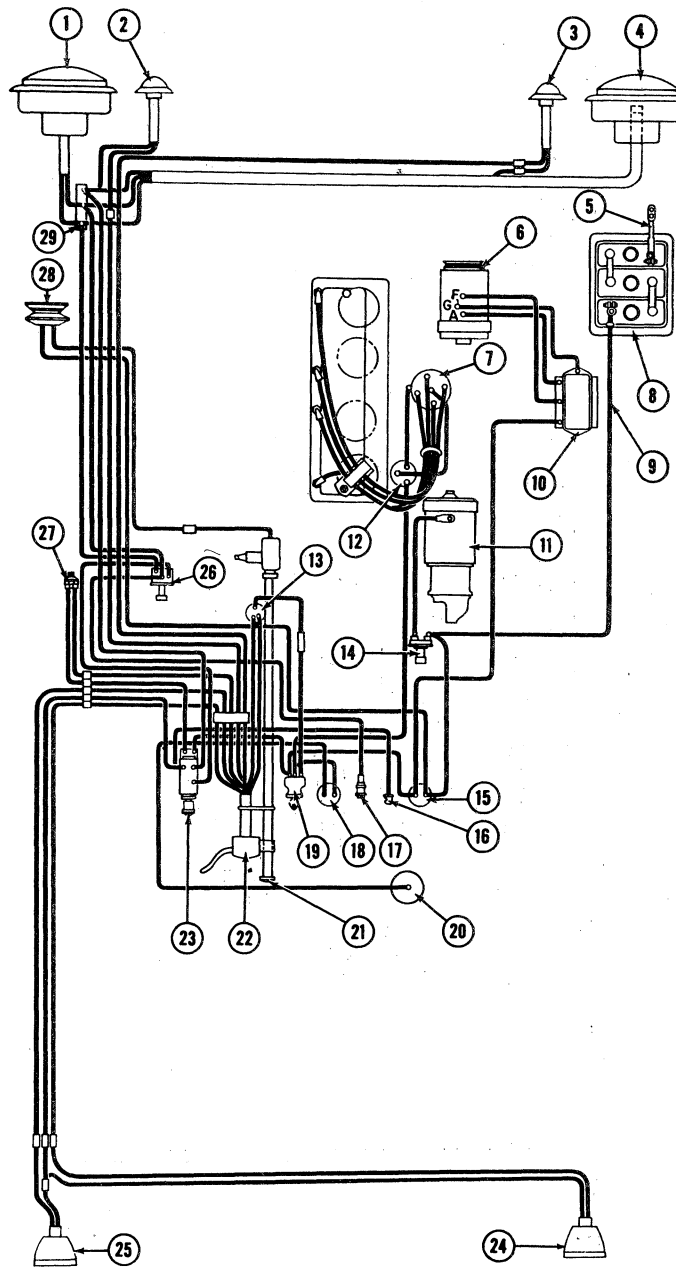
- | | |
|-------------------------|---------------------------------|
| 1—Left Headlamp | 14—Ignition Coil |
| 2—Left Parking Lamp | 15—Ignition Switch |
| 3—Right Parking Lamp | 16—Ammeter |
| 4—Right Headlamp | 17—Dash Light |
| 5—Generator | 18—Tell-Tale Light |
| 6—Distributor | 19—Fuel Gauge |
| 7—Voltage Regulator | 20—Light Switch |
| 8—Negative Ground Cable | 21—Fuel Gauge Sending Unit |
| 9—Battery | 22—Tail and Stop Light |
| 10—Positive Cable | 23—Light Switch Circuit Breaker |
| 11—Starting Motor | 24—Dimmer Switch |
| 12—Starting Switch | 25—Stop Light Switch |
| 13—Horn | 26—Junction Block |



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FIG. 142—WIRING DIAGRAM—MODEL CJ-3A

- | | |
|-------------------------|----------------------------|
| 1—Left Headlamp | 13—Dash Light |
| 2—Left Parking Lamp | 14—Tell-Tale Light |
| 3—Right Parking Lamp | 15—Fuel Gauge |
| 4—Right Headlamp | 16—Ignition Switch |
| 5—Generator | 17—Light Switch |
| 6—Voltage Regulator | 18—Fuel Gauge Sending Unit |
| 7—Negative Ground Cable | 19—Tail and Stop Light |
| 8—Distributor | 20—Dimmer Switch |
| 9—Ignition Coil | 21—Stop Light Switch |
| 10—Battery | 22—Horn |
| 11—Starting Motor | 23—Junction Block |
| 12—Ammeter | |



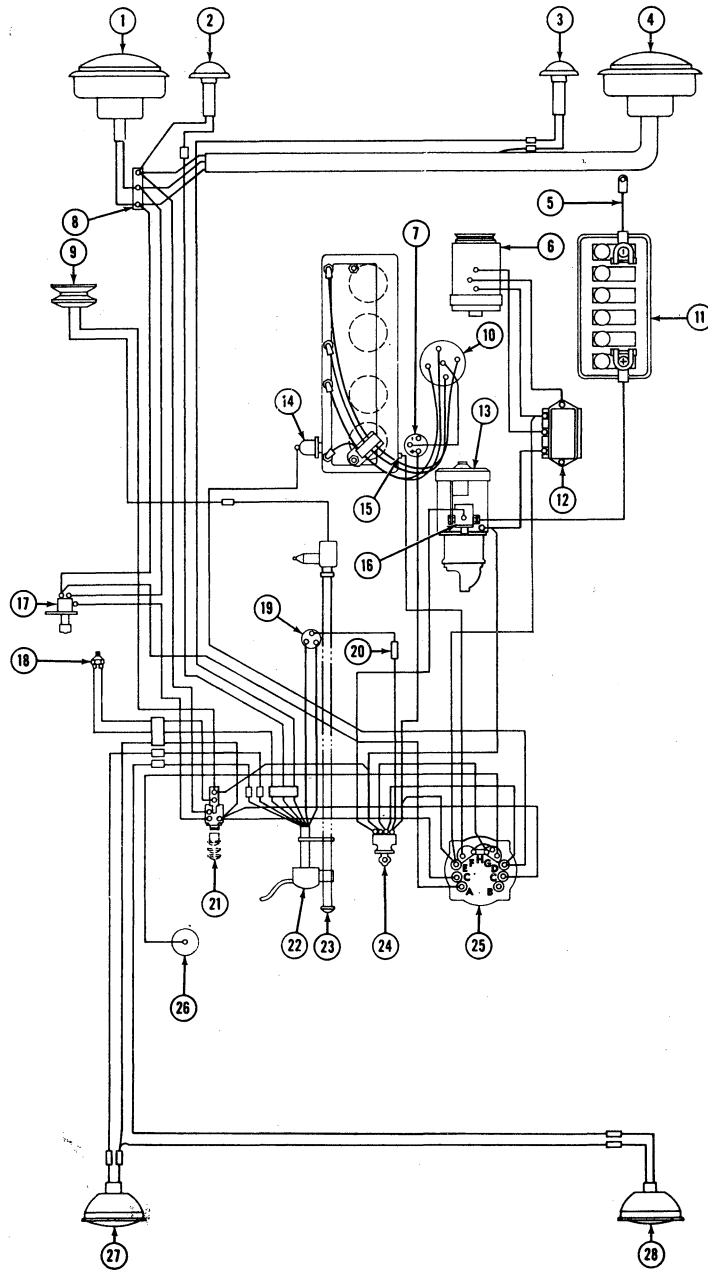
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FIG. 143—WIRING DIAGRAM—MODEL CJ-3B

(Up to Serial No. 35522)

- | | |
|-------------------------|------------------------------|
| 1—Left Headlamp | 16—Dash Light |
| 2—Left Parking Lamp | 17—Tell-Tale Light |
| 3—Right Parking Lamp | 18—Fuel Gauge |
| 4—Right Headlamp | 19—Ignition Switch |
| 5—Negative Ground Cable | 20—Fuel Gauge Sending Unit |
| 6—Generator | 21—Horn Button |
| 7—Distributor | 22—Directional Signal Switch |
| 8—Battery | 23—Light Switch |
| 9—Positive Cable | 24—Right Tail and Stop Lamp |
| 10—Voltage Regulator | 25—Left Tail and Stop Lamp |
| 11—Starting Motor | 26—Dimmer Switch |
| 12—Ignition Coil | 27—Stop Light Switch |
| 13—Signal Flasher | 28—Horn |
| 14—Starting Switch | 29—Junction Block |
| 15—Ammeter | |

ELECTRICAL SYSTEM



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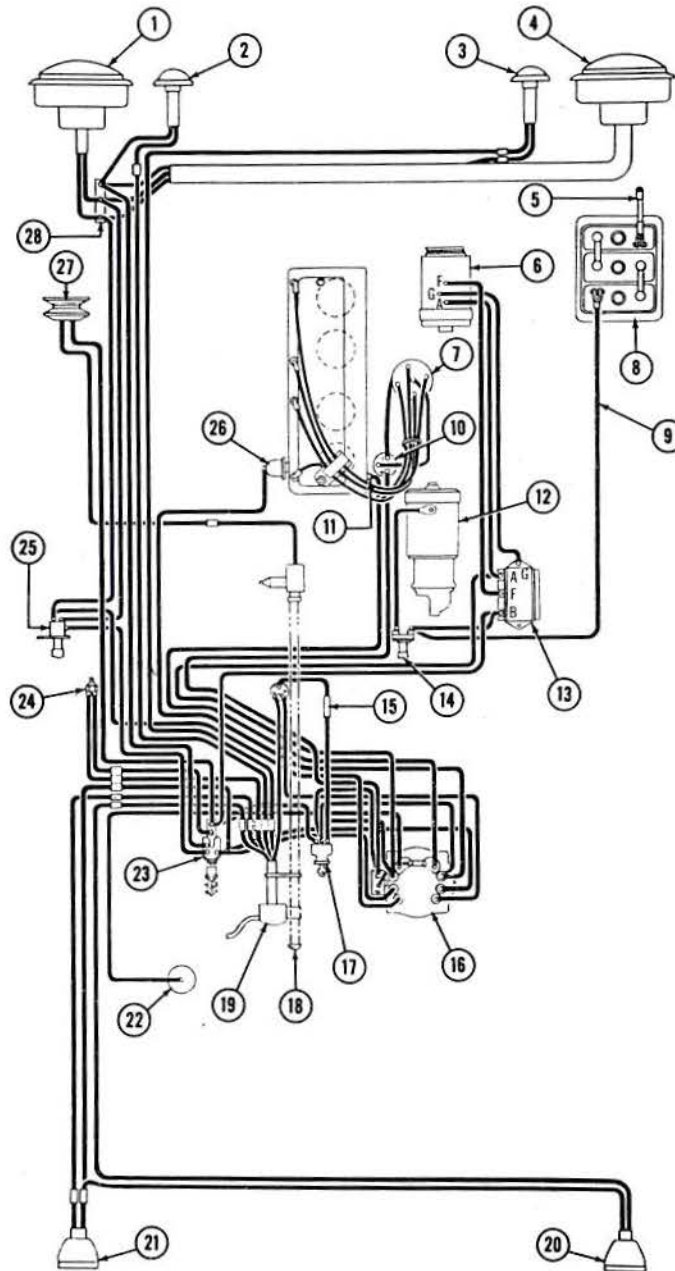
FIG. 144—WIRING DIAGRAM—MODEL CJ-3B

(Serial No. 35522 and after)

- 1—Left Headlamp
- 2—Left Parking and Signal Lamp
- 3—Right Parking and Signal Lamp
- 4—Right Headlamp
- 5—Battery Ground Strap
- 6—Generator
- 7—Ignition Coil
- 8—Junction Block
- 9—Horn
- 10—Distributor
- 11—Battery
- 12—Voltage Regulator

- 13—Starting Motor
- 14—Oil Pressure Signal Switch
- 15—Temperature Sending Unit
- 16—Solenoid Switch
- 17—Foot Dimmer Switch
- 18—Stop Light Switch
- 19—Directional Signal Flasher
- 20—Fuse
- 21—Light Switch
- 22—Directional Signal Switch
- 23—Horn Button
- 24—Ignition and Starter Switch

- 25—Instrument Cluster
 - A—Upper Beam Indicator
 - B—Turn Signal Indicator
 - C—Instrument Lights
 - D—Oil Pressure Indicator
 - E—Charging Indicator
 - F—Temperature Gauge
 - G—Fuel Gauge
 - H—Instrument Voltage Regulator
- 26—Fuel Gauge Tank Unit
- 27—Left Tail and Stop Lamp
- 28—Right Tail and Stop Lamp



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FIG. 145—WIRING DIAGRAM—MODELS CJ-5 AND CJ-6
(Up to Serial No. 49248 Model CJ-5 and No. 12577 CJ-6)

- | | |
|-----------------------------|------------------------------|
| 1—Left Headlamp | 15—Fuse |
| 2—Left Parking Lamp | 16—Instrument Cluster |
| 3—Right Parking Lamp | 17—Ignition Switch |
| 4—Right Headlamp | 18—Horn Button |
| 5—Negative Ground Cable | 19—Directional Signal Switch |
| 6—Generator | 20—Right Tail and Stop Lamp |
| 7—Distributor | 21—Left Tail and Stop Lamp |
| 8—Battery | 22—Fuel Gauge Sending Unit |
| 9—Positive Cable | 23—Light Switch |
| 10—Ignition Coil | 24—Stop Light Switch |
| 11—Temperature Sending Unit | 25—Dimmer Switch |
| 12—Starting Motor | 26—Oil Pressure Sending Unit |
| 13—Voltage Regulator | 27—Horn |
| 14—Starting Switch | 28—Junction Block |

ELECTRICAL SYSTEM

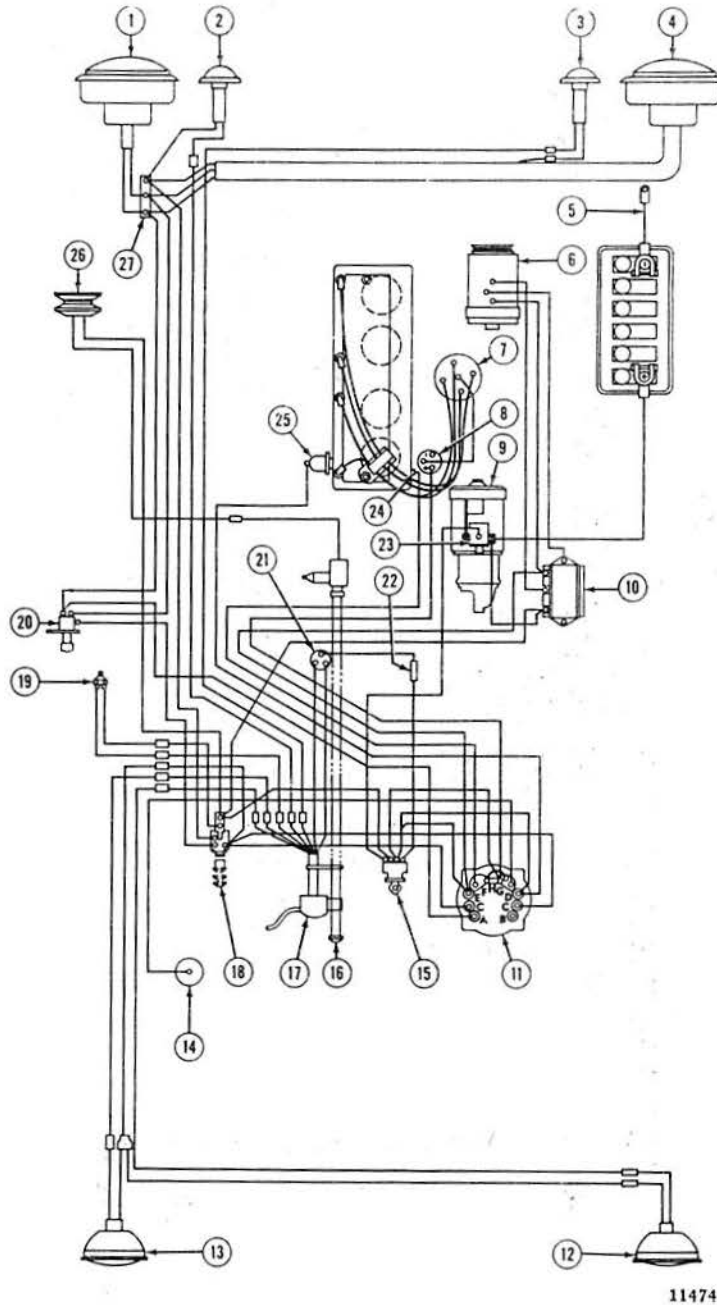
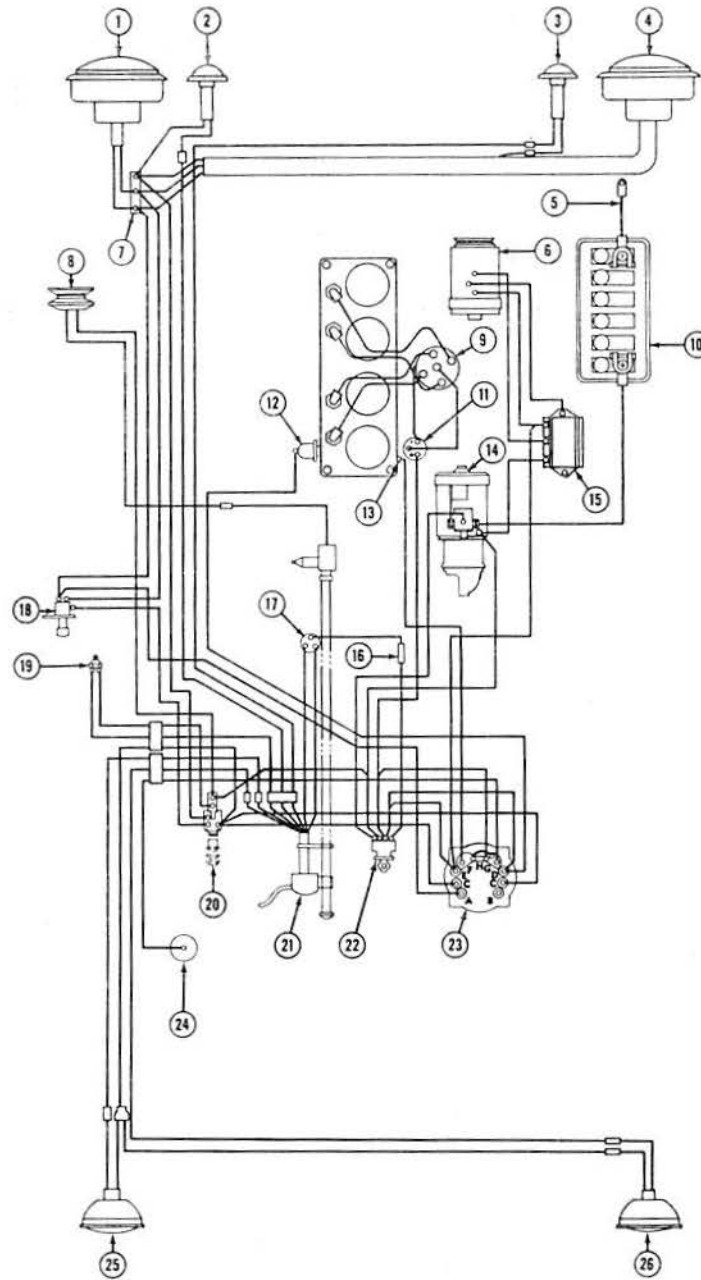


FIG. 146—WIRING DIAGRAM

(Model CJ-5 after Serial No. 49248, Model CJ-6 after Serial No. 12577)

- | | | |
|--|---|--|
| <ul style="list-style-type: none"> 1—Left Headlamp 2—Left Parking and Directional Lamp 3—Right Parking and Directional Lamp 4—Right Headlamp 5—Battery Ground Cable 6—Generator 7—Distributor 8—Ignition Coil 9—Starting Motor 10—Voltage Regulator 11—Instrument Cluster <li style="padding-left: 20px;">A—Upper Beam Indicator | <ul style="list-style-type: none"> B—Turn Signal Indicator C—Instrument Lights D—Oil Pressure Indicator E—Charging Indicator F—Temperature Gauge G—Fuel Gauge H—Instrument Voltage Regulator 12—Right Tail and Stop Lamp 13—Left Tail and Stop Lamp 14—Fuel Gauge Tank Unit 15—Ignition and Starter Switch 16—Horn Button | <ul style="list-style-type: none"> 17—Directional Signal Switch 18—Light Switch 19—Stop Light Switch 20—Foot Dimmer Switch 21—Directional Signal Flasher 22—Fuse 23—Solenoid Switch 24—Temperature Sending Unit 25—Oil Pressure Signal Switch 26—Horn 27—Junction Block |
|--|---|--|



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FIG.147—WIRING DIAGRAM—MODEL DJ-3A

- 1—Left Headlamp
- 2—Left Parking and Directional Signal
- 3—Right Parking and Directional Signal
- 4—Right Headlamp
- 5—Negative Cable to Ground
- 6—Generator
- 7—Junction Block
- 8—Horn
- 9—Distributor
- 10—Battery
- 11—Ignition Coil
- 12—Oil Pressure Signal Switch

- 13—Temperature Sending Unit
- 14—Starting Motor
- 15—Voltage Regulator
- 16—Fuse
- 17—Directional Signal Flasher
- 18—Foot Dimmer Switch
- 19—Stop Light Switch
- 20—Light Switch
- 21—Directional Signal Switch
- 22—Ignition and Starter
- 23—Instrument Cluster
- A—Upper Beam Indicator

- B—Turn Signal Indicator
- C—Instrument Lights
- D—Oil Pressure Indicator
- E—Charging Indicator
- F—Temperature Gauge
- G—Fuel Gauge
- H—Instrument Voltage Regulator
- 24—Fuel Gauge Tank Unit
- 25—Left Tail and Stop Lamp
- 26—Right Tail and Stop Lamp

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 result. 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 capacity should check from .25 to .28 microfarads. In the absence of a tester check by substituting a new condenser.

I-8. Distributor Points

a. Examine the distributor points. If they show wear, poor mating, transferred metal, or pitting then new ones should be installed. Clean the points with a suitable solvent and a stiff bristled brush.

b. Check the alignment of the point for a full, square contact. If not correctly aligned, bend the stationary contact bracket slightly to provide alignment.

c. The contact gap should be set at .020" [0,508 mm.], measured with a wire gauge. Adjustment of the gap is accomplished by loosening the lock screw (Fig. 148, 39) and turning adjusting eccentric screw (7), until correct gap is secured. Be sure that the fiber block on the breaker arm is resting on the highest point on the cam while the adjustment is being made. Recheck the gap after locking the adjustment.

d. Apply a thin film of cam lubricant to the cam to lessen fiber block wear.

e. Check point contact spring pressure, which should be between 17 and 20 ounces [0,487 a 0,56 kg.]. Check with a spring scale hooked on the breaker arm at the contact and pull at right angle to the breaker arm. Make the reading just as the points separate. 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. Too low a pressure will cause engine missing at high speeds. Too high a pressure will cause rapid wear of the cam, block, and points.

I-9. Governor Mechanism

The spark advance of this distributor is automatically controlled by a centrifugal governor built in the distributor body. The centrifugal type governor should be checked for free operation. Hold the governor shaft and turn the cam to the left as far as possible and release it. The cam should immediately return to the original position without drag.

Should a distributor test fixture be available it is best to make a check through the entire advance range, following the instructions of the fixture manufacturer.

I-10. Distributor Removal

a. Remove high-tension wires from the distributor cap terminal towers, noting the order in which they are assembled to ensure correct reassembly. No. 1 spark plug terminal tower is in the 5 o'clock position. Starting with this tower, the wires are

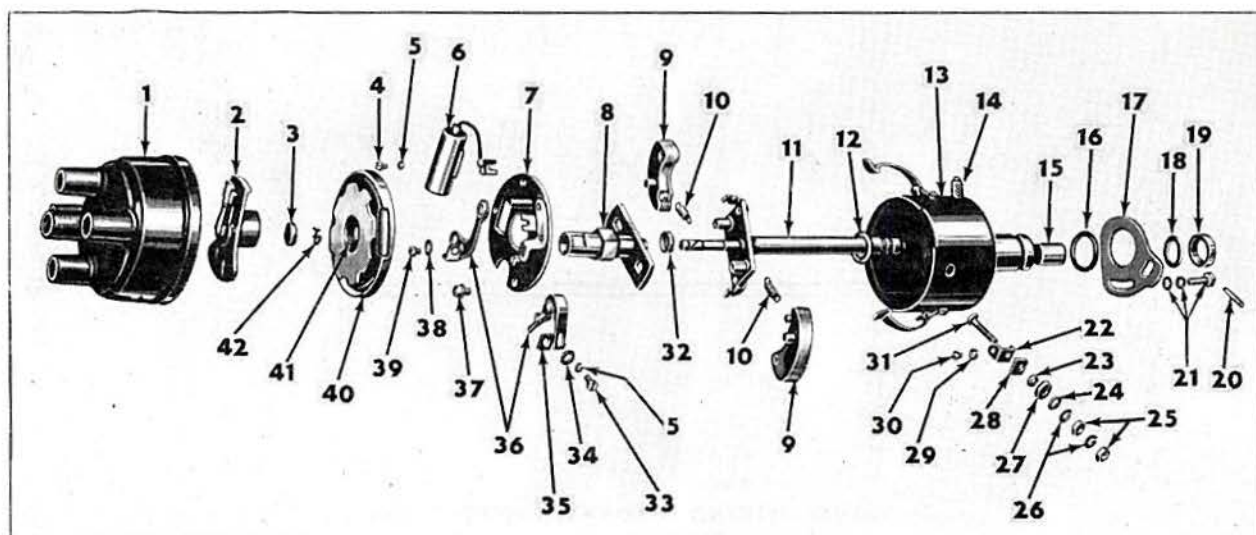


FIG. 148—TYPICAL DISTRIBUTOR

- | | | |
|----------------------------|------------------------|----------------------------------|
| 1—Cap | 15—Bearing | 29—Connector Lockwasher |
| 2—Rotor | 16—Rubber O Ring | 30—Connector Screw |
| 3—Cam Oiling Wick | 17—Advance Arm | 31—Terminal Post |
| 4—Condenser Mounting Screw | 18—Lower Thrust Washer | 32—Cam Spacer |
| 5—Lockwasher | 19—Drive Shaft Collar | 33—Breaker Arm Spring Clip Screw |
| 6—Condenser | 20—Collar Rivet | 34—Spring Clip Screw Washer |
| 7—Breaker Plate | 21—Screw and Washers | 35—Spring Clip |
| 8—Cam and Stop Plate | 22—Connector | 36—Distributor Points |
| 9—Governor Weight | 23—Bushing | 37—Breaker Plate Screw |
| 10—Governor Spring | 24—Terminal Washer | 38—Washer |
| 11—Drive Shaft | 25—Terminal Nut | 39—Locking Screw |
| 12—Thrust Washer | 26—Terminal Lockwasher | 40—Plate Seal |
| 13—Base | 27—Insulating Washer | 41—Felt Washer |
| 14—Oiler | 28—Terminal Insulation | 42—Snap Ring |

installed in a counterclockwise direction in 1-3-4-2 firing order. See Fig. 150.

- b. Remove the primary lead from the terminal post at the side of the distributor.
- c. Unlatch the two distributor cap springs and remove the cap.
- d. Note the position of the rotor in relation to the base. This should be remembered to facilitate re-installing and timing.
- e. Remove the screw holding the distributor to the crankcase and lift the assembly from the engine.

I-11. Distributor Disassembly

- a. Remove the rotor.
- b. Remove the dust cap which is seated in the housing with finger-tight press fit.
- c. Remove the breaker plate assembly. To do this, remove the two mounting screws and disconnect the strap lead by removing one screw directly above the primary lead terminal on the side of the housing. Rotate the assembly to align the slot in the edge of

the breaker plate with the primary lead terminal insulators and screw and lift the assembly from the housing.

- d. Remove the condenser.
- e. Remove the distributor points.
- f. Remove the shaft assembly. To do this, file off the upset end of the pin which is placed through the collar and shaft at the lower end of the housing and drive out the pin with a suitable punch. Remove the collar and washer. Pull the shaft from the housing.
- g. Should it be necessary to remove the cam assembly, first remove the felt wick from the upper end. Use long-nose pliers to compress and remove the spring locking clip located at the bottom of the drilled center opening of the cam. Remove the cam.

I-12. Distributor Inspection

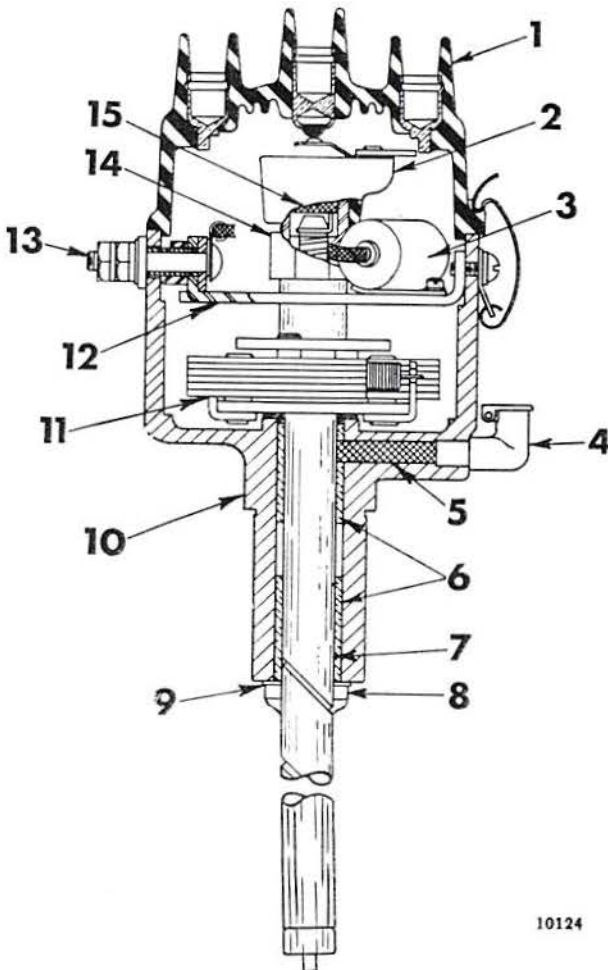
If the shaft and bearings are worn sufficiently to allow .005" or more looseness of the shaft, they must be replaced. Before installing new bearings, soak them in medium grade engine oil and allow them to drain. Wipe all oil from the upper part of the housing. At assembly, apply a film of grease to the upper drive shaft washer and put a small amount of grease in the bearing bore just above the bearings. Lubricate the governor mechanism sparingly with medium grade engine oil. After assembly place 3 to 5 drops of engine oil in the oiler mounted on the side of the housing and 5 drops on the felt located in the center opening of the cam directly below the rotor. Place a very light smear of grease on the cam and 1 drop of oil on the breaker arm pivot.

Before installing the distributor, check the friction spring mounted on the lower end of the drive shaft and replace it if worn or damaged.

I-13. Installation and Ignition Timing

If the engine crankshaft has been rotated, with the distributor off, it will be necessary to place No. 1 piston in firing position to correctly install the distributor.

To locate the firing position of No. 1 piston, first remove No. 1 spark plug and turn the engine until No. 1 piston is moving up on the compression stroke as indicated by compression pressure being forced through the spark plug opening. Turn the engine 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. Fig. 26 and 27. Oil the distributor housing where it bears in the cylinder block and install the distributor on the cylinder block. Mount the rotor on distributor shaft and turn the shaft until the rotor points towards No. 1 spark plug terminal tower position (when cap is installed) with the contact points just breaking. 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.



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FIG. 149—DISTRIBUTOR

- | | |
|---------------------------|--------------------------|
| 1—Cap | 9—Thrust Washer |
| 2—Rotor | 10—Base |
| 3—Condenser | 11—Governor Weight |
| 4—Oiler | 12—Breaker Plate |
| 5—Felt Wick (Cam Sleeves) | 13—Primary Terminal Stud |
| 6—Absorbent Bearing | 14—Cam and Stop Plate |
| 7—Drive Shaft | 15—Felt Wick |
| 8—Drive Shaft Collar | |

Note: The CJ-5 and CJ-6 distributor (IAD 4041) which has been released for service replacement on the CJ-3B is identical to the CJ-3B distributor

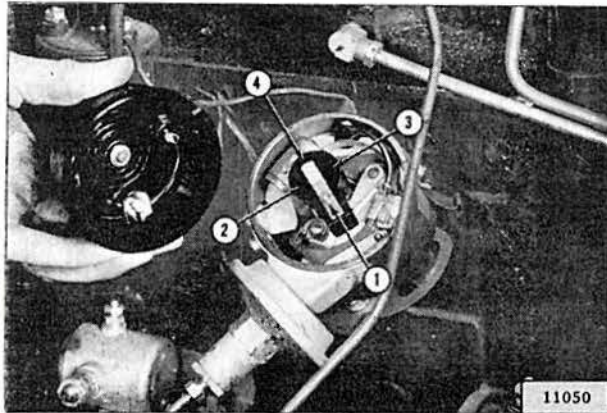


FIG. 150—FIRING POSITIONS

(IAD 4008A) except for the hold down arm. This hold down arm locates the distributor approximately 36° from the installed position of the CJ-3B distributor. Therefore, to engage the drive when installing a CJ-5 or CJ-6 distributor (IAD 4041) on a CJ-3B engine from which a IAD 4008A distributor has been removed, install as follows: Remove the oil pump. Place the distributor in the correct timing position and install the hold down screw. Install the oil pump after first carefully engaging the distributor drive and meshing the gears without disturbing the correct timing position of the distributor.

Connect the primary wire from the coil to the distributor. Install spark plugs. Install spark plug wires, placing them in the distributor cap terminal towers starting with No. 1 (Fig. 150), and installing in counter-clockwise direction in firing order sequence which is 1-3-4-2. Start the engine and run it until thoroughly warm and then recheck the timing with a neon timing light.

Accelerate the engine and check the automatic advance action by noting the movement of the crankshaft pulley mark.

I-14. 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.

Note: Prolonged idling just before removing and checking the plugs should be avoided as it may produce false indications.

Spark plug operating temperatures may have been too hot, too cold, or normal as described.

a. At too hot a temperature, the tip of the insulator will show dark spots and blisters after fairly short service. 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.

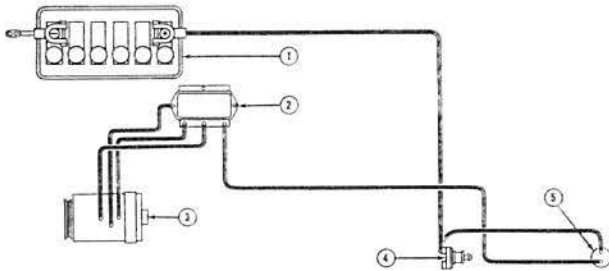
Note: If such cracking appears on certain plugs after fairly short service, it may be caused by water leaks in the associated cylinders.

b. At too cold a temperature plug operation, in the early stages, will result in a dull black sooting of the plug. This condition frequently is found in new vehicles 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. 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 other than the type of spark plugs and the cause should be determined before changing plugs. The design of the engine calls for plugs equivalent to 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, in turn, will produce too easy a heat flow path and result in cold plug operation. This will be evident by excessive flattening and deformation of the gasket. Prevailing temperatures, condition of the cooling system, and air-fuel mixture can affect the engine operating temperature and should be taken into consideration.

I-15. GENERATOR

The generator is an air-cooled, two-brush unit which cannot be adjusted to increase or decrease output. For replacement, voltage regulator and generator must be matched for voltage and capa-



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FIG. 151—CHARGING CIRCUIT

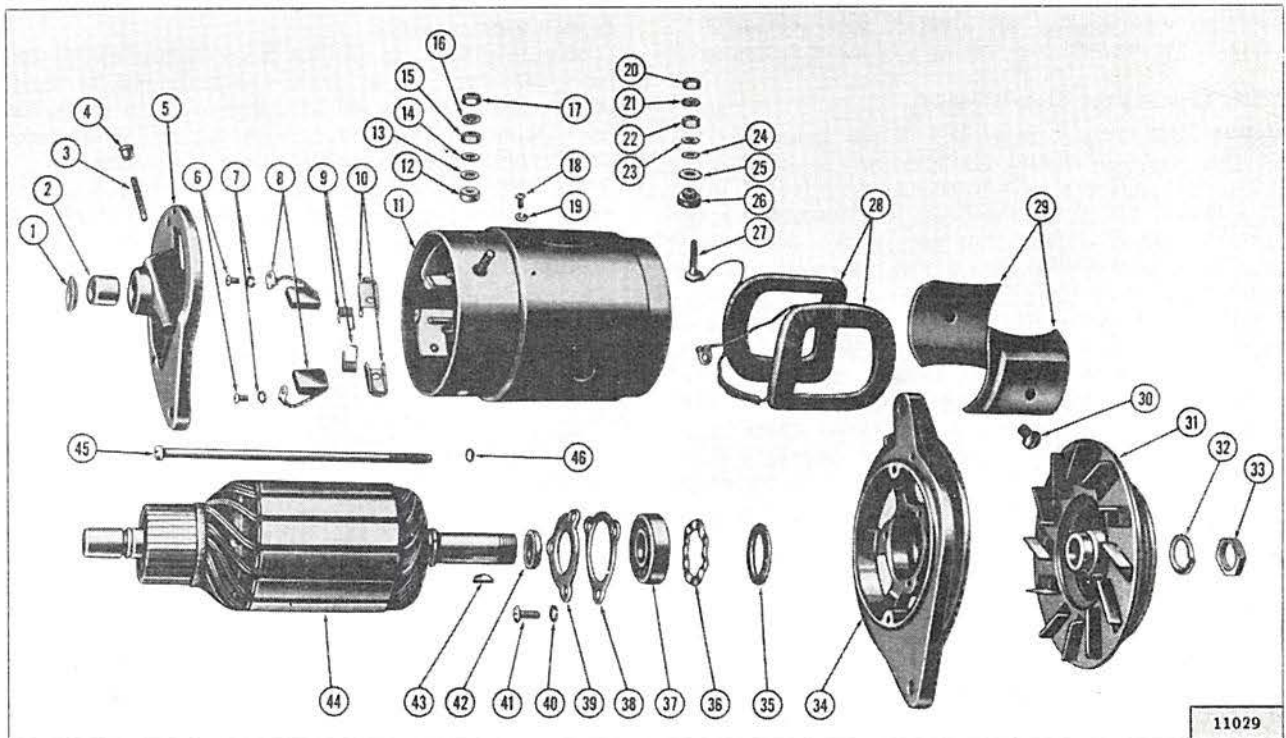
- | | |
|---------------------|--------------------|
| 1—Battery | 4—Starter Switch |
| 2—Voltage Regulator | 5—Charge Indicator |
| 3—Generator | |

city, polarity, and common source of manufacture. Otherwise, either a loss of ampere capacity or a burned out generator will result. Generators for these vehicles are either 6-volt or 12-volt. Par. I-1 explains the change to the 12-volt system. Refer to the specifications at the end of this section for information on correct generator rating for a specific model series.

The circuit breaker, voltage regulator, and current-limiting regulator are built into one combination unit. Because the regulator and battery are part of the generator circuit, the output of the generator depends upon the state of charge and temperature of the battery. With a discharged battery, the output will be high, decreasing proportionally as the battery becomes charged. For service information covering current regulator see Par. I-22.

I-16. Generator Maintenance

A periodic inspection should be made of the charging circuit, Fig. 151. The interval between these



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FIG. 152—GENERATOR

- | | |
|-----------------------|----------------------------------|
| 1—Oil Retainer | 24—Washer |
| 2—Bearing | 25—Insulating Washer |
| 3—Felt Wick | 26—Insulating Bushing |
| 4—Oiler | 27—Stud |
| 5—Commutator End Head | 28—Left and Right Field Coil |
| 6—Brush Lead Screw | 29—Pole Shoes |
| 7—Lockwasher | 30—Pole Shoe Screw |
| 8—Brush Set | 31—Drive Pulley and Fan Assembly |
| 9—Brush Spring | 32—Lockwasher |
| 10—Brush Arm | 33—Shaft Nut |
| 11—Frame | 34—Drive End Head |
| 12—Insulating Bushing | 35—Felt Washer |
| 13—Washer | 36—Felt Washer Retainer |
| 14—Lockwasher | 37—Ball Bearing |
| 15—Hex Nut | 38—Gasket |
| 16—Lockwasher | 39—Bearing Retainer |
| 17—Hex Nut | 40—Lockwasher |
| 18—Ground Screw | 41—Retainer Screw |
| 19—Lockwasher | 42—Felt Washer |
| 20—Hex Nut | 43—Woodruff Key |
| 21—Lockwasher | 44—Armature |
| 22—Hex Nut | 45—Thru Bolt |
| 23—Lockwasher | 46—Lockwasher |

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 6000 miles [9.600 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-18.

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 arcing and reduced output. Test the tension with a spring scale. Check the specifications section at end of this section for correct spring tension for generator in question.

I-17. Generator Disassembly

Before beginning disassembly of the generator to correct electrical system malfunctions proceed with inspection and test procedures as detailed in Par. I-27 thru I-43. If it is definitely determined that trouble exists within the generator, which necessitates dismantling, proceed as follows.

6-volt Generator Only:

Remove the generator band and 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 and let the spring down against the sides of the brushes to hold them up in the brackets.

Both 6 and 12-volt Generator:

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 the bearing, oil guard and felt washer.

I-18. 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 $\frac{1}{32}$ " [0,8 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. 153, 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-19. 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 1.6 to 1.8 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 termin-

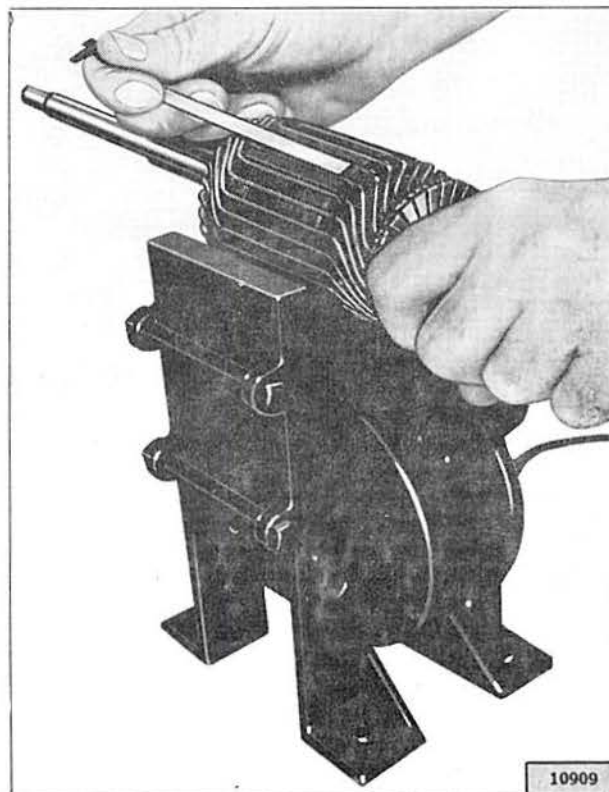


FIG. 153—GROWLER

als, 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-20. 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 frame 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-21. Assembling Generator

Install the felt grease retainer and washer in the drive end head. See Fig. 152. 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 and nut. 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 to 35 lb-ft. [3,4 a 4,8 kg-m.].

I-22. CURRENT-VOLTAGE REGULATORS

I-23. Description and Operation

For replacement, voltage regulator and generator must be matched for voltage and capacity, polarity, and common source of manufacture. Otherwise, either a loss of ampere capacity or a burned out generator will result.

These regulators are used with shunt-type generators and have three units each with a separate function to perform. These units are the circuit breaker unit, the voltage regulator unit, and the current limiting regulator unit.

I-24. 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.

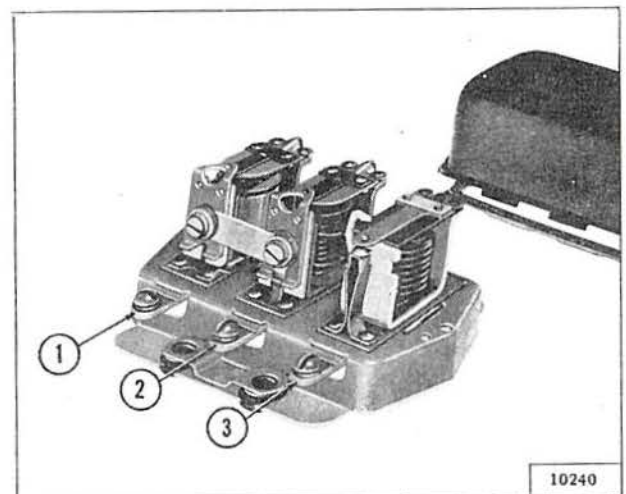


FIG. 154—AUTO-LITE VOLTAGE REGULATOR

- 1—"BAT" Terminal
- 2—"FLD" Terminal
- 3—"ARM" Terminal

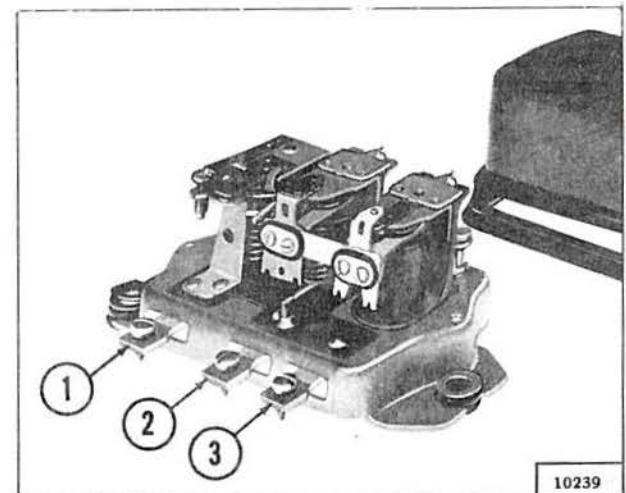


FIG. 155—DELCO-REMY VOLTAGE REGULATOR

- 1—"BAT" Terminal
- 2—"ARM" Terminal
- 3—"FLD" Terminal

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.

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-25. 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 voltage 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-26. 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-27. 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.

CAUTION: 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. 151, disconnect the armature cable at the regulator. Connect one lead of a 6-12v 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 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 maximum.

Generator "F" terminal to regulator "F" terminal—.05-volt maximum.

Battery terminal to regulator "B" terminal—.1-volt maximum.

Regulator ground screw to generator frame—.03-volt maximum.

Regulator ground screw to battery ground post—.03-volt maximum.

Generator frame to battery ground post—.03-volt maximum.

1-28. Test Procedure

a. Circuit Breaker—Connect an ammeter in series between the regulator B-terminal and the lead wire removed from that terminal. Connect a voltmeter between the regulator A-terminal and the regulator mounting base. 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 rpm. 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 headphones. 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 closing 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—Connect the ammeter as in step a. Connect the voltmeter between the regulator B-terminal and the regulator base. Remove the variable resistance from the field circuit. Run the generator at half output for 15 minutes to bring the regulator to normal operating temperature. Keep the cover on the regulator during the warm-up period and also when taking readings.

Stop the engine then bring it up to approximately 2500 generator rpm. Adjust the amperage to half 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 ohm 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—Connect the regulator and the test equipment as in step b. Running the generator at approximately 300 generator rpm., turn on lights and accessories so that the generator must charge at maximum rate. The ammeter should give a reading within the limits specified.

To adjust 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. Keep the cover on the regulator when taking these readings.

Connect a headphone (2000 ohms or higher) between the regulator F-terminal and ground to pick up the sound of opening and closing of the contacts. Clear, regular clicks should be heard over the headphones; they should not be irregular 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. below 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, equaling 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 half maximum output for five minutes with the cover on the regulator. Repeat the testing procedure for all units as described in a, b, c above. Be sure cover is on regulator when taking readings.

I-29. Quick Checks

I-30. 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 rpm. The charging rate should rise to its maximum value then taper off to a minimum charge as the battery becomes charged.

I-31. 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-32. 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.
- b.** Output does not drop—shorted field circuit in generator. Inspect generator.

I-33. Test Two

Disconnect the field lead at the regulator.

- a.** Output drops to zero—shorted field in regulator. See test 3.
- b.** Output does not drop—shorted wiring harness. Repair or replace wiring harness.

I-34. 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), check for high resistance (test 4), and clean contacts per instructions in Par. I-37.
- b.** Output does not drop—shorted field circuit in the regulator. Clean the regulator contacts and in-

spect the regulator visually for incorrect wiring between units and shorted leads.

I-35. 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.
- b.** Voltage reading above .03 volts—Inspect ground circuit for poor connections and eliminate the high resistance. See test 5.

I-36. 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-28.
- b.** An unsteady beat is heard—dirty or sticking contacts. Clean contacts per instructions in Par. I-37.
- 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-37. 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-27.

I-38. 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-39. Test Six

Read the voltmeter.

- a.** Voltage builds up—open series circuit. See test 7.

b. Voltage does not build up—regulator out of adjustment, field circuit open, grounded series circuit. See test 8.

I-40. Test Seven

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-27a. 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-41. Test Eight

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 9.

b. Voltage does not build up—grounded series circuit. Remove regulator for overhaul.

I-42. Test Nine

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-27.

b. Voltage does not build up—clean the contacts and repeat test. If the voltage still does not build up, see test 10.

I-43. Test Ten

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-27.

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.

I-44. 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.

Fig. 157 illustrates a typical 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.

Effective with Model CJ-3A vehicle Serial No. 30973, a $4\frac{1}{2}$ " [11.43 cm.] starting motor was adopted. This change incorporated a new starting switch and flywheel drive which are described separately below. This starter is equipped with sealed type absorbent bronze bearings and no lubrication is required. The service procedures outlined below will apply to the starting motors of all the models covered here.

I-45. 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.

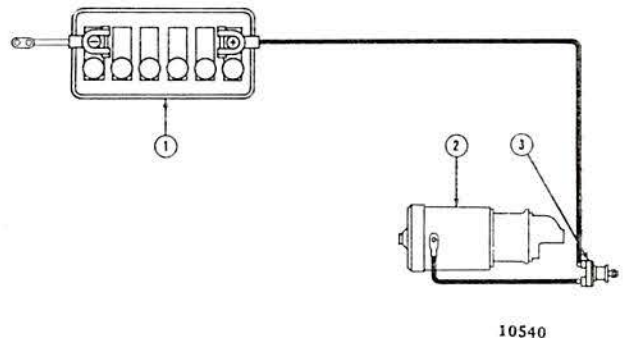


FIG. 156—STARTING CIRCUIT

1—Battery
2—Starter Motor
3—Starter Switch

I-46. 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 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-47. 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.

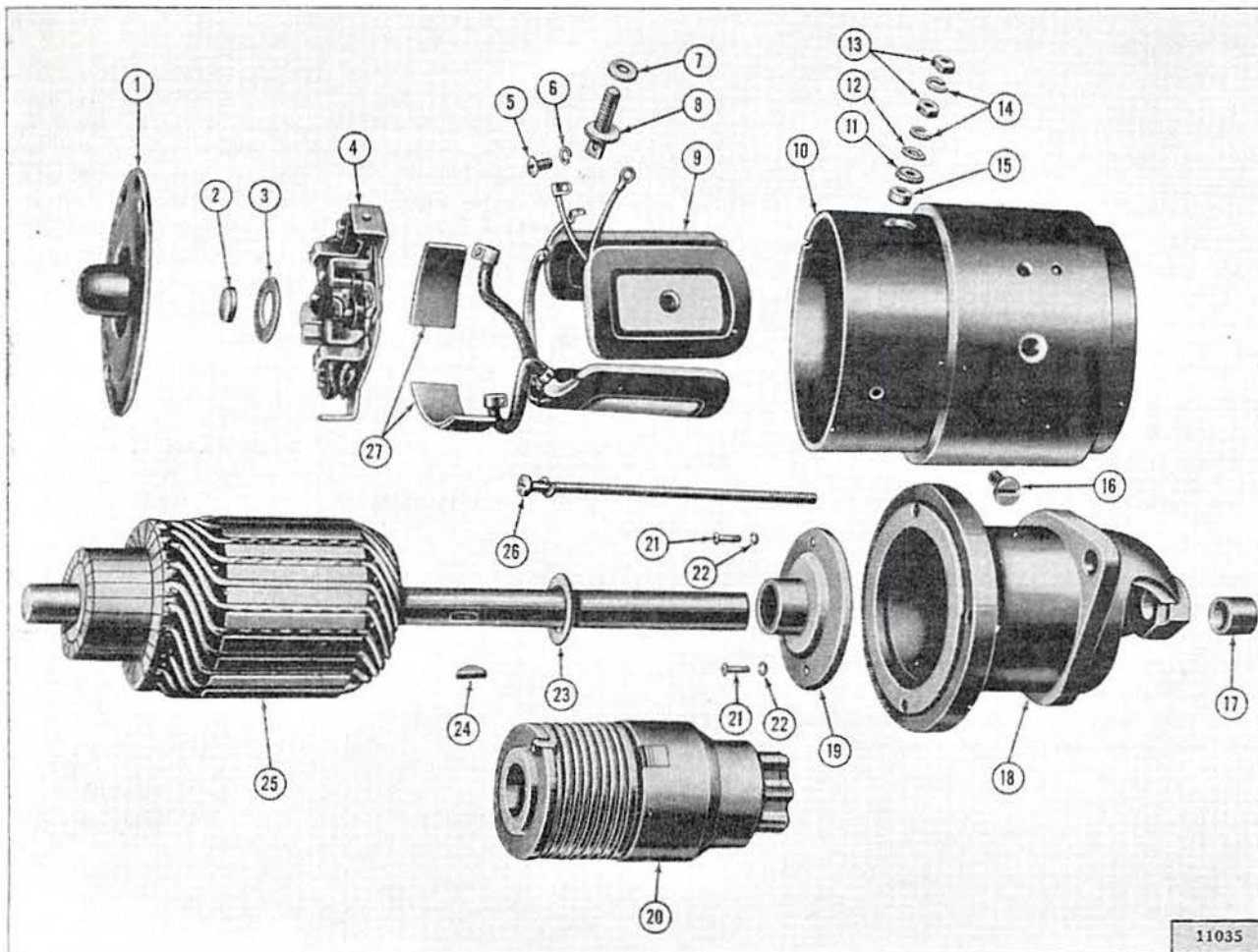


FIG. 157—TYPICAL STARTING MOTOR

1—End Plate
2—Plug
3—Thrust Washer
4—Brush Plate Assembly
5—Screw
6—Lock Washer
7—Insulating Washer
8—Terminal
9—Field Coil and Pole Shoe Set

10—Frame
11—Insulating Washer
12—Washer
13—Nut
14—Lock Washer
15—Insulating Bushing
16—Pole Shoe Screw
17—Sleeve Bearing
18—Drive End Frame

19—Intermediate Bearing
20—Bendix Drive
21—Screw
22—Lock Washer
23—Thrust Washer
24—Key
25—Armature
26—Thru Bolt
27—Insulator

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1-48. Deleted.

1-49. Overhaul Procedure

At periodic intervals the starting motor circuit should be thoroughly checked and the motor removed from the engine for cleaning and checking.

1-50. 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.

1-51. 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-52. Commutator

Check the commutator for wear and discoloration. If the commutator is rough or worn the armature should be removed and the commutator turned down in a lathe.

I-53. 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 armatures 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. 153 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-54. 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-55. 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-56. 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-50 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-57. Bench Test

The motor should first be checked to see that the

free running voltage and current are within specifications. To test, connect the 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. Using a spring scale and torque arm 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 motor for high resistance. The Bendix Drive should be checked for correct operation. The Bendix pinion should be checked to see that it shifts when the motor is operated under no load.

I-58. Bendix Starter Drive

• Model CJ-2A

The Bendix type flywheel drive Fig. 158, used on Model CJ-2A is designed so that as the starting motor is energized, centrifugal force sends the counterweighted gear into engagement with the teeth on the flywheel. When the engine starts and the speed of the engine exceeds the comparable speed of the starting motor, the drive pinion is forced out of engagement with the flywheel.

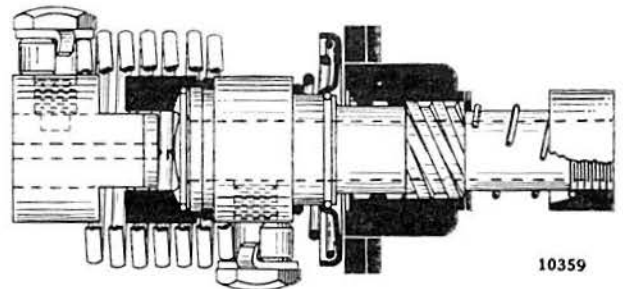


FIG. 158—STARTING MOTOR BENDIX DRIVE

The Bendix spring absorbs the shock of engagement. There are two types of Bendix drives and springs: right hand and left hand. The type used on these models is of the right hand type.

To determine a right or left hand Bendix drive, turn the drive pinion so the threads on the shaft will show. Hold the end of shaft toward you and note spiral of thread: right hand spiral, right hand drive, left hand spiral, left hand drive.

To determine a right or left hand spring, note the spiral of the coil: if to the right, it is a right hand spring — if to the left, it is a left hand spring.

If the Bendix drive spring shows signs of being distorted, a new spring should be installed.

Do not lubricate the Bendix drive sleeve. Wash it thoroughly with a suitable solvent and install it dry but be sure it is clean.

I-59. Overrunning Clutch Drive

• Early Model CJ-3A

Starting motors used on early Models CJ-3A are equipped with the overrunning clutch type drive, Fig. 159. In this drive the clutch and pinion slides on companion splines and the pinion is manually engaged, with the flywheel teeth, by the starting

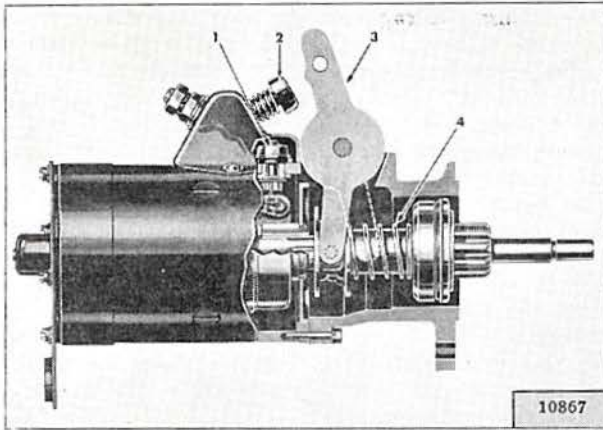


FIG. 159—STARTING MOTOR WITH CLUTCH DRIVE

- 1—Contact Plate Nut
- 2—Switch Button
- 3—Shift Yoke
- 4—Bendix Drive Spring

switch control arm before the electrical connection is made at the starting switch. Should the switch control arm fail to completely mesh the pinion, engagement is completed by the Bendix drive spring (Fig. 159) as soon as the armature starts to rotate. When the engine starts, the flywheel drives the pinion faster than the starting motor armature bringing the over-running clutch into action to disengage the pinion and prevent the engine from driving the armature at excessive speeds.

Should the overrunning clutch fail in service it will be necessary to install a new assembly.

Note that Model CJ-2A is equipped with Bendix type drive, early CJ-3A with overrunning clutch type, late CJ-3A, CJ-3B, DJ-3A, CJ-5 and CJ-6 with the Bendix "Folo-Thru" type. Each type drive requires a flywheel ring gear with a different number of teeth. When replacing a flywheel or ring gear be sure to count the teeth to assure installation of the correct parts.

I-60. Bendix Folo-Thru Drive

• Late CJ-3A, CJ-3B, CJ-5, CJ-6, DJ-3A

Models CJ-3A after vehicle serial No. 30973, CJ-3B, DJ-3A, CJ-5 and CJ-6 are equipped with the Bendix Folo-Thru type drive which is designed to overcome premature demeshing of the drive pinion from the flywheel ring gear until a predetermined engine speed is reached. See Fig. 160.

No repairs or adjustments are possible on this drive and a complete new unit must be installed if trouble develops.

I-61. 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.

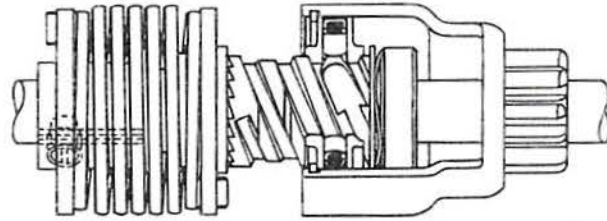


FIG. 160—BENDIX FOLO-THRU DRIVE

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-62. 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.

Should it be impossible to file the switch contact plates to obtain a clean full surface contact the switch should be replaced.

Models CJ-2A, late CJ-3A, early CJ-3B, early CJ-5 and early CJ-6 are equipped with a conventional foot type starting switch. The terminals are exposed and this type switch may be checked by shorting across the terminals. When this is done use care to make a good solid connection to prevent arcing.

The switch used on early Model CJ-3A is shown in Fig. 159.

The shift yoke meshes the starting motor pinion with the flywheel gear after which the electrical connection is made through switch button. The switch button is adjustable to vary distance the shift yoke travels before making contact with the button. It is possible to screw the button out far enough to prevent switch engagement through

movement of the shift yoke, however, the range of adjustment is not sufficiently great to cause incorrect engagement of the pinion with the flywheel gear.

The lower switch contact plate is attached to the starting motor housing with Nut. This nut must be kept tight to prevent excessive drop of voltage at the switch.

Later Model CJ-3B, CJ-5 and CJ-6, and all Model DJ-3A starting switches are of the solenoid type, mounted directly on the starting motors. This type switch is energized by turning the ignition key to the extreme right position. Should a solenoid switch fail in service it is necessary to install a new assembly.

I-63. Ignition Switch

The ignition switch serves both to energize the ignition system and engage the starter switch. With the key in the vertical position, the electrical system is OFF. Turning the key to the left energizes only the instruments and auxiliary equipment such as radio and heater. Turning the key to the right energizes the ignition system and auxiliary equipment. Turning the key "hard right" engages the starter switch. To remove the lock cylinder from the switch, first turn the key to the left (ignition-auxiliary) position. Then insert a short piece of wire or a paper clip into the lock release hole in the switch body. Pressing in on the wire will compress the lock cylinder retainer, allowing the cylinder to be removed. Either part, the lock cylinder or the switch unit, may be replaced as needed.

Two switches that are interchangeable have been used in production. Early switches were held in place by a bezel and tension spring. Later switches are held in place by a threaded bezel nut. Lock cylinders are not interchangeable between these two switches. Early lock cylinders were $1\frac{7}{32}$ " [31 mm.] long. Later lock cylinders are $1\frac{17}{32}$ " [39 mm.] long. Be sure to get the correct replacement when changing lock cylinders.

I-64. Fuel Gauge

- CJ-2A, CJ-3A, early CJ-3B.

The fuel gauge circuit is composed of the indicating unit, mounted on the instrument panel, and the fuel tank unit, connected by a single wire through the ignition switch.

Should the gauge fail to register, check all wire connections to be sure they are tight and clean; also be sure both units are well grounded. If, after this check, the gauge does not indicate properly, remove the wire from the tank unit and connect it to a new tank unit which must be grounded to the tank or frame for test. Turn the ignition switch "ON" and move the float arm through its range of travel, watching the dash unit to determine if it indicates correctly. If it fails to do so the trouble is probably in the dash unit and it should be replaced.

Should a new tank unit be unavailable for this test, disconnect tank unit wire at the instrument panel gauge. Connect one lead of a 6 V, 1 CP test light to the instrument panel unit terminal and with the ignition switch "ON" ground the other lead. If the unit is operating correctly the pointer will move approximately three-quarter across the dial.

Do not attempt to repair either unit; replacement is the only procedure.

I-65. Indicators and Gauges

- Late CJ-3B, CJ-5, CJ-6, DJ-3A

Two gauges (fuel and temperature) and two indicators (oil pressure and battery charge) that are located in the instrument cluster are electrically operated.

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 resistance-type sending unit mounted on the engine.

The battery charge indicator operates when there is a difference in potential between the generator and the battery. The battery charge indicator lights when the generator is not charging the battery. The indicator light goes out when the generator begins to charge the battery.

The oil pressure indicator is connected by a single wire to a diaphragm switch located on the engine. When engine oil pressure is low or zero and the ignition switch is on, the oil pressure indicator will light. When engine speed is increased slightly above idle speed, raising the oil pressure to approximately 6 psi. [0.2 kg-cm²], the diaphragm switch will open the circuit and the indicator light will go out.

A voltage regulator maintains a constant voltage to the gauges in normal operation. On early vehicles, this voltage regulator was mounted on the rear of the instrument cluster. On current vehicles, the voltage regulator is integral with the fuel gauge.

Should trouble develop in the gauges, first check the regulator (fuel gauge on current production vehicle). 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 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 two gauges register incorrectly, check the lead wire from the gauge to the sending unit for shorts or open connections. Next disconnect the gauge from the sending unit, and

connect the gauge to a new fuel tank sending unit which has been grounded to the vehicle. If the gauge registers incorrectly when operating the new unit, replace the gauge; if correctly, replace the sending unit.

Should a new fuel tank unit not be available for testing, use a 6- or 12-volt test light in its place. When the gauge is operating correctly, the pointer will move approximately three-quarters across the dial.

On some vehicles, the temperature gauge may register on or close to the H (hot) mark when coolant temperature is 190°F. to 200°F. [88°C. a 93°C.]. In such cases, a 25-ohm, 1-watt resistor may be installed on the temperature gauge which will place the pointer just beyond the center mark at a coolant temperature of 190°F. to 200°F. Install the resistor between the two terminals on the back of the gauge. Insulate the exposed leads of the resistor with electrical tape.

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 defects are corrected, the indicator light does not go on and off properly, then the diaphragm type switch in the cylinder block should be replaced.

I-66. LIGHTING SYSTEM

The wiring of the lighting systems is shown in the wiring diagrams, which indicate the various units in relation to their positions in the vehicle. The wires in the various circuits are of different colors or are marked by tracers to aid 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-67. Main Light Switch — Early CJ-2A

The first type Model CJ-2A switch, used in production through serial No. 10252 is shown in Fig. 161. To remove the switch from the instrument panel it is first necessary to remove the switch control button and shaft. The shaft is retained in the switch housing by a snap ring. To remove the shaft compress the snap spring by pressing against it with a sharp tool through hole in housing.

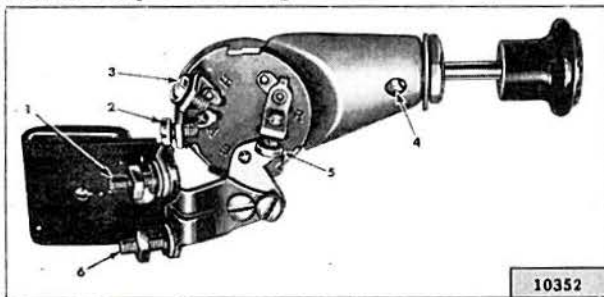


FIG. 161—MAIN LIGHT SWITCH—
EARLY MODEL CJ-2A

- 1—To Ammeter
- 2—To Parking Lights
- 3—To Headlamps through Dimmer Switch
- 4—Control Handle Retaining Snap Ring
- 5—To Rear Lights
- 6—To Dash and Stoplight Switches also Heater or other Accessories

Refer to wiring diagram and to the switch illustration when making installation.

I-68. Main Light Switch

• Late CJ-2A, CJ-3A, CJ-3B, CJ-5, CJ-6, DJ-3A

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. 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.

The light switch shown in Fig. 162 was superseded by the one shown in Fig. 163 for models CJ-3B, DJ-3A, CJ-5, CJ-6.

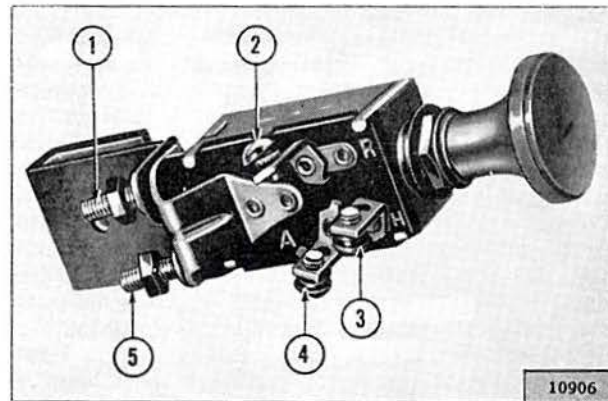


FIG. 162—MAIN LIGHT SWITCH
Late CJ-2A, All CJ-3A,
Early CJ-3B, DJ-3A, CJ-5, CJ-6

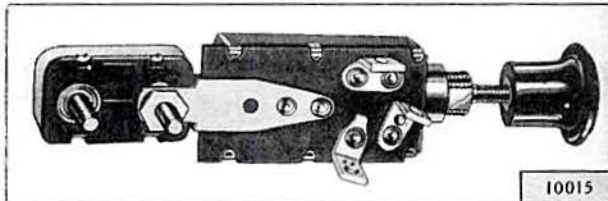


FIG. 163—MAIN LIGHT SWITCH
Late CJ-3B, DJ-3A, CJ-5, CJ-6

I-69. Stop Light Switch

The stop light switch is of the diaphragm type and is located in the front end of the master brake cylinder. Should the switch become inoperative, it is necessary to install a new one. Fig. 164 shows the wiring of the stop light circuit.

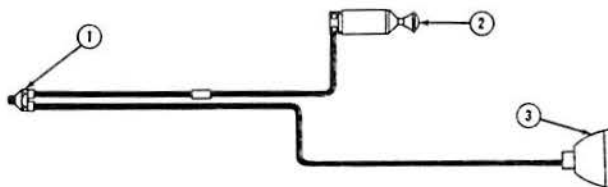


FIG. 164—STOP LIGHT CIRCUIT 10610

- 1—Stop Light Switch
- 2—Light Switch
- 3—Tail Light

I-70. PRIMARY CIRCUIT

Before testing the primary circuit, make certain that the battery is satisfactory or install a fully charged battery for the primary circuit tests. Also, check the starter motor for excessive voltage drop and check the starter motor itself for excessive draw.

a. Measure the voltage at the coil primary terminals while cranking the engine with the starter motor. If the voltage is less than $4\frac{1}{2}$ volts with 6-volt system or 9 volts with 12-volt system the trouble will be found in the primary circuit. If there is no voltage at all, check for a break in the primary circuit, possibly in the coil primary winding.

b. To check the primary circuit, turn the ignition on, turn the engine until the points are closed, and then measure the voltage drop across each portion of the circuit with a voltmeter.

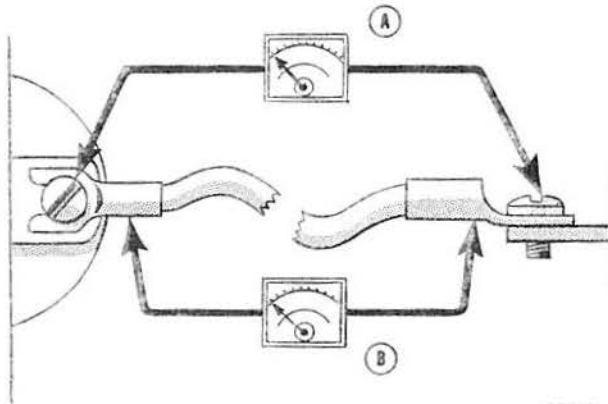


FIG.165 —VOLTAGE DROP TEST

A—RIGHT WAY—Voltmeter indicating drop across wire and connections.

B—WRONG WAY—Voltmeter indicating drop across wire only. Does not show bad connections.

Note: Most voltage drops will be found at the connections of wires to terminals as dirt, oxidation, etc. can cause excessive resistance at these points. Measure voltage drops in wires as shown in Fig. 165 to take this into account.

c. Connect the voltmeter from the battery cable terminal on the starter solenoid to the battery terminal of the coil primary. If the voltmeter reads more than 0.2 volt, perform the checks given in steps d, e, and f following.

d. Connect the voltmeter from the solenoid terminal to the battery terminal of the ignition switch. If the voltmeter reads more than .05 volt, check and clean the connections at solenoid, light switch, and ignition switch.

e. If the voltmeter reading in step d is less than .05 volt, connect the voltmeter from the battery terminal to the ignition terminal on the ignition switch. If the voltage drop is more than 0.1 volt, repair or replace the ignition switch.

f. If the voltage drop in step e is not more than 0.1 volt, connect the voltmeter from the ignition terminal of the ignition switch to the battery termi-

nal of the coil primary. If the voltmeter reads more than .05 volt, clean and tighten the connections and check again. If the voltmeter again reads more than .05 volt, replace the wire.

g. Connect the voltmeter from the distributor primary terminal on the coil to the coil terminal on the distributor. Voltage drop should not exceed .05 volt. Clean and tighten connections if necessary.

h. Connect the voltmeter from the coil terminal on the distributor to a clean, paint-free spot on the distributor body. The reading should not exceed .05 volt. 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 is clean and tight.

i. Open the points and check the voltmeter. It should read close to peak voltage. Low voltage indicates that a circuit through the distributor (a short) exists while the points are open.

j. Disconnect the condenser lead and open the points. A jump to full voltage indicates a short in the condenser. Replace the condenser. If there is no jump to full voltage, overhaul or replace the distributor.

k. 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 voltmeter. If the voltmeter registers a voltage drop, perform the checks in steps l and m following.

l. Check for voltage drop in the battery ground cable. Clean the battery post, cable terminals, and contact surface on the bellhousing, or on body if a noticeable deflection of the voltmeter occurs.

m. Check for any voltage drop between the distributor body and a clean, paint-free spot on the cylinder block. If there is any voltage drop, remove the distributor and clean the mounting surfaces of distributor body and cylinder block.

I-71. SECONDARY CIRCUIT

If satisfactory ignition is not obtainable 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. Test the coil. Bring the coil up to operating temperature using the coil heat feature of a coil tester, if available. Refer to the coil tester manufacturer's instructions for specific hook-ups for performing the checks given in steps b, c, and d following.

b. 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. Measure the resistance of the secondary winding. If the resistance is more than 20,000 ohms, a fault in the secondary winding is indicated.

c. Check for a grounded secondary by touching the tester ground lead to the coil cover. If resistance

is not over 100,000 ohms, the secondary is grounded to the cover.

d. If the secondary winding is satisfactory, measure the primary current draw in accordance with the instructions of the test equipment manufacturer.

e. Check the secondary circuit for leakage. With the coil primary in the circuit with the breaker unit of the tester, connect a long, high-tension test lead to the coil tower. Check the secondary circuit for leakage by performing the checks given in steps f, g, h, and i following.

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.

f. Check 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 the cap one at a

time and test each plug contact with the high-voltage lead and 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.

g. Check 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.

h. Check 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.

i. Check the 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.

FIG. 166—PARKING LIGHT

- 1—Bezel
- 2—Lens
- 3—Bulb
- 4—Gasket
- 5—Housing and Cable
- 6—Screw

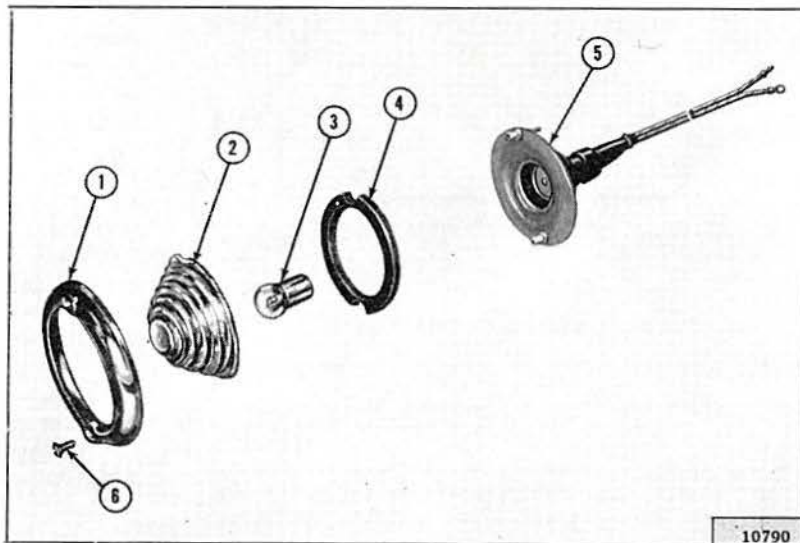


FIG. 167—TAIL AND STOP LIGHT

- 1—Ring
- 2—Lens
- 3—Gasket
- 4—Retainer
- 5—Bulb
- 6—Gasket
- 7—Housing and Socket



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I-72. Head Lamps

Each sealed beam head lamp can only be replaced as a complete unit. Either 5000-series (early production) or the newer 6000-series sealed beam units may be used. However, both head lamps on a vehicle should be of the same series as the method of aiming each series is different. If the two lamps cannot be matched as to series, aim each lamp according to the instructions for aiming that series given below.

Note: 6000-series lamps have a figure "2" molded into the glass at the top of the lens, whereas 5000-series lamps do not have any figure. Series refers to the lamp trade numbers; for example, trade number 5400S is a 5000-series lamp.

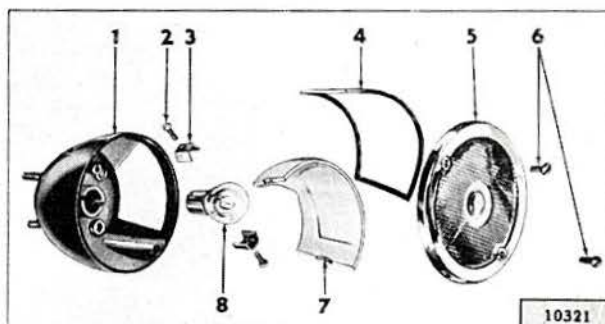


FIG. 168—TAIL AND STOP LIGHT—DJ-3A

- 1—Housing (left side)
- 2—Retainer Screw
- 3—Lens Retainer
- 4—Gasket
- 5—Bezel
- 6—Screw
- 7—License Lens
- 8—Bulb

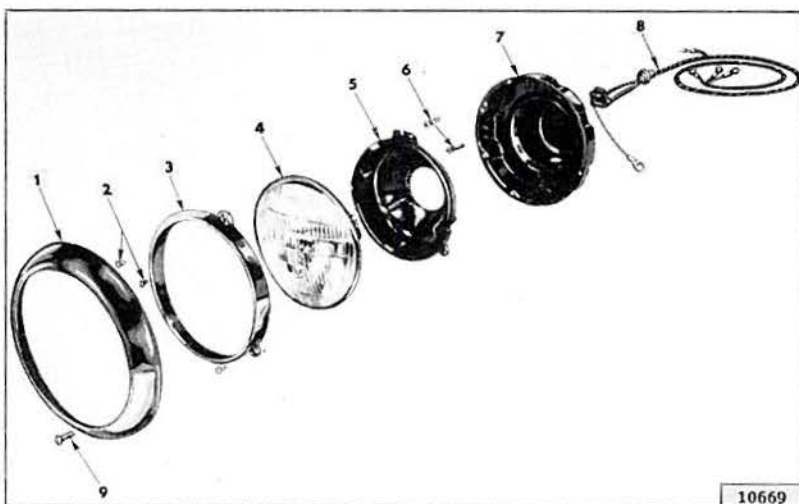


FIG. 169—HEAD LAMP

- 1—Door
- 2—Retaining Screw
- 3—Retaining Ring
- 4—Sealed Beam Unit
- 5—Mounting Ring
- 6—Adjusting Screw
- 7—Housing
- 8—Wires
- 9—Door Screw

I-73. Head Lamp Aiming

All 5000-series lamps must be aimed on the high beam. All 6000-series lamps must be aimed on the low beam. Lamps may be aimed either with mechanical aimers or by using a screen. If mechanical aimers are used, follow instructions supplied with the aiming equipment. If a screen is to be used, preparation for aiming is as follows:

- a. Locate the vehicle in a darkened area with a level floor area and with a screen (may be a wall) having a nonreflecting white surface. A reference line should be marked on the floor 25 feet [7,62 m.] away from and parallel to the screen. Position the vehicle perpendicular to the screen and with the front head lamps directly over the reference line.
- b. Locate the middle tape on the screen so that it is aligned with the center line of the vehicle.
- c. Equalize all tire pressures.
- d. Rock the vehicle from side to side to equalize springs and shock absorbers.
- e. Measure the distance between vehicle head lamp centers. Then, position marker tapes vertically on the screen to the right and left of the middle tape at half this distance.
- f. Measure the distance from the center of each lamp to the surface on which the vehicle rests.

Position a marker tape horizontally on the screen to cross the vertical tapes (at the measured height for 6000-series lamps; 2" [50,8 mm.] lower than this height for 5000-series lamps) of each lamp center respectively.

- g. Remove the head lamp doors.
- h. Clean the head lamps.

I-74. Aiming 5000-series Head Lamps

- a. Turn the headlights on high beam. Cover the lamp not being aimed. Be sure to use the horizontal reference line on the screen that is 2" lower than the vehicle lamp height.
- b. Turn the vertical aiming screw, located at the top of the lamp housing, counterclockwise until the lamp beam is considerably lower than the horizontal reference line on the screen. Then, turn the same screw clockwise until the center of high intensity coincides with the reference line. See Fig. 170.

Note: Always bring the beam into final position by turning both aiming screws clockwise so that the unit is held under proper tension when the operation is complete.

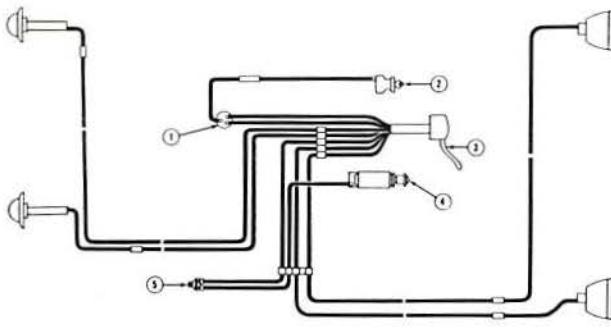
placing the wire be sure to use a non-corrosive soldering flux when soldering the wire to the contact sleeve.

Early production vehicles do not have a horn button cap retainer. The retainer may be installed in the field. To install, coat the outside of the horn button cap and the inside of the retainer with liquid soap, and push the retainer into place over the cap. The flanged end of the retainer should be placed down. For current production horn button, see Fig. 172.

I-77. Directional Signals

Fig. 173 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



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FIG. 173—DIRECTIONAL SIGNAL CIRCUIT

- | | |
|-------------------|---------------------|
| 1—Flasher | 4—Light Switch |
| 2—Ignition Switch | 5—Stop Light Switch |
| 3—Control | |

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.

I-78. Major Electrical Component Replacement

• Auto-Lite and Delco-Remy Components

With the exception of the generator and voltage regulator, Auto-Lite and Delco-Remy electrical components may be intermixed on a particular vehicle as an approved production practice. No attempt should be made to convert to a complete Auto-Lite or Delco-Remy system. Auto-Lite components should be replaced by Auto-Lite components and Delco-Remy components should be replaced by Delco-Remy components insofar as availability of replacement components will allow.

In those cases, however, where a component is being replaced with one produced by the other manufacturer, the following points should be noted.

a. Generator—If an Auto-Lite generator is being installed in place of a Delco-Remy generator, in addition to replacing the voltage regulator (see caution below) a different support bracket will have to be installed. It is not practical to change from an Auto-Lite to a Delco-Remy generator as a different engine front plate is required.

CAUTION: Do not intermix an Auto-Lite and a Delco-Remy generator and voltage regulator. Generator and voltage regulator must be either both Auto-Lite components or both Delco-Remy components.

b. Voltage Regulator—When an Auto-Lite voltage regulator is installed as a replacement for a Delco-Remy regulator, in addition to replacing the generator (see caution below) the adapter plate used with the Delco-Remy installation is discarded. As the terminals (BAT, FLD, etc.) are in a different location on Auto-Lite regulator as opposed to the Delco-Remy regulator, identify the wires as they are removed so they may be reinstalled on the proper terminals of the new regulator. See Fig. 154 and 155.

CAUTION: Do not intermix an Auto-Lite and a Delco-Remy generator and voltage regulator. Generator and voltage regulator must be either both Auto-Lite components or both Delco-Remy components.

c. Distributor—No special instructions are required for interchanging Auto-Lite and Delco-Remy distributors on these models.

d. Starting Motor—No special instructions are required for interchanging Auto-Lite and Delco-Remy starting motors.

I-79. SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Battery Discharged:	
Shorted Cell in Battery.....	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
Insufficient Driving.....	Recharge Battery
Low Regulator Setting.....	Correct Setting
Stuck Cut-out in Regulator.....	Correct
Low Electrolyte Level in Cells.....	Add Distilled Water
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
Slipping Generator Belt.....	Adjust Belt
Worn Out Brushes.....	Install New Brushes
Weak Brush Spring Tension.....	Replace
Out of Round Commutator.....	Repair
Fails To Charge—	
Open Charging Circuit.....	Correct
Sticking Brushes.....	Repair or Replace
Dirty or Burned Commutator.....	Clean Commutator
Grounded Commutator.....	Replace
Open Circuit in Field.....	Replace
Weak Soldering on Armature.....	Repair
Grounded Wiring.....	Repair
Defective Regulator.....	Replace Regulator
Too High Charging Rate—	
Regulator Improperly Adjusted.....	Adjust or Replace
Short in Armature.....	Replace
Grounded Field-to-regulator Wire.....	Correct
Shorted Cell in Battery.....	Replace Battery
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
Worn Out Brushes.....	Install New Brushes
Weak Brush Spring Tension.....	Replace
Worn Bearings.....	Replace
Burned Starter Switch Contacts.....	Replace Switch
Will Not Turn Engine—	
Open Circuit at Starter.....	Correct
Solenoid Open or Stuck.....	Replace Solenoid
Starter Switch Defective.....	Replace Switch
Starter Drive Broken or Stuck.....	Repair or Replace
Battery Discharged.....	Recharge Battery

I-79. SERVICE DIAGNOSIS—Continued

SYMPTOMS	PROBABLE REMEDY
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:	
Broken or Loose Electrical Connection.....	Check Wiring and Connections at Horn Button and Battery—Clean and Tighten
Battery Low or Dead.....	Check Battery
Contact Points Burned or Broken Off.....	Replace Parts Necessary
Horn Sounds Unsatisfactory Tone:	
Poor Electrical Connection.....	Check Connections at Horn, Horn Button, Battery
Battery Low.....	Check with Hydrometer
Loose Cover and Bracket Screws.....	Tighten Bracket Bolts at Horn
Voltage at Horn too High or too Low.....	Check with Voltmeter

I-80. ELECTRICAL SYSTEM SPECIFICATIONS

	6-volt	12-volt
BATTERY:		
Make	Auto-Lite	Auto-Lite
Model	1M-100	11-HS
Plates per Cell	15	9
Ampere-hour Rating	100	50
Terminal Ground	Negative	Negative
Specific Gravity:		
Fully Charged	1.260	1.260
Recharge at	1.225	1.225
Height	8 ⁵ / ₈ " [219 mm.]	9 ⁷ / ₃₂ " [234 mm.]
Length	8 ²³ / ₃₂ " [221 mm.]	10 ¹⁵ / ₆₄ " [266 mm.]
Width	7" [178 mm.]	6 ²⁵ / ₃₂ " [172 mm.]
BATTERY LOCATION	Under hood-right side	Under hood-right side
GENERATOR:		
Make	Auto-Lite	Auto-Lite
Model:		
CJ-2A, CJ-3A	GDZ 4817	
CJ-3A late	GDZ 6001	
CJ-3B, CJ-5, CJ-6, DJ-3A	{GGW 4801 {GGW 7404	{GJC 7002 {GJP 7202 {GJP 7402A
Ground Polarity	Negative	Negative
Controlled Output:		
30 amp.		GJC 7002
35 amp.	{GDZ 4817 {GDZ 6001	{GJP 7202 {GJP 7402A
45 amp.	{GGW 4801 {GGW 7404	
Rotation—Drive End	Clockwise	Clockwise
Ratio—Generator to Crankshaft Revolutions	1.5:1	1.5:1
Cut-in Engine rpm	883	883
Control	CV Regulator	CV Regulator
Armature End Play .....	.003" to .010" [0,076 a 0,25 mm.]	.003" to .010" [0,076 a 0,25 mm.]
Brushes	2	2
Brush Spring Tension:		
35 to 53 oz. [990 a 1500 gr.]	{GDZ 4817 {GDZ 6001 {GGW 4801	{GJC 7002 {GJP 7202 {GJP 7402A
18 to 36 oz. [510 a 1020 gr.]	GGW 7404A	Ball Bronze
Bearing—Drive End	Ball	
Bearing—Commutator End	Bronze	
GENERATOR:		
Make	Delco-Remy	Delco-Remy
Model	1102811	1102096
Type	Shunt (Ventilated)	Shunt (Ventilated)
Rotation—Drive End	Clockwise	Clockwise
Armature End Play .....	.005" [0,13 mm.]	.005" [0,13 mm.]
Brushes	2	2
Brush Spring Tension	28 oz. [974 gr.]	28 oz. [974 gr.]
Bearing—Drive End	Ball	Ball
Bearing—Commutator End	Bronze	Bronze
REGULATOR:		
Make	Auto-Lite	Auto-Lite
Model:		
For GDZ 4817, GDZ 6001	{VRP-6003 {VRP-4007 {VBO-4601	
For GGW 4801, GGW 7004A	VBO-4601C	
For GJC 7002		VRX-6009
For GJP 7202, GJP 7402A		VBO-4201E-4A
Type	Vibrator	Vibrator
Cutout Relay:		
Closing Voltage @ Generator rpm	6.3 to 6.8 @ 1000	12.6 to 13.6 @ 1325
Reverse Current to Open	4 to 6 amp.	3 to 5 amp.
Regulated Voltage	7.1 to 7.3	14.3 to 14.7
Regulated Current	49 amp. max.	39 amp. max.

I-80. ELECTRICAL SYSTEM SPECIFICATIONS—(Continued)

	6 Volt	12 Volt
REGULATOR:		
Make.....	Delco-Remy	Delco-Remy
Model.....	1972063	1972029
Type.....	Vibrator	Vibrator
Cutout Relay Closing Voltage.....	5.9 to 6.7	11.8 to 13.5
Regulated Voltage.....	6.9 to 7.4	13.8 to 14.8
Regulated Current.....	42 to 47	27 to 33
STARTING MOTOR:		
Make.....	Auto-Lite	Auto-Lite
Model:		
CJ-2A.....	MZ-4113	
CJ-3A.....	MZ-4137	
CJ-3B early.....	MZ-4162	
CJ-3B, CJ-5, CJ-6, DJ-3A (late).....	{MCH-6207 MCH-6203	{MDM-6005 MDU-7004
CJ-3B, CJ-5, CJ-6, DJ-3A (current).....	MCH-6215	MDU-7004
Rotation—Drive End.....	Clockwise	Clockwise
Engine Cranking Speed.....	185 rpm. @ room temperature	200 rpm. @ room temperature
Armature End Play.....	.005" to .030" [0,127 a 0,762 mm.]	.005" min. [0,127 min.]
Brushes.....	4	4
Brush Spring Tension.....	42 to 53 oz. [1,2 a 1,5 kg.]	31 to 47 oz. [0,9 a 1,3 kg.]
Bearings.....	3 Bronze	3 Bronze
Lock Test:		
Temperature.....	70°F. [21°C.]	70°F. [21°C.]
Amps (max.):	335	
MDM-6005.....		170
MDU-7004.....		280
Volts.....	2.0	4.0
Stall Torque: (min.).....	6.0 lb-ft. [85 kg-m.]	
MDM-6005.....		1.5 lb-ft. [21 kg-m.]
MDU-7004.....		6.2 lb-ft. [88 kg-m.]
No Load Test:		
Temperature.....	70°F. [21°C.]	70°F. [21°C.]
Amps (max.).....	65	50
Volts.....	5	10
RPM (min.):	4300	
MDM-6005.....		4400
MDU-7004.....		5300
Control Switch.....	Solenoid	Solenoid
Drive:		
Type.....	Bendix Folo-Thru	Bendix Folo-Thru
Pinion Meshes.....	Front	Front
No. of Teeth—Pinion.....	9	9
No. of Teeth—Flywheel.....	129	129
Flywheel Tooth Face Width.....	.375" [9,5 mm.]	.375" [9,5 mm.]
STARTING MOTOR:		
Make.....	Delco-Remy	Delco-Remy
Model.....	1108077	1107746
Rotation—Drive End.....	Clockwise	Clockwise
Engine Cranking Speed.....	185 rpm.	185 rpm.
Armature End Play.....	.005" to .050" [0,127 a 1,270 mm.]	.005" to .050" [0,127 a 1,270 mm.]
Brushes.....	4	4
Brush Spring Tension (min.).....	24 oz. [680 gr.]	35 oz. [992 gr.]
Bearings.....	3 Bronze	3 Bronze
Lock Test:		
Temperature.....	70°F. [21°C.]	70°F. [21°C.]
Amps.....	600	435
Volts.....	3.0	5.8
Torque.....	15 lb-ft.	10.5 lb-ft.
No Load Test:		
Amps.....	60	75
Volts.....	5.0	10.3
RPM (min.).....	6000	6900
Control Switch.....	Solenoid	Solenoid
COIL:		
Make.....	Auto-Lite	Auto-Lite
Model:		
CJ-2A early.....	CR-3033XE	CAF-4003
All Other Models.....	CR-6009 CAL-4001 CAL-4001-A 200576 200577 200488	CAG-4002 200562 200574 200564

I-80. ELECTRICAL SYSTEM SPECIFICATIONS—(Continued)

	6 Volt	12 Volt
COIL:—Continued		
Amperes:		
Engine Stopped.....	5 @ 6.3V	2. to 82.9 @ 12.5V
Engine Idling.....	2.5	2.8 to 2.9
DISTRIBUTOR:		
Make.....	Auto-Lite	Auto-Lite
Model:		
CJ-2A.....	IGW-4177-1	
CJ-2A, CJ-3A, CJ-3B.....	IAD-4008	
CJ-3A.....	IAD-4008-T	
CJ-3B.....	IAD-4008-A	
CJ-3B, CJ-5.....	IAD-4008-AT	
CJ-3B, CJ-5, CJ-6.....	IAD-4041	
CJ-3B, CJ-5, CJ-6, DJ-3A.....	IAY-4012	IAY-4012
CJ-3B, CJ-5, CJ-6, DJ-3A.....	IAY-4401	IAY-4401
Type Advance.....	Centrifugal	Centrifugal
Firing Order.....	1-3-4-2	1-3-4-2
Breaker Point Gap.....	.020" [0,508 mm.]	.020" [0,508 mm.]
Breaker Arm Tension.....	17 to 20 oz. [482 a 567 gr.]	17 to 20 oz. [482 a 567 gr.]
Cam Angle.....	42°	42°
Max. Auto. Advance.....	11° @ 1700 rpm.	11° @ 1700 rpm.
Max. Vacuum Advance.....	None	None
Condenser Capacity.....	.25 to .7° mfd.	.25 to .28 mfd.
DISTRIBUTOR:		
Make.....	Delco-Remy	Delco-Remy
Model.....	1112432	1112432
Spark Advance—Centrifugal:		
Start.....	0° @ 425 rpm.	0° @ 425 rpm.
Maximum.....	10° to 12° @ 1950 rpm.	10° to 12° @ 1950 rpm.
Breaker Gap.....	.022" [0,56 mm.]	.022" [0,56 mm.]
Cam Angle.....	25° to 34°	25° to 34°
Breaker Arm Tension.....	19 to 23 oz.	19 to 23 oz.
Condenser Capacity.....	.2 mfd.	.2 mfd.
TIMING:		
Crankshaft.....	5° BTC @ Idle	5° BTC @ Idle
Mark Location:		
CJ-2A, CJ-3A.....		
CJ-3B, CJ-5, CJ-6, DJ-3A.....	Crankshaft Pulley	Crankshaft Pulley
Firing Order.....	1-3-4-2	1-3-4-2
SPARK PLUGS:		
Make and Model.....	Champion J8	Champion J8
Thread.....	14 mm.	14 mm.
Thread Reach.....	3/8" [9,47 mm.]	3/8" [9,47 mm.]
Gap.....	.030" [0,762 mm.]	.030" [0,762 mm.]
LAMP BULB TRADE NUMBERS:		
Headlights.....	5040-S or 6006	5400-S or 6012
Parking Lights.....	63	67
Park and Directional Signal.....	1158	1176
Stop, Tail, and Directional Signal.....	1158	1034
Indicator Lamps:		
Headlight Beam.....	51	53
Directional Signal.....	51	53
Charge.....	51	53
Oil Pressure.....	51	53
Instrument Lamp.....	55	57
Flasher, Directional Signal.....	P229D	524
Fuse Data:		
Directional Signal.....	SFE 14	SFE 9
Heater.....	SFE 14	SFE 9

CLUTCH

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Adjustment.....	J-6	Heavy-Duty Clutch.....	J-2
Clutch Lever Hole Cover.....	J-5	Installation.....	J-8
Clutch Pedal Adjustment.....	J-3	Pilot Bushing Inspection.....	J-7
Clutch Removal.....	J-4	Service Diagnosis.....	J-11
Clutch Adjusting Fixture Data.....	J-13	Trouble Shooting.....	J-9
Clutch Specifications.....	J-12		

J-1. GENERAL

Model CJ-2A and DJ-3A are equipped with the Auburn clutch. Models CJ-3A, CJ-3B, CJ-5 and CJ-6 are equipped with either the Auburn or the Rockford clutch. Both of these clutches are of the single plate dry disc type and both have an 8½" [21,59 cm.] driven plate. The driven plates are built with spring center vibration neutralizers and have two flexible facings which provide smooth engagement of the engine power. Both clutches have approximately the same torque capacity and total

plate pressure and use the same driven plate and release bearing. The Auburn clutch, however, has three pressure springs while the Rockford clutch has six pressure springs. Clutch control is through a cable near the left side of the frame connecting the clutch pedal fulcrum to the cross shaft.

J-2. Heavy-Duty Clutch

An 8½" [216 mm.] diameter clutch is standard equipment on all vehicles covered by this manual. A heavy-duty 9¼" [235 mm.] diameter clutch is

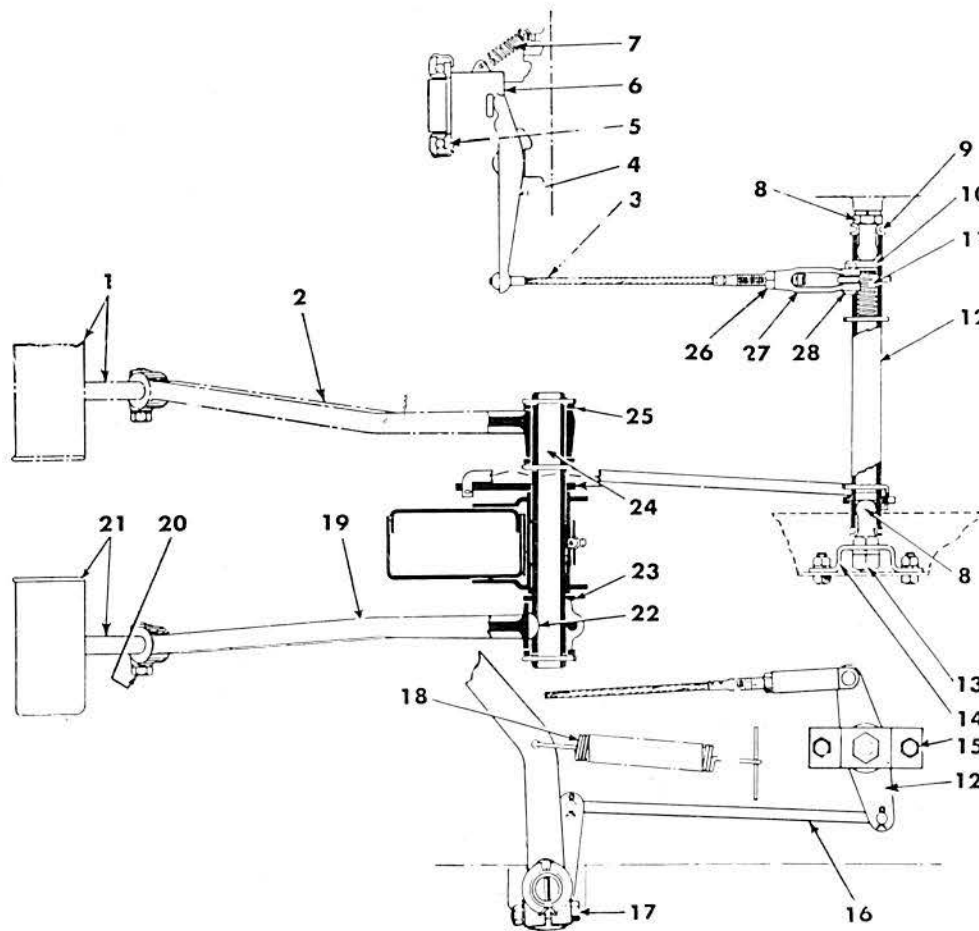


FIG. 174—CLUTCH CONTROL—MODELS CJ-2A, CJ-3A AND DJ-3A

- | | | | |
|---------------------------|---------------------------|----------------------------|----------------------------------|
| 1—Brake Pedal Pad | 8—Ball Stud | 15—Bracket to Frame Bolt | 22—Pedal to Shaft Key |
| 2—Brake Pedal | 9—Dust Seal | 16—Pedal Rod | 23—Pedal Shaft Washer |
| 3—Control Cable | 10—Control Tube Retainer | 17—Pedal Clamp Bolt | 24—Pedal Shaft |
| 4—Control Lever | 11—Control Tube Spring | 18—Pedal Retracting Spring | 25—Brake Master Cylinder Tee Bar |
| 5—Release Bearing | 12—Control Tube and Lever | 19—Clutch Pedal | 26—Adjusting Yoke Lock Nut |
| 6—Release Bearing Carrier | 13—Ball Stud Nut | 20—Pedal Pad Clamp Bolt | 27—Adjusting Yoke |
| 7—Bearing Carrier Spring | 14—Frame Bracket | 21—Clutch Pedal Pad | 28—Adjusting Yoke Clevis Pin |

available for installation on these vehicles when desired.

J-3. 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.

Note: Some older 'Jeep' vehicles may develop side movement of the clutch and brake pedals resulting from wear of the pedals, shafts, and bushings. One way to compensate for this wear is to install a pedal slack adjuster kit.

Clutch control used on Models CJ-2A, and CJ-3A is shown in Fig. 174.

The free pedal clearance is adjusted by lengthening or shortening the clutch control lever cable. Correct clearance is $1\frac{1}{2}$ " [38,1 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 $\frac{1}{16}$ " [1,58 mm.] between the clutch release bearings and the clutch fingers.

To make this adjustment, loosen clutch control lever cable adjusting yoke locknut Fig. 177. With a wrench unscrew the cable, then tighten the locknut.

Clutch control used on Models CJ-3B, CJ-5, CJ-6, and DJ-3A is shown in Fig. 177. The free pedal clearance is adjusted by lengthening or shortening the clutch control cable. Correct clearance is 1" [25,4 mm.].

To make this adjustment, loosen lock nut, and unscrew cable to proper adjustment then tighten locknut. Free pedal travel is measured at the clutch pedal pad.

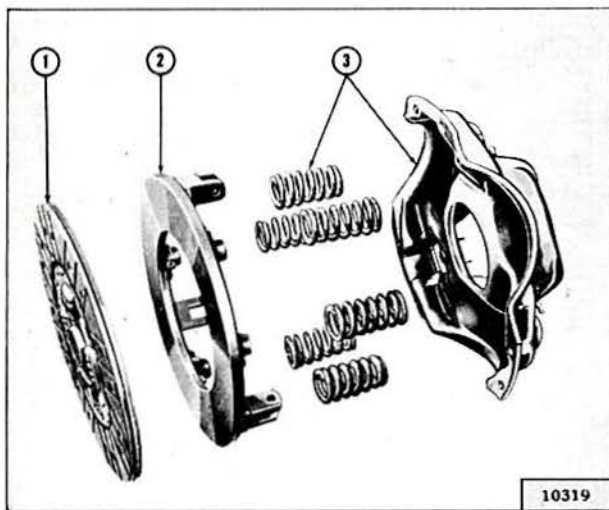


FIG. 175—ROCKFORD CLUTCH—CJ-3B, CJ-5, CJ-6

- 1—Driven Plate and Hub
- 2—Pressure Plate
- 3—Backing Plate and Pressure Spring

J-4. Clutch Removal

When it is necessary to remove the clutch, follow the procedure outlined in section K for the removal of the transmission or transmission and transfer case from the vehicle. Then remove the flywheel housing from the engine. Procedure for clutch removal.

a. Mark the clutch pressure plate and engine flywheel so that the clutch assembly may be installed in the same position after adjustments are completed.

b. Remove four clutch attaching bolts leaving two opposed bolts to be removed last.

c. Remove the remaining bolts equally, a little at a time, to prevent distortion of the clutch pressure plate and to relieve the clutch springs evenly.

d. Remove clutch assembly from flywheel.

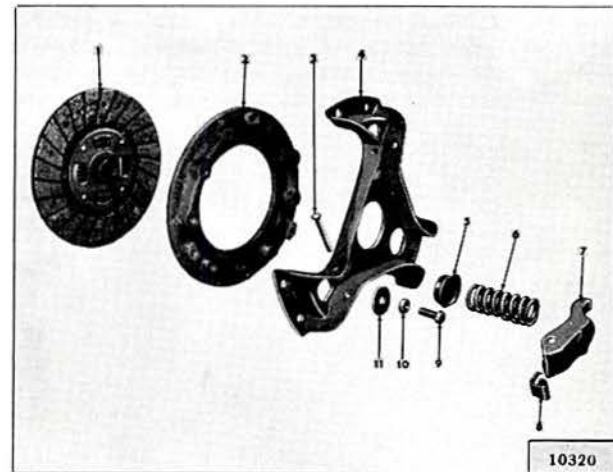


FIG. 176—CLUTCH—DJ-3A

- 1—Driven Plate and Hub
- 2—Pressure Plate
- 3—Pivot Pin
- 4—Bracket
- 5—Spring Cup
- 6—Pressure Spring
- 7—Release Lever
- 8—Return Spring
- 9—Adjusting Screw
- 10—Jam Nut
- 11—Washer

J-5. Clutch Lever Hole Cover

• Model DJ-3A

A clutch control lever hole cover was installed on Model DJ-3A effective with Serial No. 56337-11645 to prevent the entry of dust and dirt into the bell housing and clutch. The cover is attached where the clutch control lever enters the left side of the bell housing. It is recommended that this cover be installed on DJ-3A vehicles that do not have it.

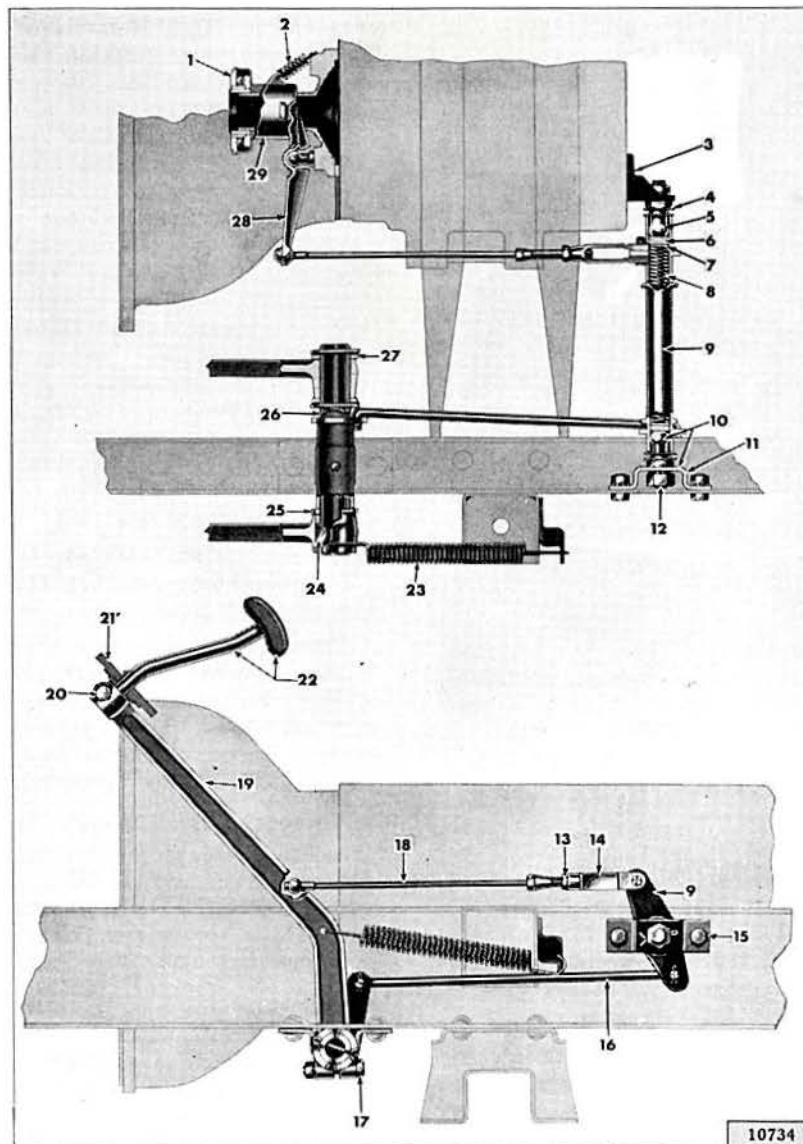


FIG. 177—CLUTCH CONTROL
CJ-3B, CJ-5, CJ-6, AND DJ-3A

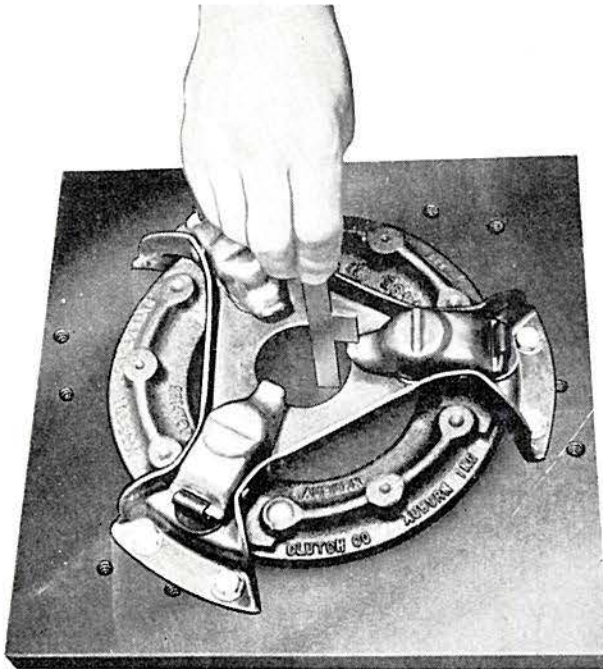
- | | | |
|--------------------------|-------------------------|----------------------------|
| 1—Clutch Release Bearing | 11—Frame Bracket | 21—Draft Pad |
| 2—Carrier Spring | 12—Ball Stud Nut | 22—Pedal Pad and Shank |
| 3—Ball Stud | 13—Yoke Lock Nut | 23—Retracting Spring |
| 4—Dust Seal | 14—Adjusting Yoke | 24—Pedal to Shaft Key |
| 5—Pad | 15—Bolt | 25—Washer |
| 6—Retainer | 16—Pedal Release Rod | 26—Pedal Shaft |
| 7—Clevis Yoke Pin | 17—Pedal Clamp Bolt | 27—Master Cylinder Tie Bar |
| 8—Control Tube Spring | 18—Control Cable | 28—Control Lever |
| 9—Control Lever and Tube | 19—Clutch Pedal | 29—Bearing Carrier |
| 10—Ball Stud and Bracket | 20—Screw and Lockwasher | |

J-6. Clutch Lever Adjustment

The procedures for clutch adjustment given in Par. J-7 require the use of a clutch adjusting fixture, tool W-296. The clutch pressure plate adjustment must be checked before installing a

new or reconditioned clutch. The proper spacer thickness and gauge length for a particular clutch is listed in J-13.

a. Place the proper thickness spacers between the pressure plate face and the clutch adjusting fixture.



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FIG. 178—ADJUSTING CLUTCH FINGERS

- 1—Adjustment Gauge
- 2—Adjustment Nut
- 3—Fixture Mounting Bolt
- 4—Clutch Fixture

Locate the spacers under the pressure plate fingers and at the center of the pressure plate face.

b. With the spacers properly installed, bolt the pressure plate to the adjusting fixture. Draw the bolts down evenly a little at a time until they are tight.

c. Using the proper gauge length check the lever adjustment as shown in Fig. 179.

d. Lever adjustment can be altered by removing the lever clips, loosening the lock nut and turning the adjusting screw in or out as required.

J-7. Pilot Bushing Inspection

Inspect the transmission mainshaft pilot bushing which is pressed into the center of the flywheel. If the bushing is worn or damaged, it should be removed, using a pilot bushing remover. 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 a pilot bushing installing and burnishing tool 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 removed (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.

J-8. Clutch Installation— Auburn and Rockford

a. 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.

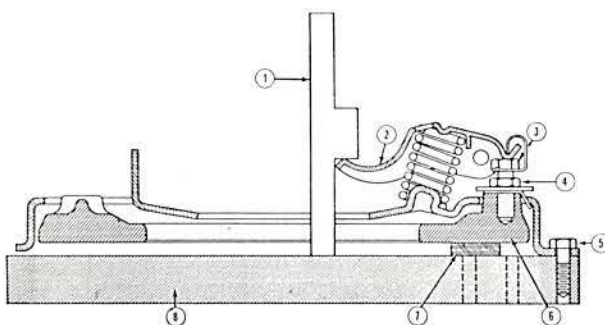
b. Inspect Clutch Release Bearing and Sleeve

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.

c. Reassembly

To assemble the clutch to the flywheel, first put a small amount of light cup grease in the flywheel pilot bushing, install the driven plate, with short end of hub toward the flywheel, then place the pressure plate assembly in position. With a clutch plate aligning arbor or a spare transmission main 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



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FIG. 179—CHECKING CLUTCH
LEVER ADJUSTMENT

- 1—Gauge
- 2—Clutch Lever
- 3—Adjusting Screw
- 4—Lock Nut
- 5—Mounting Bolt
- 6—Clutch Pressure Plate
- 7—Thickness Spacer
- 8—Clutch Adjusting Fixture

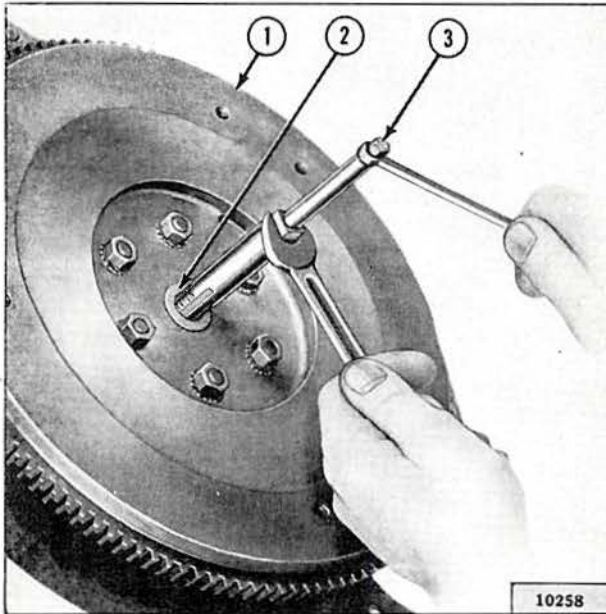


FIG. 180—REMOVING PILOT BUSHING FROM FLYWHEEL

- 1—Flywheel
- 2—Pilot Bushing
- 3—Pilot Bushing Remover

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 cable so there is 1" [25,4 mm.] free pedal travel.

J-9. TROUBLE SHOOTING

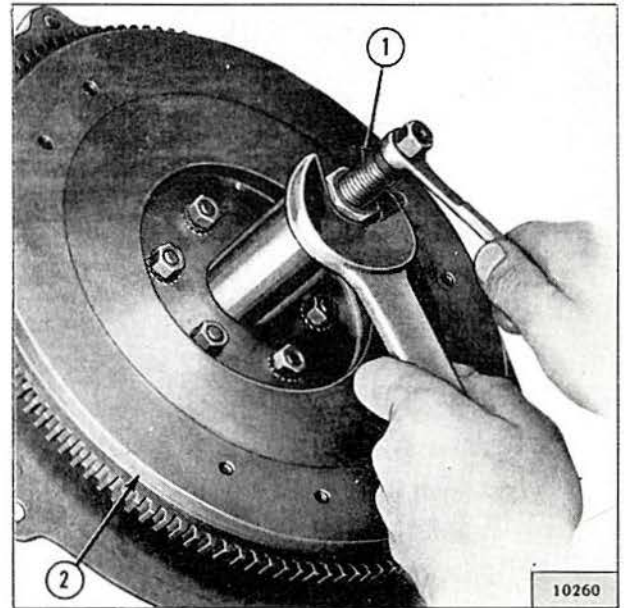


FIG. 181—INSTALLING PILOT BUSHING TO FLYWHEEL

- 1—Pilot Bushing Installing and Burnishing Tool
- 2—Flywheel

J-10. Vehicle Vibrations

• Model DJ-3A

See also Service Diagnosis in the Rear Axle Section and Body Section for other possible causes. With some DJ-3A vehicles a vibration may occur particularly upon deceleration or partial deceleration. It is especially noticeable between 33 and 45 mph. [53 a 72 kph.] when traveling downhill. This vibration is caused by changes in friction characteristics of the clutch driven disc hub and can usually be reduced to normal by use of clutch driven disc having four main springs and two opposed springs-within-springs.

J-11. 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
Vehicle Vibration (Model DJ-3A)	See "Trouble Shooting" on preceding page.

J-12. CLUTCH SPECIFICATIONS

MODEL:	CJ-2A
Pressure Plate:	
Make.....	Auburn
Type.....	Single Dry Plate
No. Springs.....	3
Spring Pressure @ 1 ⁵ / ₁₆ ".....	180-195 lbs. [81,6 a 88,4 kg.]
Total Plate Pressure.....	
Driven Plate:	
Make.....	Borg & Beck
Facings.....	Woven-Moulded
Diameter.....	8 ¹ / ₂ " [21,6 cm.]
Thickness.....	.132"-.138" [0,343 cm.]
Torque Capacity.....	144 lb.-ft. [19,9 kg.-m.]
Clutch Release Bearing:	
Type.....	Sealed Ball Bearing Prelubricated
Clutch Shaft Bushing:	
Location.....	In Flywheel
Material.....	Bronze Bushing
Size.....	.628" I.D. [15,9 mm.]
Clutch Pedal Adjustment.....	1 ¹ / ₂ " [38,1 mm.]

MODEL:	DJ-3A, CJ-3A, CJ-3B, CJ-5, CJ-6		
	STANDARD		OPTIONAL
Pressure Plate:			
Make.....	Auburn	Rockford	Auburn
Type.....	Single Dry Plate	Single Dry Plate	Single Dry Plate
No. Springs.....	3	6	3
Spring Pressure @ 1 ⁵ / ₁₆ ".....	220-230 lbs. at 1 ⁵ / ₁₆ " [91,63 a 104,33 kg.-39,7 mm.]	170-180 lbs. at 1.312" [77,11 a 81,65 kg.-33,3 mm.]	238 to 264 lb. @ 1 ¹³ / ₁₆ " [106,94 a 119,75 kg. @ 46 mm.]
Total Plate Pressure.....	1140 lb. [517 kg.]	1140 lb. [517 kg.]	1366 lb. [619 kg.]
Driven Plate:			
Make.....	Borg & Beck	Borg & Beck	Borg & Beck
Facings.....	Woven-Moulded	Woven-Moulded	Woven Moulded
Diameter.....	8 ¹ / ₂ " [21,6 cm.]	8 ¹ / ₂ " [21,6 cm.]	9 ¹ / ₄ " [23,4 cm.]
Thickness.....	.135" [0,343 cm.]	.132"-.138" [0,343 cm.]	.125" [3,17 mm.]
Torque Capacity.....	165 lb.-ft. [22,81 kg.-m.]	165 lb.-ft. [22,81 kg.-m.]	216 lb.-ft. [29,87 kg.-m.]
Clutch Release Bearing:			
Type.....	Sealed Ball Bearing Prelubricated	Sealed Ball Bearing Prelubricated	Sealed Ball Bearing Prelubricated
Clutch Shaft Bushing:			
Location.....	In Flywheel	In Flywheel	In Flywheel
Material.....	Bronze Graphite	Bronze Graphite	Bronze Graphite
Size.....	I.D. .628" [15,9 mm.]	I.D. .628" [15,9 mm.]	I.D. .628" [15,9 mm.]
Clutch Pedal Adjustment.....	1" [25,4 mm.]	1" [25,4 mm.]	1" [25,4 mm.]

J-13. CLUTCH ADJUSTING FIXTURE DATA

Manufacturer	Disc Diameter	Spacer Thickness	Gauge Length
Auburn.....	8 ¹ / ₂ " [21,6 cm.]	.310" [0,787 cm.]	1 ¹⁵ / ₁₆ " [55,23 mm.]
Rockford.....		.305" [0,774 cm.]	1 ¹⁵ / ₁₆ " [55,23 mm.]
All.....	9 ¹ / ₄ " [23,4 cm.]	.285" [0,723 cm.]	1 ¹⁵ / ₁₆ " [55,23 mm.]

TRANSMISSION AND TRANSFER CASE

Contents

SUBJECT	PAR.
Remote Control.....	K-2
Separating Cases.....	K-6
Transfer Case.....	K-17
Transmission.....	K-5, K-10, K-11

K-1. GENERAL

Model CJ-2A after Serial No. 38221, Models CJ-3A, CJ-3B, CJ-5 and CJ-6 are equipped with a heavy duty, three speed synchro-mesh type transmission with cane type shift. Fig. 184. It 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. Shift is smooth and positive through a cane type control lever mounted in a shift housing at the top of the assembly. Poppet balls and springs retain the gears in mesh and an interlock prevents shifting into two gears at one time.

All 4-wheel-drive vehicles are also equipped with a transfer case attached to the rear of the transmission. Transfer case repair procedures begin with Par. K-17.

Model CJ-2A before Serial No. 38221 is equipped with the same transmission, with minor differences, but with a remote control shift. Model DJ-3A is equipped with a similar transmission, however, the construction is somewhat different because it is not designed to receive a transfer case for four-wheel drive.

For DJ-3A vehicles, the transmission repair procedures begin with Par. K-10.

K-2. Transmission Remote Control

- Early CJ-2A and DJ-3A

First disconnect the transmission shift rods from the remote control levers. Check for binding of the remote control shaft on the steering column and make the necessary corrections to eliminate any binding condition.

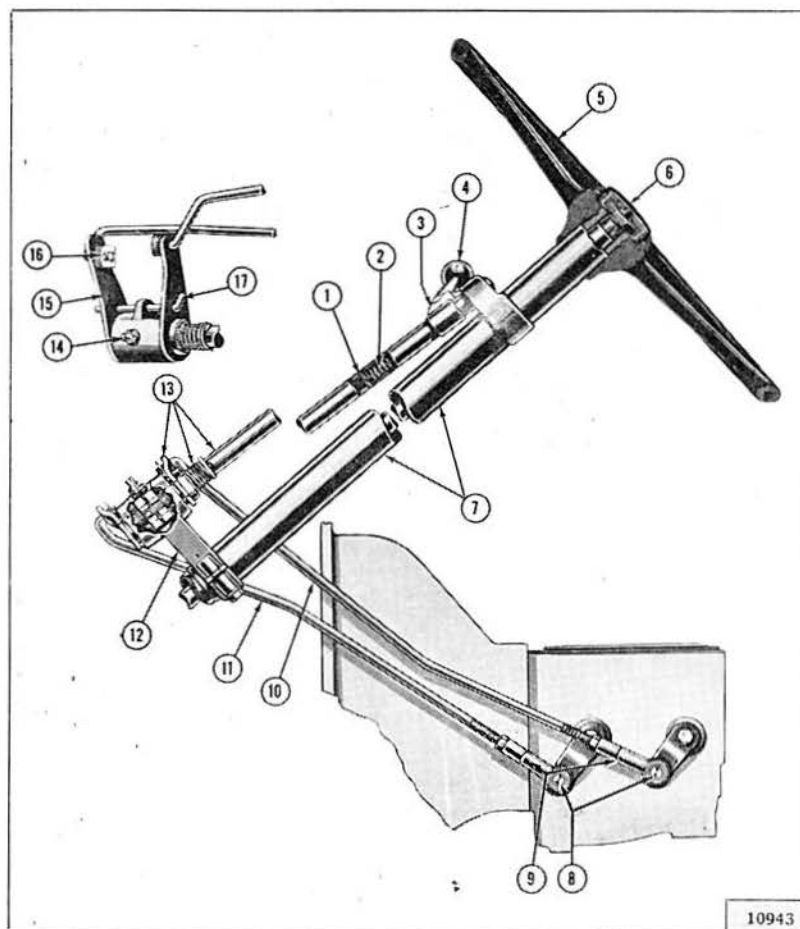


FIG. 182—TRANSMISSION REMOTE CONTROL
(Models DJ-3A and CJ-2A up to Serial No. 38221)

- | | | | |
|-------------------|----------------------|------------------------|------------------------|
| 1—Stop Screw | 6—Horn Button Nut | 10—Shift Rod | 14—Lubrication Fitting |
| 2—Bias Spring | 7—Column and Bearing | 11—Shift Rod | 15—Lever and Clutch |
| 3—Gearshift Lever | 8—Clevis Pins | 12—Cross-Shift Bracket | 16—Anti-Rattler |
| 4—Lever Ball | 9—Shift Rod Yokes | 13—Control Shaft | 17—Aligning Rod |
| 5—Steering Wheel | | | |

If the shift is not smooth and positive, first make sure the gears are in neutral position then remove the shift rods at the transmission by removing clevis pins, Fig. 184 No. 21, and slip a short piece of snug fitting $\frac{1}{4}$ " [6.35 mm.] aligning rod, through the gearshift levers and housing as shown in insert drawing.

This places the clutch and shift lever assemblies in the neutral position. Adjust the shift rod yokes, at the transmission end so clevis pins, can be installed freely without moving the shift levers on the transmission after which remove alignment pin.

If shifting from first to second is difficult or transmission hangs in first gear, shorten the low and reverse shift rod one turn at a time until the condition is corrected. Usually three turns are required.

Should the fault continue after completing the above adjustment, check further as outlined below. First remove the lubricating fitting. Use a narrow feeler gauge which will enter the opening for the lubricator and check the clearance between the faces of the shifting clutches. This clearance should be .015" to .031", [$\frac{1}{64}$ " to $\frac{1}{32}$ "] [.397-.794 mm.]. If this clearance is greater the assembly must be removed for adjustment. The shift dog, which engages the clutch slots should not have more than .009" [.229 mm.] clearance in the slots. If the clearance between the clutch grooves and cross pins is too great, these parts must be replaced. Improved remote control shift rods were installed in production on Model DJ-3A effective with vehicle serial number 56337-12606. If a smooth and easy shift pattern cannot be obtained on vehicles with serial numbers lower than this, after adjusting the shift linkage as outlined above, install new rods Part 921111, low and reverse; Part 921140, high and intermediate.

K-3. Removal of Remote Control

- Early CJ-2A and DJ-3A

To remove the remote control the following procedure is suggested:

- Remove shifting rods from the transmission and also from the steering remote control clutch levers.
- Remove gearshift lever fulcrum pin and the gearshift lever.
- Remove plates on the toe board at the steering post.
- Remove two screws holding remote control housing to the steering post and lift the housing from the positioning pin.
- Remove the assembly down through the floor pan.
- Remove the lower clutch and shift lever from the housing by turning counterclockwise.
- Remove upper clutch and shift lever in the same manner.
- Wash all parts in a suitable cleaning solution.

K-4. Reassembly of Remote Control

- Early CJ-2A and DJ-3A

Check clearance of shift dog which engages in slot of clutches, and if found to be greater than .009" [.2286 mm.] clearance, replace the worn parts.

Assemble upper clutch lever assembly in housing making sure that 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 one full turn until the hole in the clutch lever aligns with hole in the housing.

Assemble the lower clutch lever assembly in housing until faces of clutches contact then back off not more than one-half turn which should bring the aligning hole in the lever in line with the hole in the housing. If the one-half turn does not bring the alignment hole in proper position, it will be necessary to grind off (square with axis not to exceed .015") [.397 mm.] the face of the lower clutch; in other words, backing off not more than one-half turn from face to face contact gives the proper clearance of .015" to .031" [.397-.794 mm.] between the two clutches.

Assemble the unit to the steering post in reverse order of dismantling and adjust remote control rods.

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 at the transmission end and either lengthen or shorten it slightly to correct this condition.

Early production 4-wheel-drive models have a transmission low-gear ratio of 2.798.

Late production models have a transmission low-gear ratio of 3.339. This later transmission can be identified by the threaded gear shift lever for the gear shift knob. Both production transmissions are interchangeable.

K-5. TRANSMISSION

- Models CJ-2A, CJ-3A, CJ-3B, CJ-5, CJ-6

The following repair procedures given in Par. K-6 through K-9 for the standard 3-speed transmission apply in general to all models listed. Minor differences between models that affect the procedure are noted. Procedure for the optional 4-speed transmission begins with Par. K-11.

Removal is as follows:

- Drain the transmission and transfer case. Replace the drain plugs.
- Remove the floor pan inspection plate.
- Remove the shift lever and shift housing assembly and its gasket from the transmission. On early CJ-2A models, remove the remote control rods.
- Remove the set screw from the transfer case shift lever pivot pin. Remove the pivot pin, shift levers, and shift lever springs.
- If the vehicle is equipped with power take-off, remove the shift lever plate screws and lift out the lever.
- Disconnect the front and rear propeller shafts from the transfer case, following the procedure detailed in Section L. Should the vehicle be equipped with power take-off, disconnect the transfer case end of the power take-off drive shaft.
- Disconnect the speedometer cable at the transfer case.

- h. Disconnect the hand brake cable.
- i. Disconnect the clutch release cable at bellcrank yoke end.
- j. Place jacks under the transmission and engine, protecting the engine oil pan with a block of wood.
- k. Remove the nuts holding rear mounting to frame cross member.
- l. Remove the transfer case snubbing rubber bolt nut at cross member.
- m. Remove bolts holding frame center cross member to frame side rail and remove cross member.
- n. Remove bolts holding transmission to flywheel bellhousing.
- o. Force transmission to right to disengage clutch control lever tube ball joint.
- p. Lower jacks under engine and transmission. Slide transmission and transfer case assemblies toward rear of vehicle until the clutch shaft clears the flywheel housing.
- q. Lower jack under transmission. Remove transmission and transfer case as an assembly from under the vehicle.
- r. For separation of the transmission and transfer case, refer to Par. K-6.

K-6. Separating Transmission and Transfer Case

- a. Remove the six screws and lockwashers attaching the transfer case rear cover 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 steps 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 step b above, follow the procedure in step e below.
- e. Install transmission mainshaft retaining plate, tool W-194, as shown in Fig. 185 to prevent the mainshaft from pulling out of the transmission case. Should this tool be unavailable, loop a piece

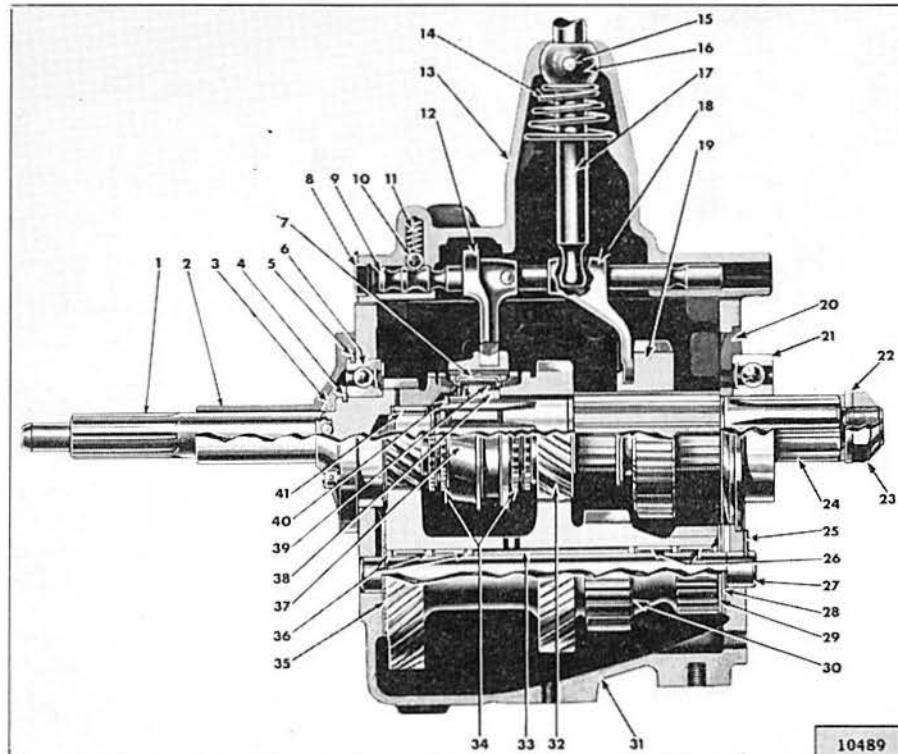
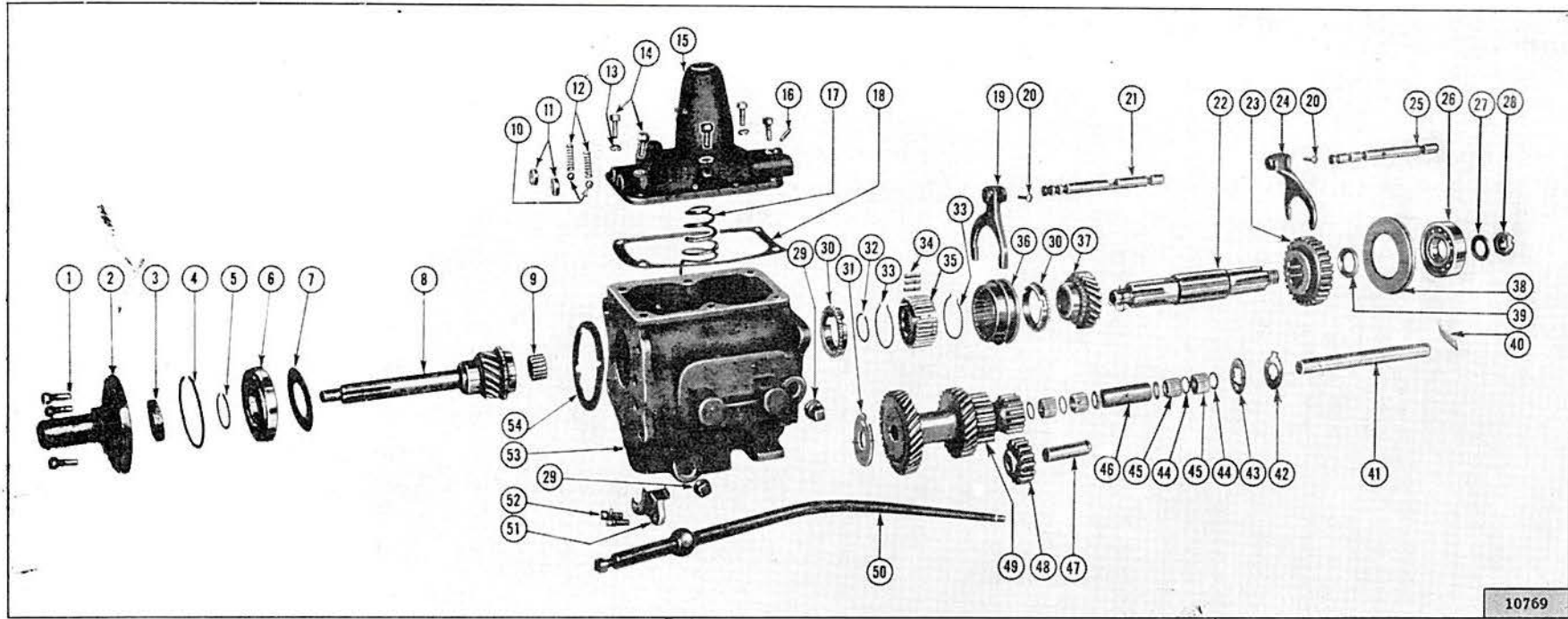


FIG. 183—THREE-SPEED TRANSMISSION

- | | |
|---|---|
| 1—Main Drive Gear | 22—Main Shaft Washer |
| 2—Main Drive Gear Bearing Retainer | 23—Main Shaft Nut |
| 3—Main Drive Gear Bearing Retainer Oil Seal | 24—Main Shaft |
| 4—Main Drive Gear Snap Ring | 25—Idler and Countershaft Lock Plate |
| 5—Main Drive Gear Bearing Snap Ring | 26—Countershaft Gear Bearing Rollers |
| 6—Main Drive Gear Bearing | 27—Countershaft Thrust Washer Rear—Steel |
| 7—Synchronizer Shifting Plate | 28—Countershaft |
| 8—Shift Rail Cap | 29—Countershaft Thrust Washer Rear—Bronze |
| 9—Shift Rail—High and Intermediate | 30—Countershaft Gears |
| 10—Shift Rail Poppet Ball | 31—Transmission Case |
| 11—Shift Rail Poppet Spring | 32—Main Shaft Second Speed Gear |
| 12—Shift Fork—High and Intermediate | 33—Countershaft Bearing Spacer |
| 13—Control Housing | 34—Synchronizer Blocking Ring |
| 14—Control Lever Support Spring | 35—Countershaft Thrust Washer Front—Bronze |
| 15—Control Lever Housing Pin | 36—Countershaft Bearing Washer |
| 16—Control Lever Fulcrum Ball | 37—Intermediate and High Speed Clutch Sleeve |
| 17—Gear Shift Lever | 38—Intermediate and High Clutch Hub |
| 18—Shift Fork—Low and Reverse | 39—Synchronizer Spring |
| 19—Sliding Gear—Low and Reverse | 40—Intermediate and High Clutch Hub Snap Ring |
| 20—Main Shaft Bearing Adapter | 41—Main Shaft Pilot Bearing Roller |
| 21—Main Shaft Bearing | |



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FIG. 184—THREE-SPEED TRANSMISSION—MODELS LATE CJ-2A, CJ-3A, CJ-3B, CJ-5, CJ-6

- 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—Control Housing
- 16—Interlock Plunger
- 17—Shift Lever Spring
- 18—Shift Tower Gasket

- 19—High and Intermediate Shift Fork
- 20—Shift Fork Pin
- 21—High and Intermediate Shift Rail
- 22—Main Shaft
- 23—Sliding Gear
- 24—Low and Reverse Shift Fork
- 25—Low and Reverse Shift Rail
- 26—Rear Bearing
- 27—Main Shaft Washer
- 28—Main Shaft Nut
- 29—Filler Plug
- 30—Blocking Ring
- 31—Front Countershaft Thrust Washer
- 32—Clutch Hub Snap Ring
- 33—Synchronizer Spring
- 34—Synchronizer Plate
- 35—Clutch Hub
- 36—Clutch Sleeve

- 37—Second Speed Gear
- 38—Rear Bearing Adapter
- 39—Bearing Spacer
- 40—Lock Plate
- 41—Countershaft
- 42—Rear Countershaft Thrust Washer
- 43—Rear Countershaft Thrust Washer
- 44—Countershaft Bearing Washer
- 45—Countershaft Bearing
- 46—Countershaft Bearing Spacer
- 47—Reverse Gear Shaft
- 48—Reverse Idler Gear
- 49—Countershaft Gear Set
- 50—Shift Lever
- 51—Oil Collector
- 52—Oil Collector Screw
- 53—Transmission Case
- 54—Bearing Retainer Gasket

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.

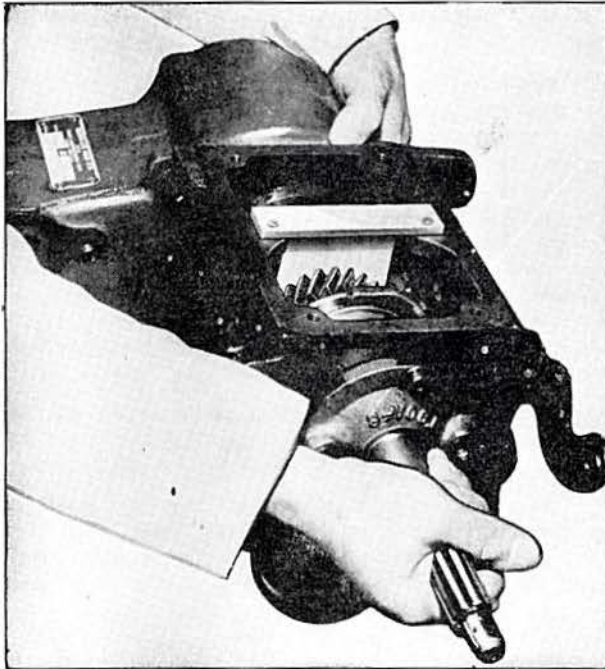


FIG. 185—MAIN SHAFT RETAINING PLATE

K-7. Disassembly

- Refer to Fig. 184

a. If the transfer case is attached, separate it from the transmission as outlined in Par. K-6.

b. Remove the shift housing and gasket from the top of the transmission case (cover plate and gasket on early CJ-2A models) if it has not been previously removed. The shift housing can be disassembled, if necessary, at this point by removing the shift rails

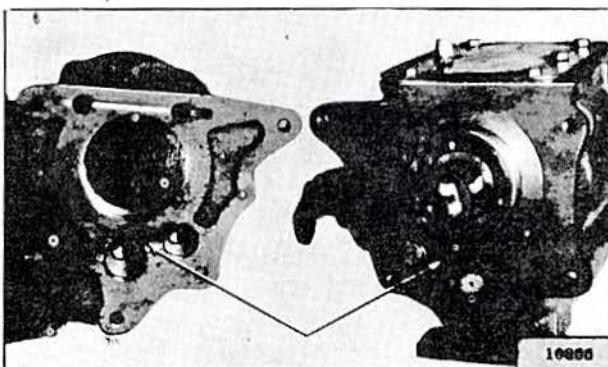


FIG. 186—SHAFT LOCK PLATE

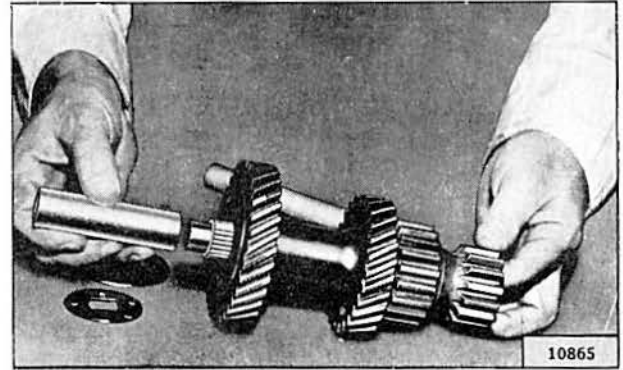


FIG. 187—COUNTERSHAFT GEAR BEARING ARBOR

and forks from the shift housing. Use care not to lose the poppet balls and springs.

Note: On early CJ-2A models equipped with side-shift remote-control transmission it is necessary to remove the main drive gear before the shift forks can be removed.

- c.** Remove the three screws and washers attaching the front main drive gear bearing retainer to the transmission. Remove the retainer and gasket.
- d.** Remove the two socket-head screws from the front end of the transmission case. These screws support the oil collector inside the case.
- e.** Tap lightly on the front end of the countershaft to loosen the lock plate. Remove the lock plate from slots cut in the rear ends of the countershaft and reverse idler shaft. Refer to Fig. 186.
- f.** Using special tool No. W-166 or a brass drift, drive the countershaft toward the rear of the case and remove it. The countershaft gear set will drop to the bottom of the transmission case. If the special tool is used, the needle bearing rollers will remain in the countershaft gear hub and the gears and bearings may later be removed as an assembly.
- g.** Remove the mainshaft rear bearing adapter.
- h.** Remove the mainshaft and gears from the case. The mainshaft assembly with the gears still in place may be removed through the rear bearing adapter opening. Do not lose pilot roller bearing when separating shafts.
- i.** Drive the main drive gear into the case enough to remove the oil collector. Remove the oil collector from the transmission case.

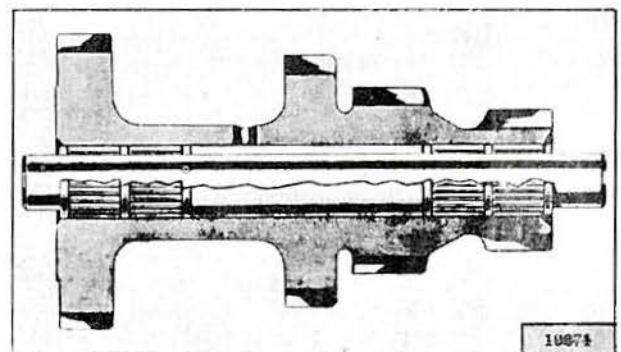


FIG. 188 -- COUNTERSHAFT BEARING SPACERS

- j. Remove the main drive gear.
- k. Remove the countershaft gear set and the three thrust washers. Remove the washers, needle bearing rollers, and spacer from the assembly.
- l. Remove the reverse idler shaft and gear by driving the shaft into the case using a brass drift.
- m. This completes the disassembly of the transmission on those models with a cane shift. On early CJ-2A models with side-shift remote-control transmission: remove the poppet and interlock assembly which floats between the shift lever assemblies; remove the shift lever assemblies by driving out the taper pins from the bottom side; and remove the shift lever oil seals.

K-8. 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.

K-9. Transmission Reassembly

- Models CJ-2A, CJ-3A, CJ-3B, CJ-5, CJ-6.
- Refer to Fig. 184.

Assemble the unit in the reverse order of disassembly, noting the following points:

- a. Effective with Model CJ-2A S/N 24196 and all other models listed, oil circulation is provided between the transmission and transfer case by the addition of drilled passages between the two units. The rear face of the transmission case is drilled with two $\frac{1}{16}$ " [11,11 mm.] holes and two $\frac{1}{4}$ " [6,35 mm.] holes. The front face of the transfer case is drilled with two $\frac{1}{16}$ " holes to register with those drilled in the transmission case. When making replacement of either unit or case, it is important that mating parts be installed, that is, if a transmission case is drilled use a drilled transfer case. It is important that the correct gasket, having openings for oil passage, be used with the drilled cases.
- b. On Model CJ-2A before S/N 38221 equipped with a side-shift remote control transmission, be sure that the interlock sleeve is of the proper length to provide correct clearance. Procedure for DJ-3A side-shift applies equally to this model with remote-control transmission.

c. On all Model CJ-2A and early Model CJ-3A, the countershaft gear assemblies included only four washers. No washers were installed at the ends of the center spacer. On later Model CJ-3A and other models listed above, a shorter spacer and two additional washers shown in Fig. 188 were used. When a transmission of the earlier type is disassembled, a change to the shorter center spacer and addition of the two washers upon reassembly is recommended.

d. Position the reverse idler gear in the case and install the shaft using care that the slot at the shaft end is correctly aligned to receive the lock plate.

e. Assemble the spacer, six washers, and four countershaft needle bearings in the countershaft gear hub, using special tool W-193 with loading sleeve, as shown in Fig. 187 and 191. 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.

f. When assembling the mainshaft gears, the low and reverse sliding gear is installed with the shift shoe groove toward the front of the transmission.

g. The sequence of assembly of the synchronizer unit is shown in Fig. 184. First install the two springs in the high and intermediate clutch hub 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 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 over the hub with the long beveled edge toward the long part of the clutch hub. Install the two blocking rings 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.

h. When installing the mainshaft, use care that the needle bearing rollers in the main drive gear are correctly positioned. Use heavy grease to hold them in position for assembly.

i. 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 which is available in .0555" and .0625" [1,410 a 1,587 mm.] thickness.

After installation of the front and rear bearing retainers on the mainshaft, turn the transmission over to allow the gears to mesh and also to permit alignment and installation of the countershaft.

j. To install the countershaft gear set in the case, first install the large bronze thrust washer 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 at the rear of the case. Start the countershaft into the case just enough to hold this washer in place. Align the slot in the countershaft with the slot in the reverse idler gear shaft to permit installation of the lock plate. Be sure the thrust washers are correctly positioned. Then position the bronze-faced washer 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.

k. 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. 186 is correctly positioned in the recess in the transfer case housing. Three $1\frac{1}{8}$ " 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.

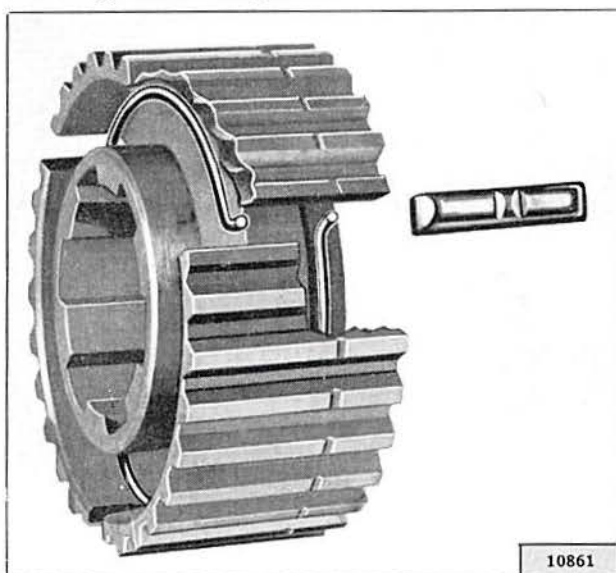


FIG. 189—SYNCHRONIZER SPRINGS

K-10. Transmission

• Model DJ-3A

a. Remove the six bolts from the transmission case cover and remove the cover and gasket. See Fig 191.

b. Drain the lubricant from housing and wash the assembly with a suitable solvent.

c. Remove the screws from the front main bearing retainer and remove retainer.

d. Shift the transmission into lower gear and place transmission main shaft retaining plate, special Tool W-194, Fig. 185, to the rear of the low and reverse speed sliding gear holding it to the transmission with two transmission cover cap screws. If this tool is not available, loop a piece of wire around the main shaft just back of the low speed sliding gear and fasten the ends of the wire to two front transmission cover screws to hold the main shaft in position. Should the transmission main shaft slide out of the transmission case, the

synchronizer parts will fall to the bottom of the transmission case.

e. Remove nut which attaches the companion flange to the main shaft; also the flat washer and lock washer.

f. Remove the companion flange with special puller tool W-172.

g. Remove the screws attaching the rear bearing retainer to case and remove retainer and gasket.

h. Remove oil seal speedometer drive gear and main shaft rear bearing from the bearing retainer.

i. Remove the shifting fork and shoe. This is accomplished by sliding the main shaft to the rear until the rear bearing is clear of the case. The main shaft may then be shifted to the side of the case sufficiently for removal of the fork and shoe.

j. Remove the idler and countershaft lock plate.

k. Using a soft drift, drive the countershaft out through the rear of the case allowing the countershaft gears to drop to the bottom of the case.

l. Remove the main drive gear 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 type rollers in the gear end of the shaft which make up the main shaft pilot bearing.

m. Remove the main shaft snap ring, the main shaft bearing snap ring and the mainshaft bearing which is grooved, from the main shaft.

n. Remove the blocking ring then remove the clutch hub and synchronizer assembly through the top.

o. Remove the low and reverse sliding gears and the constant mesh gear and main shaft in one unit, through the top.

p. Remove the countershaft gears through the top. Take care not to misplace the twenty rollers at each end of the long spacer as well as the two thrust washers and the two roller spacer bearings.

q. Using a soft drift, drive the reverse idler shaft out toward the rear and remove the gear.

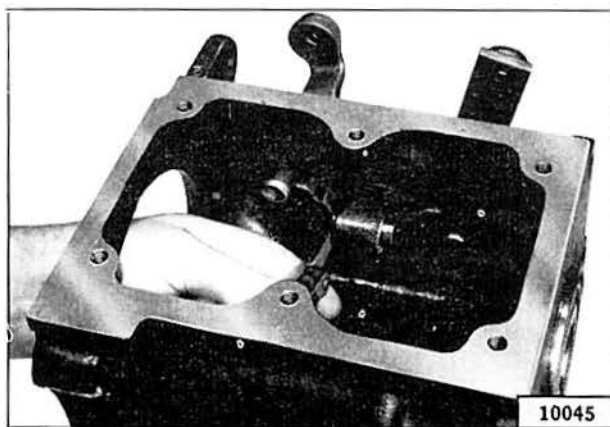
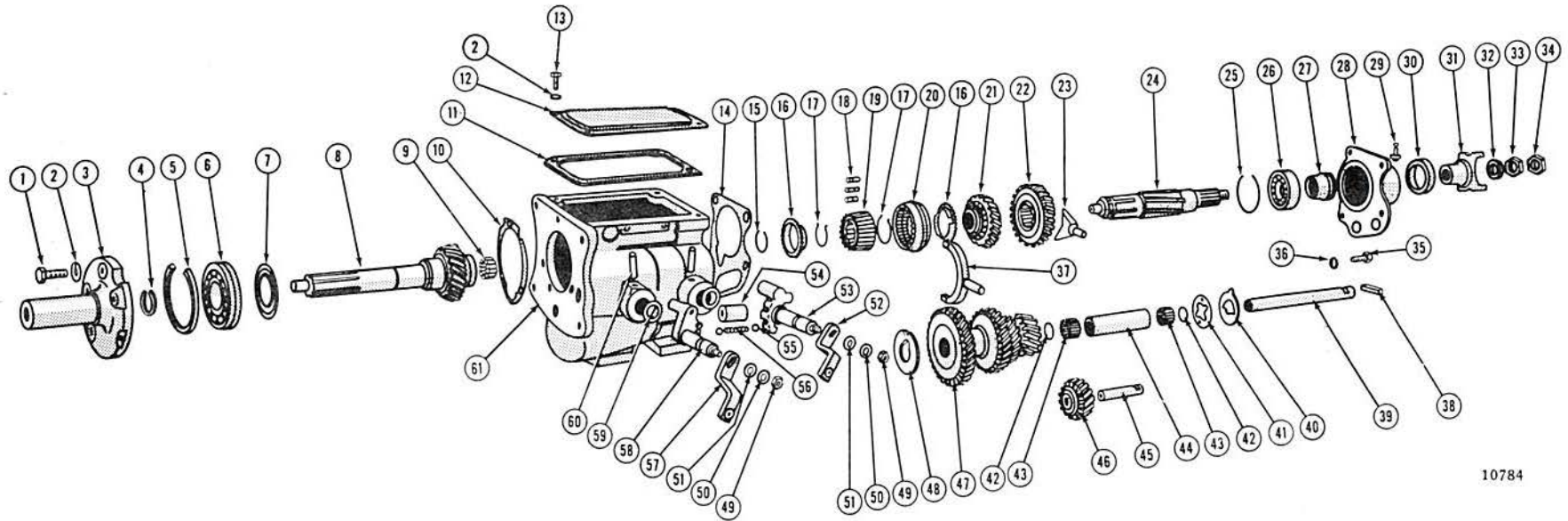


FIG. 190—INTERLOCK SLEEVE CLEARANCE

Text continued on page 171.



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FIG. 191—THREE-SPEED TRANSMISSION—MODEL DJ-3A

- | | | |
|-------------------------------------|-------------------------------|---------------------------------|
| 1—Retainer Attaching Bolt | 21—Second Speed Gear | 41—Thrust Washer (Bronze) |
| 2—Lockwasher | 22—Sliding Gear | 42—Bearing Spacer — Short |
| 3—Main Drive Gear Retainer | 23—Shifting Shoe | 43—Countershaft Bearing Rollers |
| 4—Main Drive Gear Snap Ring — Small | 24—Main Shaft | 44—Bearing Spacer — Long |
| 5—Main Drive Gear Snap Ring — Large | 25—Snap Ring | 45—Reverse Idler Gear Shaft |
| 6—Main Drive Gear | 26—Main Shaft Rear Bearing | 46—Reverse Idler Gear |
| 7—Oil Retaining Washer | 27—Speedometer Drive Gear | 47—Countershaft Gear |
| 8—Main Drive Gear | 28—Rear Bearing Retainer | 48—Front Thrust Washer (Bronze) |
| 9—Main Shaft Bearing Rollers | 29—Speedometer Driven Gear | 49—Nut |
| 10—Retainer Gasket | 30—Main Shaft Oil Seal | 50—Lockwasher |
| 11—Case Cover Gasket | 31—Transmission Yoke | 51—Control Lever Washer |
| 12—Case Cover | 32—Main Shaft Washer | 52—Control Lever |
| 13—Bolt | 33—Lockwasher | 53—Shift Lever |
| 14—Rear Bearing Retainer Gasket | 34—Main Shaft Nut | 54—Interlock Sleeve |
| 15—Snap Ring | 35—Rear Bearing Retainer Bolt | 55—Poppet Ball |
| 16—Blocking Ring | 36—Lockwasher | 56—Poppet Spring |
| 17—Synchronizer Spring | 37—Shift Fork | 57—Control Lever |
| 18—Shifting Plate | 38—Lock Plate | 58—Shift Lever |
| 19—Clutch Hub | 39—Countershaft | 59—Shift Shaft Oil Seal |
| 20—Clutch Sleeve | 40—Thrust Washer (Steel) | 60—Taper Pin |
| | | 61—Transmission Case |

Wash the inside of the case and all parts thoroughly with a suitable solvent. Examine all parts carefully and secure the necessary new parts.

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.

Locate the second-and-high shift lever for second-gear position and the other shift lever for neutral position. Use a feeler gauge to measure clearances as shown in Fig. 190 between the ends of the interlock sleeve and the notched surface of each shift lever. Clearance must be from .001" to .007" [0,025 a 0,178 mm.] on each side of the interlock sleeve.

To obtain correct clearance, interlock sleeves are available for selective fits. The different lengths can be identified by a letter at the end.

Note: If the vehicle has a 5.38 axle ratio, be certain correct speedometer gears are used when making replacements.

- 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 from the bottom of the shift lever bosses. Remove the

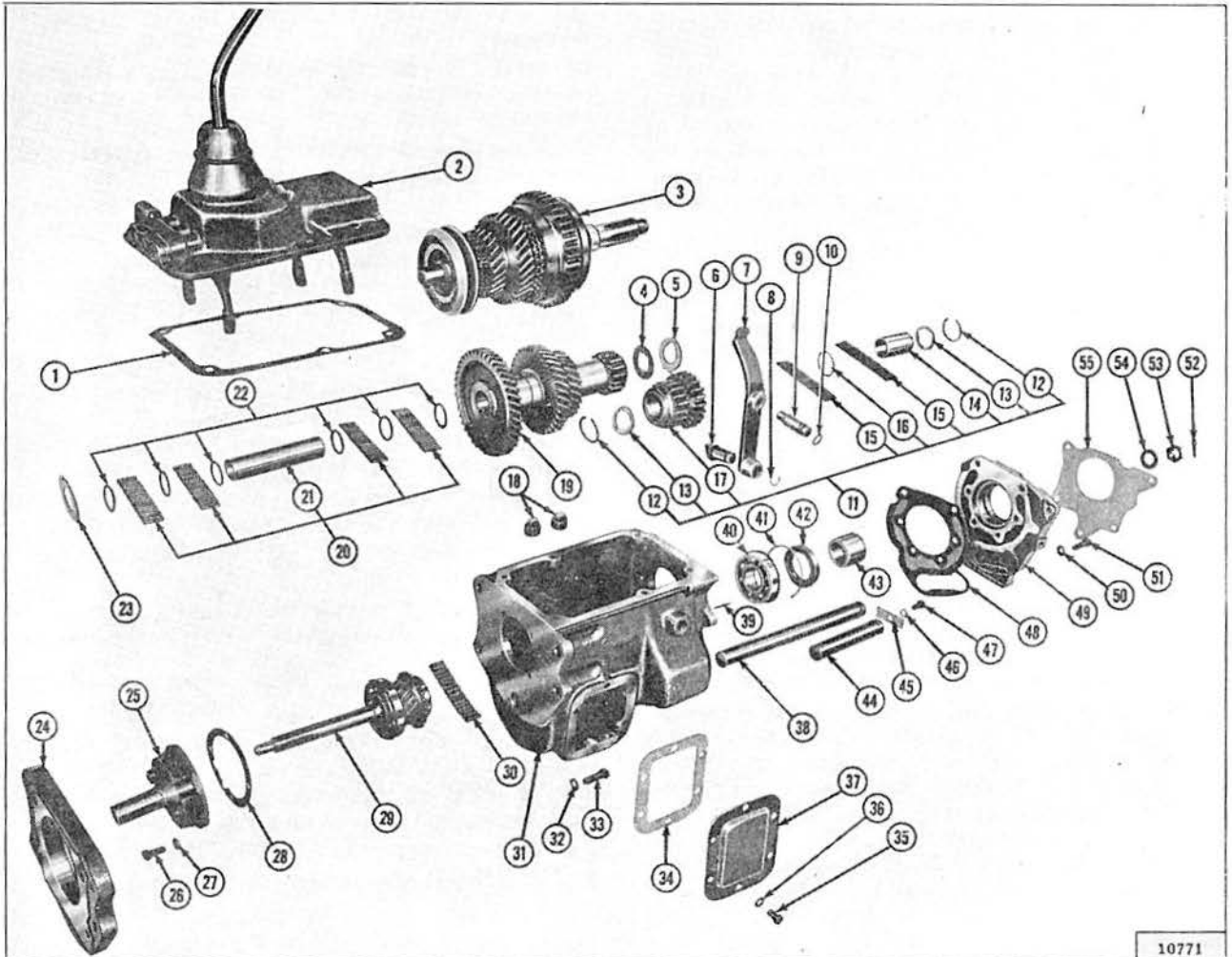


FIG. 192—FOUR-SPEED TRANSMISSION ASSEMBLY

- | | | |
|--------------------------------|--|---------------------------------|
| 1—Control Housing Gasket | 19—Countershaft Gears | 37—Side Opening Cover |
| 2—Control Housing Assembly | 20—Bearing Rollers | 38—Countershaft |
| 3—Mainshaft Assembly | 21—Spacer | 39—Shifting Arm Pivot Taper Pin |
| 4—Thrust Washer | 22—Washer | 40—Bearing |
| 5—Thrust Washer | 23—Thrust Washer | 41—Snap Ring |
| 6—Reverse Shifting Shoe | 24—Bellhousing to Transmission Adapter Plate | 42—Oil Seal |
| 7—Reverse Shifting Arm | 25—Bearing Retainer | 43—Spacer |
| 8—C-Washer | 26—Bearing Retainer Bolt | 44—Reverse Idler Shaft |
| 9—Reverse Shifting Arm Pivot | 27—Bearing Retainer Lock Washer | 45—Lock Plate |
| 10—O-Ring | 28—Bearing Retainer Gasket | 46—Lock Plate Lock Washer |
| 11—Reverse Idler Gear Assembly | 29—Main Drive Gear | 47—Lock Plate Bolt |
| 12—Snap Ring | 30—Bearing Rollers | 48—Gasket |
| 13—Thrust Washer | 31—Transmission Case | 49—Adapter Plate |
| 14—Sleeve | 32—Adapter Plate Lock Washer | 50—Adapter Plate Lock Washer |
| 15—Bearing Rollers | 33—Adapter Plate Bolt | 51—Adapter Plate Bolt |
| 16—Spacer | 34—Side Opening Cover Gasket | 52—Cotter Key |
| 17—Reverse Idler Gear | 35—Side Opening Cover Bolt | 53—Nut |
| 18—Pipe Plug | 36—Side Opening Cover Lock Washer | 54—Washer |
| | | 55—Gasket |

nuts and washers from the control levers and remove levers. Push the shafts 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. 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 gear 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.

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.

To reassemble the transmission proceed as follows:

- a. Position the reverse idler gear in the case and install the shaft using care that the slot at the shaft end is correctly aligned to receive the lock plate.
- b. To assemble the countershaft gear, it is necessary to use Tool W-166, Fig. 187. Place the mandril through the gear set and insert the long spacer positioning it at the center of the gear set. Place a set of twenty rollers at each end of the spacer followed by a spacing washer at each end. A small amount of grease will hold the spacing washer in position. Place the assembled countershaft gear set in the bottom of the case with the large gear toward the front.
- c. Install the rear main shaft bearing on the main shaft with the closed side of the bearing toward the front or low end of the shaft. Replace the bearing snap ring and main shaft snap ring.
- d. Pass the front end of the main shaft through the rear bearing opening and assemble the low and reverse sliding gear on the shaft with the shifting fork groove toward the rear.
- e. Assemble the second speed gear on the shaft with the teeth which engage in the clutch sleeve toward the front of the case.

- f. Next, assemble the synchronizer unit. The assembly sequence of the synchronizer is shown in Fig. 189. First install the two springs in the high and intermediate clutch hub. These springs must be installed with the spring tension opposed. Place the right lipped end of a 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. Fig. 191. Install the three synchronized shifting plates 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 over the hub. Install the two blocking rings one on each side of the hub.

- g. Install the shifting fork and shoe.

- h. Place some heavy grease in the main shaft pilot and position the thirteen needle type roller bearings.

- i. Install the main drive gear. If the bearing has been removed, note that the closed side is assembled toward the inside of the case.

- j. Enter the main shaft bearing in the case and assemble the shaft in position.

- k. Install the front bearing retainer.

- l. Turn the transmission case over to allow the gears to mesh and start the countershaft through the case at the rear with the lock plate slot toward the rear and in alignment with the slot in the idler gear shaft.

- m. Place the two rear thrust washers over the end of the shaft and align the countershaft gears with the shaft. Press the shaft through the gears placing the front thrust washer in position with the tongue of the washer in the slot in the case.

- n. Install the lock plate. Tap both shafts forward to put a bind on the plate to hold it in position.

- o. Install rear bearing snap ring and rear mainshaft bearing on shaft.

- p. Attach rear bearing retainer and gasket to the transmission case. Tighten cap screws evenly and securely.

- q. Install speedometer drive gear on shaft with the shoulder of gear toward the front. Check the oil seal which is installed next and replace with new one if necessary.

- r. Install the companion coupling flange with the flat washer, lock washer and nut.

- s. Check the complete transmission for operation.

- t. Install transmission case cover.

K-11. OPTIONAL 4-SPEED TRANSMISSION

- Models CJ-5, CJ-6

A four-speed transmission with a cane-type shift is optional on 'Jeep' Models CJ-5 and CJ-6. This transmission provides four speeds forward and one reverse with synchromesh engagement in second, third, and fourth speed.

For quick identification, the optional 4-speed transmission is 11 $\frac{7}{8}$ " long whereas the standard 3-speed transmission is 8" long. However the instructions for removal and installation of the two transmissions are the same. Use the procedure

outlined under the heading, "TRANSMISSION REMOVAL" for the 4-speed transmission.

K-12. 4-Speed Transmission Overhaul

• Refer to Fig. 192

a. Remove the transmission to transfer case adapter plate and gasket. Remove the oil seal from the plate and, if damaged, discard the seal.

b. Remove the transmission control housing assembly. Refer to the last paragraph of this section for its disassembly.

c. To make certain the two blocking rings, direct-and-third clutch hub, and direct-and-third clutch sleeve will be assembled in their original relationship, mark them with a quick drying lacquer or an electric pencil. Also mark the blocking ring, low-and-second clutch hub, and the low-and-second speed gear.

d. Slide the low-and-second speed gear toward the rear of the transmission case.

e. Disengage the reverse shifting arm and reverse shifting shoe from the reverse idler gear. Remove

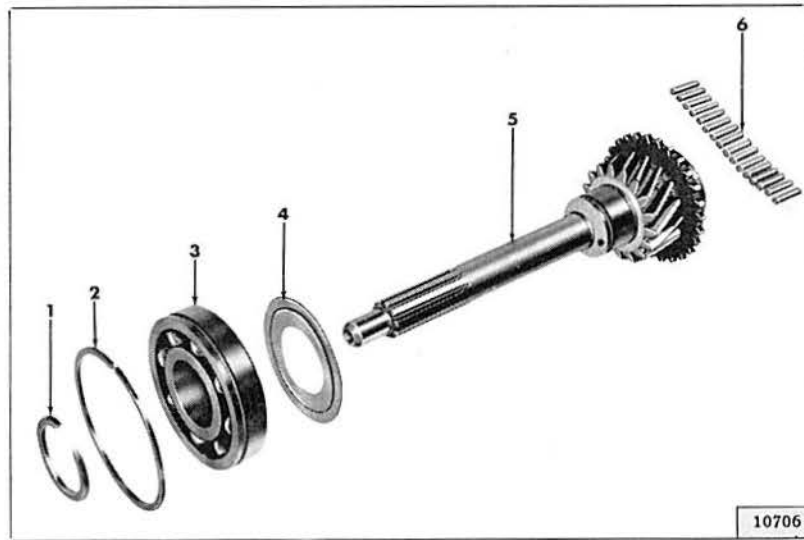


FIG. 193—FOUR-SPEED TRANSMISSION MAIN DRIVE GEAR

- | | | |
|-------------|-----------|-------------------|
| 1—Snap Ring | 3—Bearing | 5—Main Drive Gear |
| 2—Snap Ring | 4—Washer | 6—Bearing Rollers |

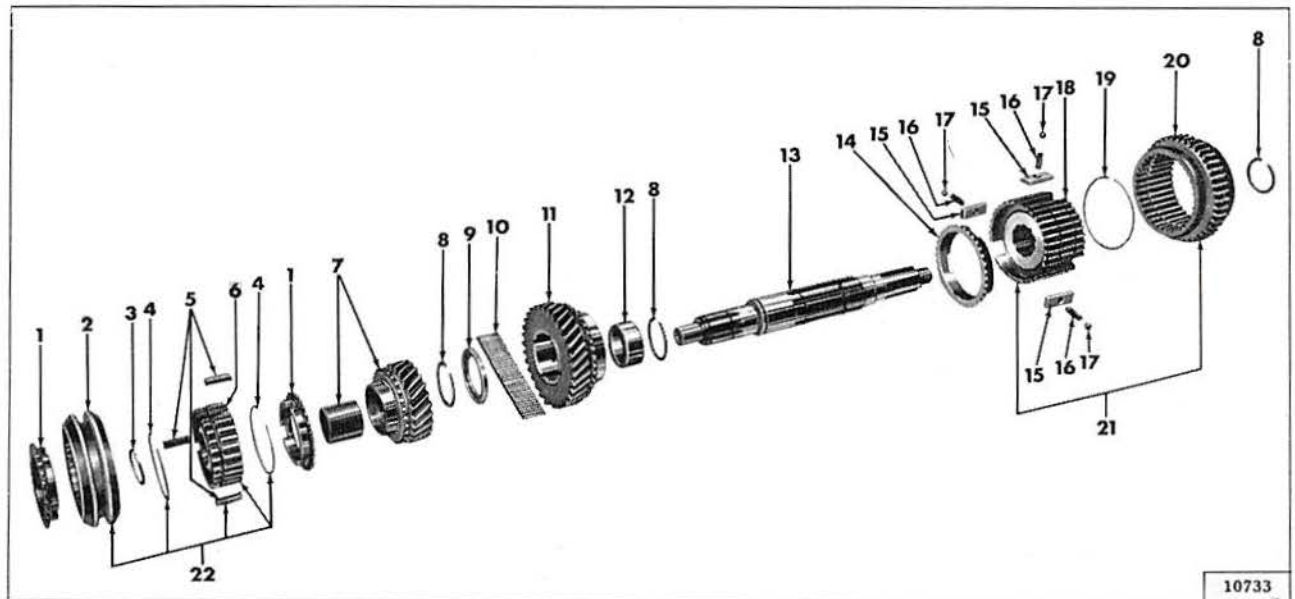


FIG. 194—FOUR-SPEED TRANSMISSION MAIN SHAFT

- | | | |
|----------------------------------|----------------------|---|
| 1—Blocking Ring | 9—Thrust Washer | 17—Ball |
| 2—Direct and Third Clutch Sleeve | 10—Bearing Rollers | 18—Low and Second Clutch Hub |
| 3—Snap Ring | 11—Second Speed Gear | 19—Retaining Ring |
| 4—Spring | 12—Spacer | 20—Low and Second Speed Gear |
| 5—Shifting Plate | 13—Mainshaft | 21—Second Speed Synchronizer Assembly |
| 6—Direct and Third Clutch Hub | 14—Blocking Ring | 22—Direct and Third Synchronizer Assembly |
| 7—Third Speed Gear Assembly | 15—Shifting Plate | |
| 8—Snap Ring | 16—Poppet Spring | |

the arm from the reverse shifting arm pivot.

f. Move the low-and-second speed gear into neutral position.

g. Remove the bearing retainer and gasket. Remove the snap rings from the main drive gear and the outer race of the ball bearing.

h. With a bearing puller, remove the main drive gear ball bearing.

i. Remove the oil slinger.

j. Remove the snap ring from the outer bearing race of the transmission mainshaft ball bearing.

k. With a bearing puller, remove the mainshaft ball bearing.

Note: It may be necessary to drive the mainshaft rearward by striking the end of the main drive gear with a lead hammer to get sufficient clearance to install the bearing puller plates.

l. Slide the direct-and-third clutch sleeve to the rear (third speed) position. Separate the mainshaft assembly from the main drive gear. Be careful not to lose any of the mainshaft pilot bearing rollers.

m. Lift the mainshaft assembly out of the top of the transmission case.

n. Remove the main drive gear from the transmission case.

o. Remove the mainshaft bearing rollers from the gear.

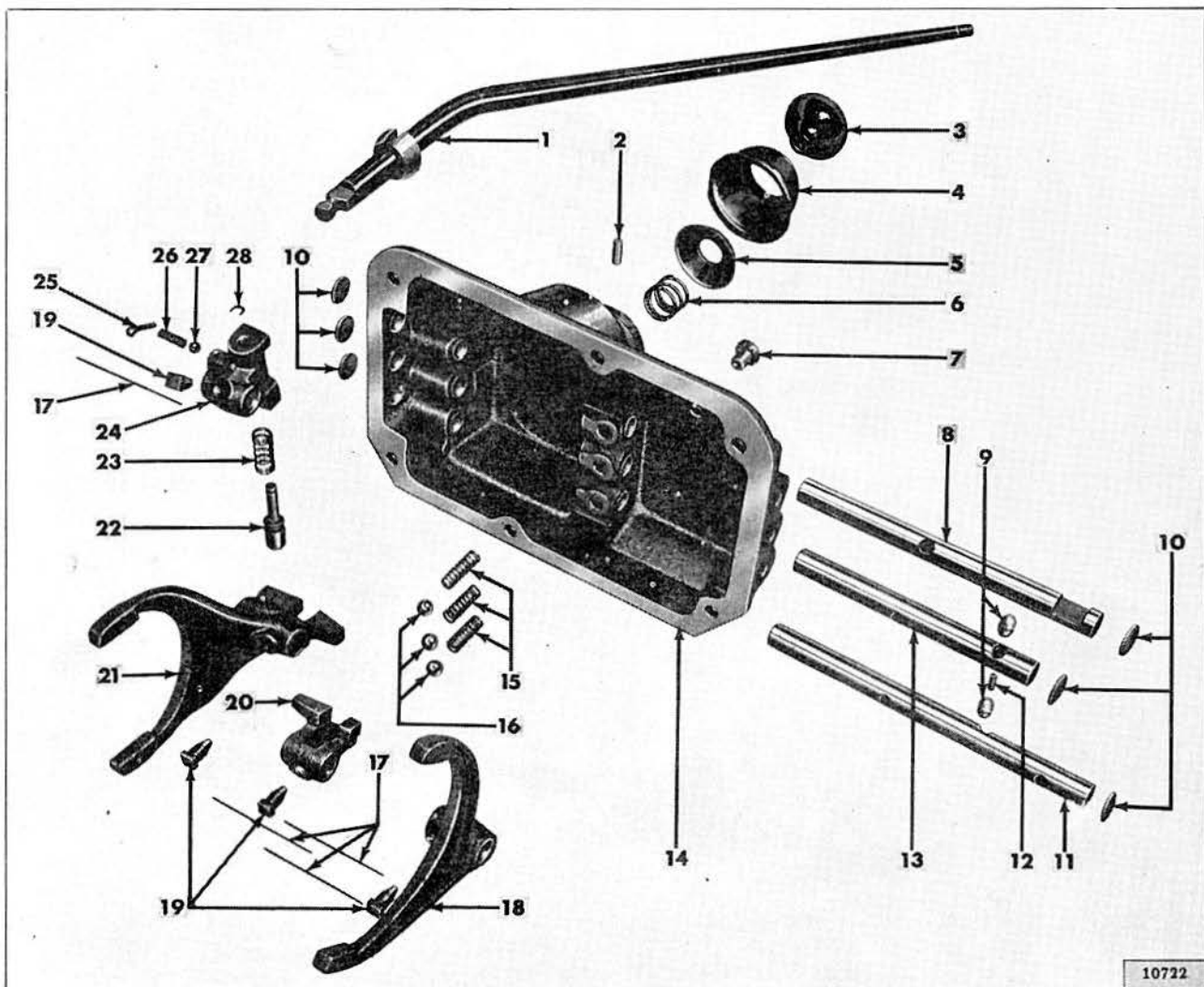


FIG. 195—FOUR-SPEED TRANSMISSION CONTROL PARTS

10722

- 1—Shift Lever
- 2—Control Housing Pin
- 3—Shift Handle
- 4—Control Housing Cap
- 5—Washer
- 6—Control Lever Spring
- 7—Breather Assembly
- 8—Reverse Shift Rail
- 9—Shift Rail Interlock Plunger
- 10—Expansion Plug

- 11—Low and Second Shift Rail
- 12—Shift Rail Interlock Pin
- 13—Direct and Third Shift Rail
- 14—Control Housing
- 15—Shift Rail Poppet Spring
- 16—Shift Rail Poppet Ball
- 17—Lockwire
- 18—Low and Second Shift Fork
- 19—Lock Screw
- 20—Shift Rail End

- 21—Direct and Third Shift Fork
- 22—Reverse Plunger
- 23—Reverse Plunger Spring
- 24—Reverse Rail End
- 25—Cotter Pin
- 26—Reverse Plunger Poppet Spring
- 27—Reverse Plunger Poppet Ball
- 28—C-Washer

v. If the synchronizer assemblies are to be disassembled and serviced proceed as follows: Wrap the second-speed synchronizer assembly in a cloth to prevent losing the lock balls and springs. Push the clutch hub out of the low-and-second-speed gear in a direction opposite the shift fork groove. Remove the cloth. Lift the balls, springs, and plates out of the hub.

w. Remove the lockplate for the countershaft and reverse idler gear shaft.

x. Use a pry bar in the slot of the reverse idler gear shaft to loosen the shaft. Then, slip the reverse idler gear shaft out of the housing and gear. Lift the reverse idler gear assembly from the transmission case.

y. To remove the countershaft, use a heavy brass drift and drive the countershaft toward the rear of the transmission case. When the countershaft end is just about even with the inside of the transmission case, use a dummy shaft to force it the remainder of the way. (Since a dummy shaft is a necessity for assembly, one should be made at this time to assist on disassembly. One can be made by using a $1\frac{1}{8}$ " [2,86 cm.] diameter steel rod cut to 9.850" [25,02 cm.] long. Break sharp edges with a mill file.) Keep the dummy shaft in contact with the countershaft at all times to prevent dropping the bearing rollers or thrust washers.

z. With the dummy shaft in position, place the transmission case on its side and carefully roll the countershaft gear cluster out of the case.

aa. Complete the disassembly by removing the dummy shaft, thrust washers, four sets of bearing rollers, and spacers.

bb. To disassemble the reverse idler gear assembly, remove one of the snap rings and tap out the washers, both sets of bearing rollers, center spacer, and sleeve. Remove the remaining snap ring.

K-13. 4-Speed Transmission Control Housing Disassembly

- Refer to Fig. 195

The gearshift lever, spring, and spring seat were previously removed for removal of the transmission from the vehicle.

a. Remove the lock wire and lock screws from the gearshift forks and gearshift rod ends. Remove the expansion plugs from the front and rear of the gearshift lever base.

b. Remove the center (third and high) gearshift rod first. Drive this gearshift rod out the rear of the gearshift lever base. As the gearshift lever is withdrawn from the center section of the gearshift base, remove the interlock pin from the crossover hole in the gearshift rod. Before the gearshift rod is removed from the center section of the gearshift base, place a finger over the hole to prevent loss of the ball and spring. Then remove the rod.

c. Remove the low- and second-speed gearshift rod in the same manner.

d. Remove the gearshift rod lock balls and springs and, with a piece of wire, push the two gearshift rod interlock plungers out of the pockets in the center section of the gearshift base.

In the reverse gearshift rod end is a spring-loaded plunger which prevents the driver from accidentally shifting into reverse gear. Should this part require servicing, proceed as follows:

Remove the cotter key from the rod end assembly and at the same time hold a finger over the hole to prevent loss of the spring. Then shake out the spring and ball. Compress the plunger and spring until the C-washer groove just clears the end of the casting. Remove the C-washer.

K-14. Assembling 4-speed Transmission

- Refer to Fig. 192.

Assemble the unit in the reverse order of disassembly noting the following points:

a. Assemble the countershaft assembly with the fabricated dummy shaft. The bronze front thrust washer and the steel backed bronze rear thrust washer should be coated with stiff lubricant and installed with the lugs engaged in the notches in the end of the gear cluster. Place the assembly in the transmission case and install the countershaft from the rear, keeping the countershaft and dummy shaft in contact to prevent dropping bearing rollers or washers. Tap the countershaft lightly into position in the front of the case but do not seat it until the reverse idler gear assembly and shaft have been installed in the case.

b. Install the reverse idler gear shaft in the case until the lock plate slot is adjacent to the slot in the countershaft. Insert the lock plate in the slots of the shafts making sure the plate ends are square with the slots. Install the lock plate screw and lockwasher to act as a pilot while tapping the shafts alternately into position in the case. Tighten the lock plate screw securely.

c. Begin assembly of the second speed synchronizer assembly (see Fig. 194) by installing the low-and-second-speed clutch hub in the low-and-second-speed gear. Install the retaining ring (19) in the speed gear. Install the retaining ring in the low and

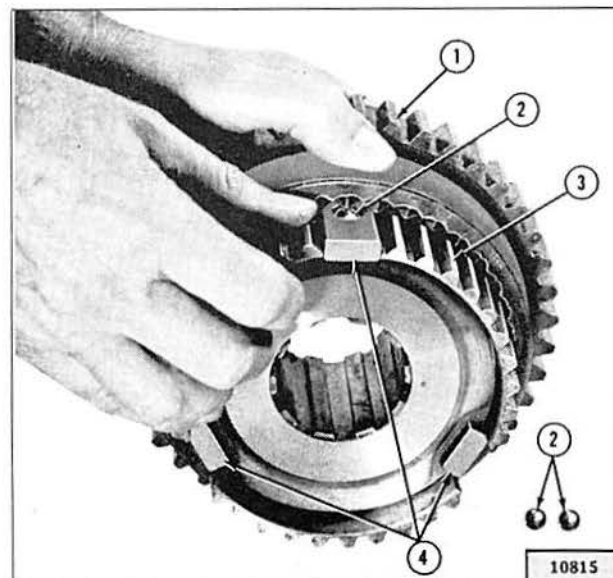


FIG. 197—ASSEMBLING SECOND-SPEED SYNCHRONIZER

second speed gear. Slide the hub out of the gear in the direction opposite the shift fork groove until the holes in the hub are clear of the gear. Install the shifter plates and springs. Push the hub back into the gear until the springs touch the internal teeth of the gear. Push one of the shifter plates toward the center of the gear while installing ball. See Fig. 197. This will hold the ball in position. Install the other two balls in the same manner. Be careful when rotating the assembly to prevent the hub from slipping out of the gear. When the balls are installed, push the hub into the gear until the balls snap into the neutral position.

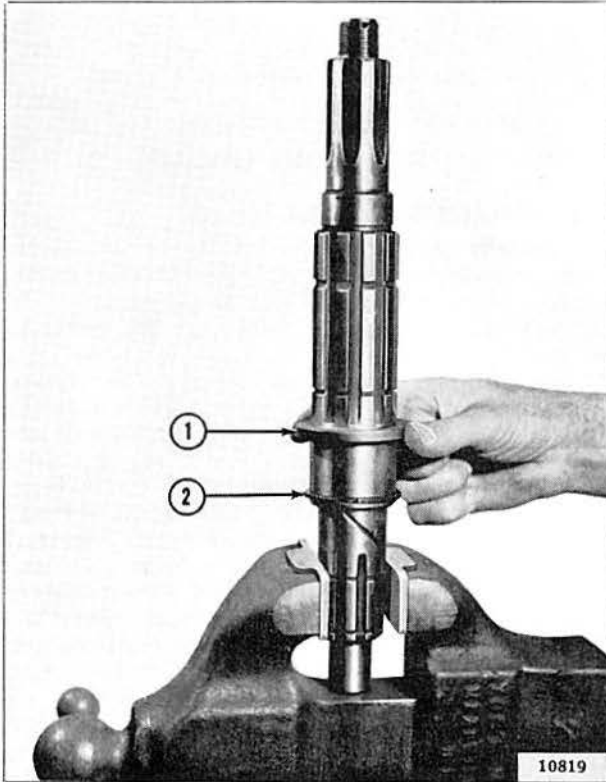


FIG. 198—SNAP RING AND THRUST WASHER INSTALLATION

d. Assemble the direct-and-third synchronizer assembly in accordance with the instructions given in Par. K-9g.

e. Start assembly of the mainshaft assembly by placing the shaft in a vise (with soft metal covering the jaws) so that the threaded end of the shaft is up. Install snap ring and thrust washer at the forward end of the second-speed gear position. See Fig. 198. Install thrust washer with the recessed side covering the snap ring.

Place a rubber band around the second-speed gear bearing surface on the shaft. Install the thirty-four bearing rollers Fig. 194 around the shaft. See Fig. 199. Install spacer on the shaft. With the tapered shoulder of the second-speed gear up, slide gear on the shaft far enough to hold the bearing rollers in place. Remove the rubber band and slide the gear down onto the thrust washer. Install the rear

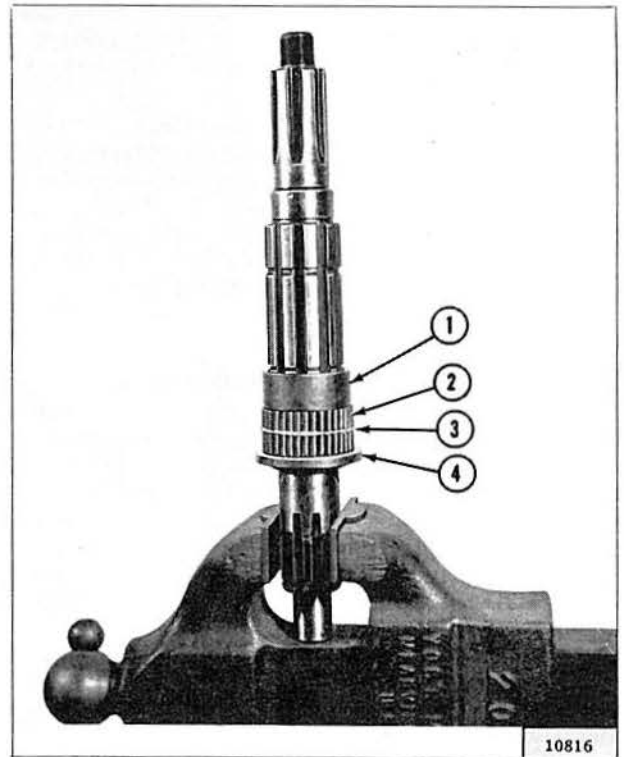


FIG. 199—SECOND-SPEED GEAR ASSEMBLY

snap ring and the blocking ring onto the tapered shoulder of the gear.

f. Install the second-speed synchronizer assembly on the mainshaft. Line up the marks made at the time of disassembly. Install the snap ring.

g. Install the third-speed gear assembly on the shaft with the tapered shoulder to the front. Slide the direct-and-third synchronizer assembly onto the mainshaft, lining up the marks made at the time of disassembly. Install snap ring.

h. Install main drive gear assembly with roller bearings in place in front of case. Install mainshaft assembly through top of case, making sure roller bearings are not knocked out of place.

i. Temporarily install main drive gear bearing retainer to support drive gear. Install snap ring on mainshaft bearing and press bearing on shaft and into case until snap ring is seated against case.

j. Remove the main drive gear bearing retainer, install the oil slinger on the drive gear. Install the snap ring on the main drive gear bearing. Then press the bearing on the shaft and into the case. Install the thickest of the four available snap rings that will fit into the groove on the main drive gear shaft.

k. Slide main drive gear bearing retainer on the shaft and hold tightly against transmission. With a feeler gauge, measure the distance between the

retainer and the case. Select gaskets that will be .003" to .005" [0,076 a 0,127 mm.] thicker than space between retainer and case. Install gaskets and retainer.

l. Complete assembly of transmission. Check condition of rear oil seal and gaskets. Reassembly of the control housing is the reverse of disassembly. Make sure safety wire is installed in all shift fork and rod and lock screws. Install new expansion plugs in base of the housing. Inspect the transmission breather for damage and replace if necessary.

K-15. Installing 4-Speed Transmission

Install the four-speed transmission in the reverse order of the removal, noting the following points: When installing the front adapter plate (Fig. 192, insert the bearing retainer in the adapter plate and position the adapter plate against the flywheel housing. With the adapter plate cap screws tight, make sure the bearing retainer can be removed freely. If not, relocate the adapter plate and tighten again to test proper location of adapter plate.

When installing rear adapter plate, be sure cap screw heads do not protrude beyond the adapter plate face or interfere with transfer case fitting tightly against rear adapter plate.

When installing transfer case gear on the transmission rear splined drive shaft tighten the large gear nut securely and insert cotter pin. Sink cotter pin well into nut slots so it will clear P.T.O. drive.

K-16. Adapter Plate Oil Seal

It is important that the four-speed transmission adapter plate oil seal be correctly installed to prevent flow of lubricant from the transfer case to the transmission. Should the lubricant level be low in the transfer case and high in the transmission, check the position of the oil seal. See Fig. 200 and 201. Correctly positioned, the lip of the oil seal is toward the transfer case. Always replace the oil seal whenever it has been removed.

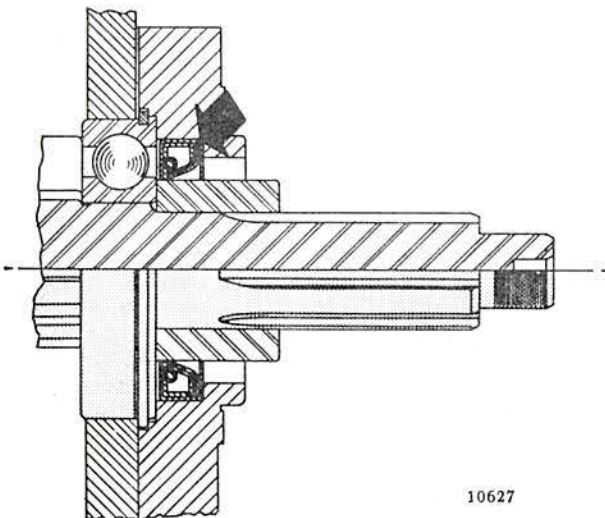


FIG. 200—INCORRECT OIL SEAL POSITION

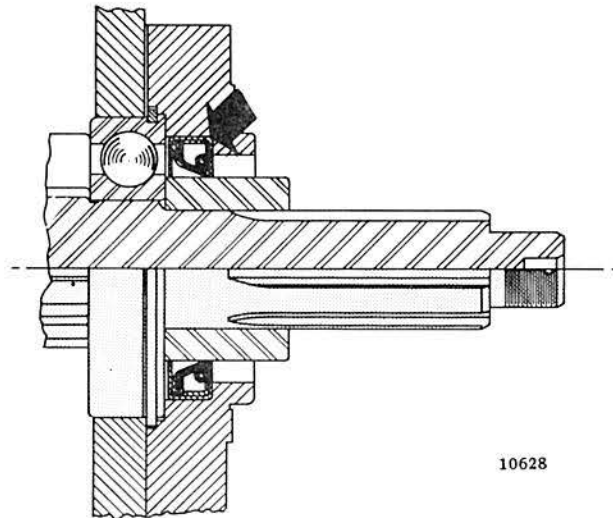


FIG. 201—CORRECT OIL SEAL POSITION

K-17. TRANSFER CASE

The transfer case is essentially a two-speed transmission located at the rear of the standard transmission which provides a low and direct gear. It also provides a means of connecting the power to the front axle.

Transfer case gears are controlled by the driver through one rod and lever in the cab which provides two- or four-wheel drive and also a high and low gear. The shift lever to the extreme rear provides 2-wheel drive by disengaging all drive to the front wheels. First position forward provides high-range 4-wheel drive. Second position forward (neutral) disengages all power to the wheels and is used primarily to provide the neutral setting necessary for the use of power take-off equipment when the vehicle is stationary. The extreme forward position provides low-range 4-wheel drive.

K-18. Removal of Transfer Case

The transfer case may be removed from the vehicle without removing the transmission. Where both transmission and transfer case are to be removed together, refer to Transmission Removal earlier in this section. To remove only the transfer case from the vehicle, proceed as follows:

- a. Drain transmission and transfer case and replace drain plugs.
- b. Disconnect the brake cable.
- c. Disconnect front and rear propeller shafts at the transfer case. See "Propeller Shafts and Universal Joints."
- d. Disconnect speedometer cable at transfer case.
- e. Disconnect the transfer case shift levers. Loosen set screw and remove pivot pin. Use a screw driver to pry shift lever springs away from shift levers. Lift levers from transfer case.
- f. Remove cover plate on rear face of transfer case. Remove cotter key, nut and washer from transmission main shaft.
- g. If possible, at this point remove the transfer case main drive gear from the transmission main shaft. If not possible, see step j below.

- h. Remove transfer case mounting bracket bolt and nut.
- i. Remove transmission to transfer case bolts.

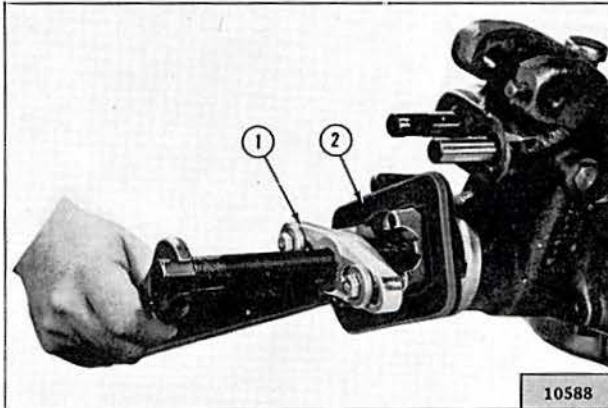


FIG. 202—UNIVERSAL JOINT FLANGE PULLER

- 1—U-Joint Flange Puller W-172
- 2—U-Joint Flange Holding Wrench C-3281

j. Remove transfer case. If the transfer case main drive gear has not been removed in step g above, proceed as follows: Brace the end of the transmission main shaft 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 main shaft bearing, which bears in both housings, remains in the transmission case.

K-19. Transfer Case Disassembly

- Refer to Fig. 196.

To remove the gears and bearings from the transfer case on the bench, the following procedure is recommended.

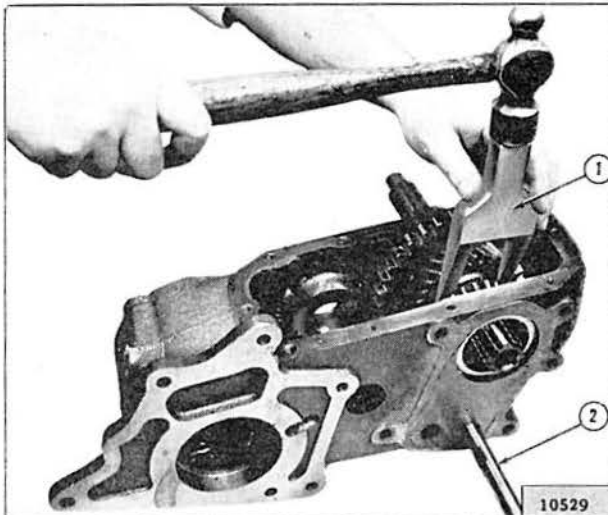


FIG. 203—BEARING CONE REMOVING WEDGE

- 1—Wedge W-139
- 2—Shift Rod

a. Remove output shaft nuts and washers using Yoke Holding Wrench, C-3281. Remove rear output shaft companion flange with brake drum

(if so equipped) and front output shaft yoke, using Tool W-172.

b. Remove cover bolts, lockwashers, and bottom cover.

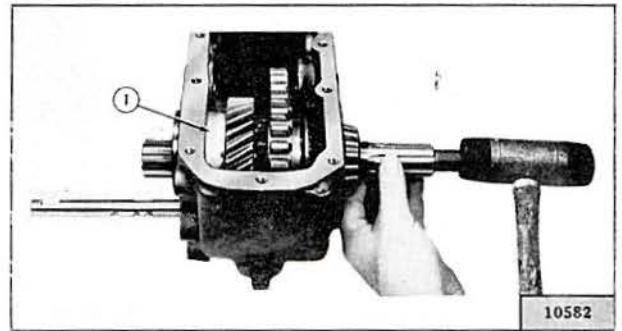


FIG. 204—BEARING CUP REMOVING RING

- 1—Removing Ring

c. Remove the lockplate screw, lockwasher, and lock plate.

d. Use a brass punch to drive out intermediate shaft to the rear of the case. Do not lose the thrust washers located at each end of the gear shaft.

e. Remove the intermediate gear, two thrust washers, needle bearings, and spacers, thru the bottom of the case.

f. Remove the poppet plugs, springs, and balls on both sides of front bearing cap. Shift front wheel shift lever to engaged position (shaft forward).

g. Remove the screws, lockwashers, holding the front bearing cap. Remove the cap as an assembly including the clutch shaft, bearing, clutch gear, fork, and shift rod. Use care not to lose the interlock which floats between the shift rods.

h. Remove the screws, lockwashers holding the brake backing plate assembly (if so equipped) and rear output cap with speedometer gear assembly. Remove entire unit as an assembly.

i. Use a rawhide hammer to drive against the front

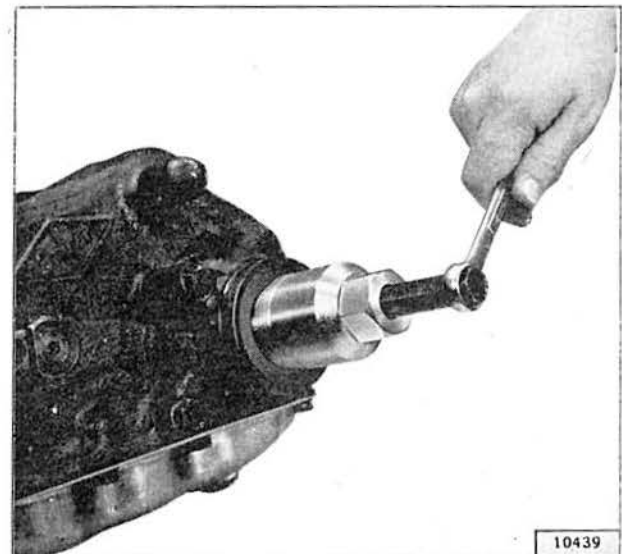


FIG. 205—PULLING OUTPUT SHAFT OIL SEAL

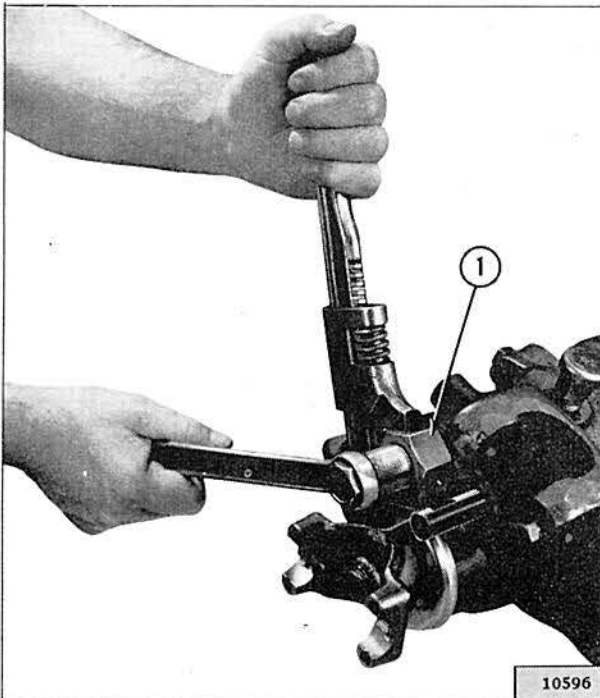


FIG. 206—SHIFT ROD OIL SEAL PULLER

1—Seal Puller

end of output shaft to drive the rear bearing cup from the case. Use Tool W-139, as shown in Fig. 203, to wedge front bearing cone and roller assembly from its seat on the shaft. Place Tool W-141, Fig. 204, on the output shaft between the front bearing and output shaft gear. Use a rawhide hammer to drive against the rear end of the output shaft to remove front bearing cup from the case. Loosen snap ring and slide it forward on the shaft. Drive the shaft thru the rear of the case. As the shaft is removed, gears, snap ring, and thrust washer will remain in the case and can be removed from the bottom. Remove rear bearing cone and roller assembly from the shaft by striking the end of the shaft lightly against a wooden block.

j. Remove the set screw in sliding gear shift fork. Remove shift rod.

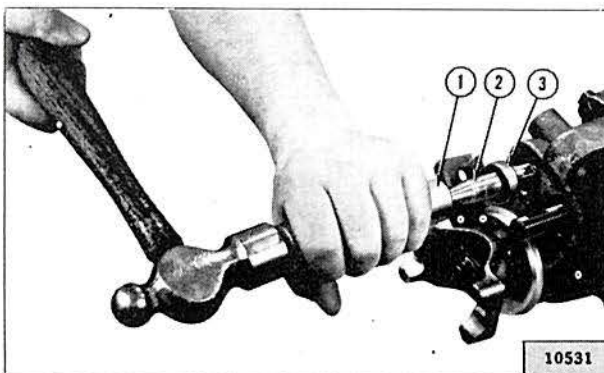


FIG. 207—SHIFT ROD OIL SEAL INSTALLER

1—Driver
2—Thimble
3—Oil Seal

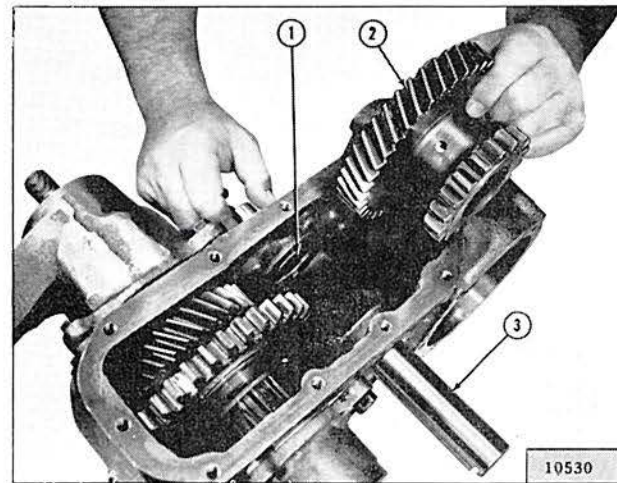


FIG. 208—THRUST WASHER PILOT

1—Pilot
2—Gear
3—Shaft

See the following paragraphs for disassembly of the front and rear bearing caps.

K-20. Front Bearing Cap Disassembly

- Refer to Fig. 196.

The front bearing cap is a separate assembly which may be removed for service. Should difficulty be experienced in this section of the transfer case, follow the sequence below for removal and disassembly.

a. Remove the output shaft yoke as outlined in Par. K-19. Remove the poppet balls and move the front wheel drive shift rod forward as outlined in Par. K-19f.

b. Remove yoke oil seal with Tool W-251, as shown in Fig. 205. Remove shift rod oil seals with Tool W-176, as shown in Fig. 206.

c. Remove the front bearing cap assembly as outlined in Par. 19g.

d. Remove the set screw from shifting fork and shifting rod. The clutch gear and shifting fork can be removed together.

e. Remove output clutch shaft assembly by carefully pressing it thru the bearing.

f. Remove bearing retainer snap ring and the bearing.

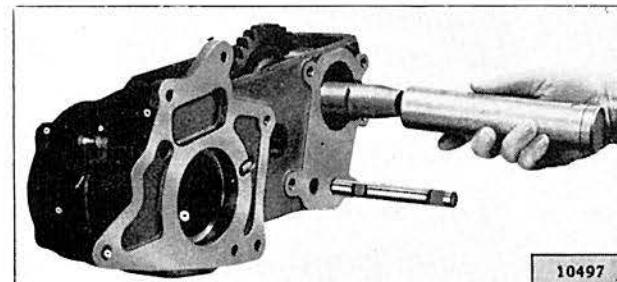


FIG. 209—OUTPUT SHAFT SNAP RING INSTALLER



FIG. 210—OUTPUT SHAFT OIL SEAL DRIVER

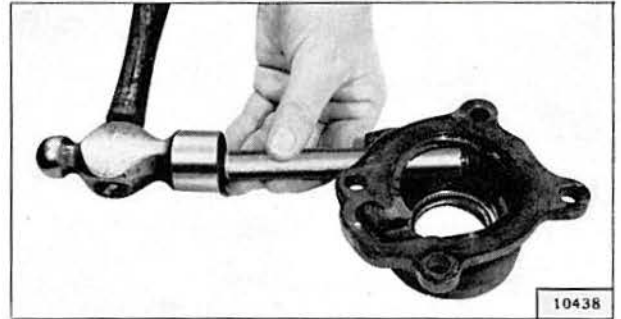


FIG. 211—SPEEDOMETER PINION BUSHING DRIVER

K-21. Rear Cap Disassembly

- Refer to Fig. 196.

The rear bearing cap is partially disassembled during the dismantling of the transfer case. The cap is, however, a separate assembly which may be removed for service. Follow the sequence below for removal and disassembly.

- Remove the output shaft rear end yoke or companion flange as outlined in Par. K-19a. Separate the brake drum and companion flange by removing bolts, lockwashers, and nuts.
- Remove the oil seal with Tool W-251, as shown in Fig. 205.
- Remove speedometer driven gear assembly.
- Remove the cap screws attaching the cap and brake backing plate to the case. Take precautions not to lose or damage bearing adjusting shims placed between the cap and the transfer case housing.
- Separate the rear cap and brake backing plate assembly. See Section P for brake service procedures.
- Remove speedometer driving gear.

K-22. Transfer Case Overhaul

- Refer to Fig. 196.

Reassembly of the transfer case is reversal of the foregoing procedure of disassembly. The output shaft snap ring may best be installed with Tool W-131, output shaft snap ring installing thimble and driver, shown in Fig. 209. Use a piece of tubing for installing the bearing cone and roller assemblies on the output shaft to prevent damage to the assemblies.

Early production transfer cases were equipped with a $1\frac{1}{8}$ " [28,58 mm.] diameter intermediate shaft and caged needle bearings. When installing the intermediate gear in early production transfer cases, insert the bearings in the gear, support the front thrust washer with Pilot Pin Tool W-192, Fig. 208, position the gears and rear thrust washer, and insert the shaft from the rear of the case.

Late production transfer cases were equipped with a $1\frac{1}{4}$ " [29,25 mm.] diameter intermediate shaft, and bearings consisting of individual rollers and spacers. A dummy shaft is required to install

the intermediate shaft. The dummy shaft should be slightly smaller in diameter than the intermediate shaft and a little shorter than the width of the intermediate gear. To install the intermediate gear, first load the bearing rollers and spacers in the gear using the dummy shaft. Then supporting the front thrust washer with the fingers, position the gears and rear thrust washer and insert the shaft from the rear of the case, driving out the dummy shaft.

Should it be necessary to replace the speedometer driven pinion bushing installation may be best made with bushing installer Tool W-133, shown in Fig. 211. When the rear bearing cap assembly is installed, check the end movement of the mainshaft which determines the adjustment of the tapered roller bearings. For correct bearing adjustment, the shaft should have .004" to .008" [0,102 a 0,203 mm.] end play. Adjustment is made by selective shim installation between the cap and the case. Shims .003", .010" and .031" [0,076, 0,254, 0,787 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 W-143, shown in Fig. 210.

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. When installing the shift rail oil seals in the front bearing cap, it is necessary to protect the seals against damage when passing over the shift rail notches. Protect them with the thimble, and install them with the driver, Tool W-130, shown in Fig. 207.

K-23. Transfer Case Installation

The installation of the assembly in the vehicle is the reverse of the removal operation covered in Par. K-5.

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 cm.] free travel as outlined in the "Clutch Section".

K-24. TRANSMISSION SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Lock in Two Gears	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

K-25. TRANSFER CASE 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 Transmission and Transfer Cases	Install New Gaskets
Grease Leak at Output Shaft	Install New Oil Seal

K-26. TRANSMISSION SPECIFICATIONS

	3-SPEED		4-SPEED
Vehicle:	CJ-2A, CJ-3A, CJ-3B CJ-5, CJ-6	DJ-3A	CJ-5, CJ-6
Make.....	Warner	Warner	Warner
Model.....	T90C (CJ-2A, CJ-3A, T90)	T96	T98A
Type.....	Synchronous Mesh	Synchronous Mesh	Synchronous Mesh
Shift Lever Location..... (CJ-2A Before Ser. 38221, on Steering Post)	On Floor	Steering Post	On Floor
Speeds.....	3 Forward — 1 Reverse	3 Forward — 1 Reverse	4 Forward — 1 Reverse
Ratios:—First.....	2.798 to 1	2.605 to 1	6.398 to 1
Second.....	1.551 to 1	1.630 to 1	3.092 to 1
Third.....	1.000 to 1	1.000 to 1	1.686 to 1
Fourth.....			1.000 to 1
Reverse.....	3.798 to 1	3.536 to 1	7.820 to 1
Interlock Poppet Clearance.....		.001" to .007" [0.025 a 0.178 mm.]	

K-27. TRANSFER CASE SPECIFICATIONS

Transfer Case:		All Models
Make.....		Spicer
Model.....		18
Shift Lever.....		On Floor
Gear Ratio:		
High.....		1.00 to 1
Low.....		2.46 to 1

PROPELLER SHAFTS AND UNIVERSAL JOINTS

L-1. GENERAL

The drive of 'Jeep' Universal models from the transfer case to the front and rear axles is through two tubular propeller shafts, each shaft having two cardan cross universal joints. The drive of 'Jeep' Dispatcher models from the transmission to the rear axle is through a tubular propeller shaft having two cardan cross universal joints. Propeller shafts and universal joints should be checked for foreign matter around the shafts, dented or bent shafts, and loose attaching bolts.

L-2. 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. 213. When installing, align the arrows in the

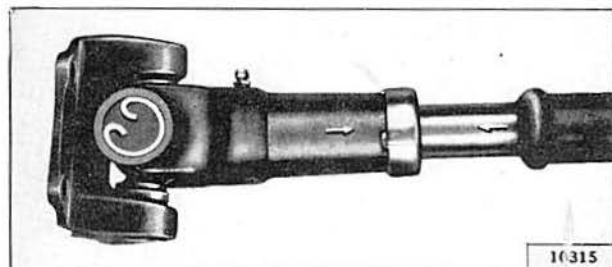


FIG. 213—ARROW MARKINGS

others of the "Snap Ring" type. This difference is in the attachment of the joints only. 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.

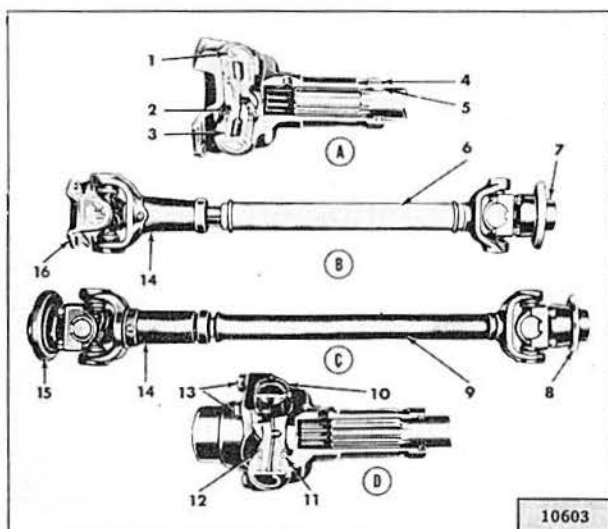


FIG. 212—UNIVERSAL JOINTS

- | | |
|-------------|-------------------|
| 1—Snap Ring | 9—Front Tube |
| 2—Journal | 10—"U" Bolt |
| 3—Bearing | 11—Retainer |
| 4—Dust Cap | 12—Gasket |
| 5—Washer | 13—"U" Bolt Nut |
| 6—Rear Tube | 14—Sleeve |
| 7—Yoke End | 15—Front Yoke End |
| 8—Yoke End | 16—Flange Yoke |

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 used are similar in construction except that some are of the "U"-bolt type and

L-3. Snap Ring Type Disassembly

This type joint is illustrated in Fig. 212. 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. Use a soft ground drift with a flat face about $\frac{1}{32}$ " [0,8 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.

L-4. Snap Ring Type Assembly

Wash all parts in cleaning solvent and inspect the parts after cleaning. Replace any parts that indicate extensive wear. It is advisable to install new gaskets on the journal assembly regardless of the condition of the old gaskets. Make certain that the grease channel in each journal trunnion is open.

Pack the bearing cones one-third full of lubricant and install the rollers.

Draw the bearings into the end yoke arm and seat them firmly against the bearing shoulders. Hold the bearings in a vertical position to prevent the needles from dropping out until the joint is assembled. If the joint binds when assembled, tap

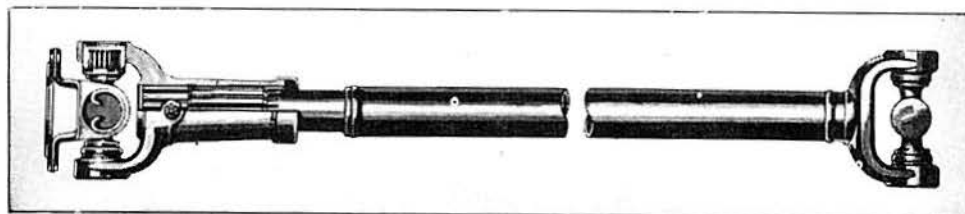


FIG. 214—PROPELLER SHAFT AND UNIVERSAL JOINTS—NEEDLE BEARING TYPE

the arms lightly to relieve any pressure on the bearings at the end of the journal.

L-5. U-Bolt Type Disassembly

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 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. Use a soft ground drift with a flat face about $\frac{1}{32}$ " [0,8 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.

L-6. U-Bolt Type Assembly

Wash all parts in cleaning solvent and inspect the parts after cleaning. Replace any parts that indicate extensive wear. It is advisable to install new gaskets on the journal assembly regardless of the condition of the old gaskets. Make certain that the grease channel in each journal trunnion is open.

Pack the bearing cones one-third full of lubricant and install the rollers.

Draw the bearings into the end yoke arm and seat them firmly against the bearing shoulders. Hold the bearings in a vertical position to prevent the needles from dropping out until the joint is assembled. If the joint binds when assembled, tap the arms lightly to relieve any pressure on the bearings at the end of the journal. Tighten the U-bolts equally. U-bolt torque wrench reading is 15 to 20 lb-ft. [2,07 a 2,76 kg-m.].

When installing the assembly in the vehicle be sure that the arrows on the propeller shaft and yoke sleeve are in alignment as shown in Fig. 213, or that the unmarked joints are aligned with the yokes in the same parallel plane.

SPECIFICATIONS

L-7. PROPELLER SHAFTS AND UNIVERSAL JOINTS

PROPELLER SHAFTS:

Dimensions:	SPICER			
	Front		Rear	
	O.D.	Length	O.D.	Length
CJ-2A, CJ-3A	$1\frac{1}{4}$ " [3,175 cm.]	$22\frac{31}{32}$ " [58,34 cm.]	$1\frac{1}{4}$ " [3,175 cm.]	$19\frac{7}{16}$ " [49,37 cm.]
CJ-3B	$1\frac{1}{4}$ " [3,175 cm.]	$33\frac{1}{16}$ " [58,57 cm.]	$1\frac{3}{4}$ " [4,45 cm.]	$19\frac{15}{16}$ " [50,64 cm.]
CJ-5 3-speed	$1\frac{1}{4}$ " [3,175 cm.]	$23\frac{7}{8}$ " [60,64 cm.]	$1\frac{3}{4}$ " [4,45 cm.]	$19\frac{15}{16}$ " [50,64 cm.]
4-speed	$1\frac{1}{4}$ " [3,175 cm.]	$28\frac{1}{4}$ " [71,75 cm.]	$1\frac{3}{4}$ " [4,45 cm.]	$14\frac{7}{16}$ " [36,67 cm.]
CJ-6 3-speed	$1\frac{1}{4}$ " [3,175 cm.]	$23\frac{7}{8}$ " [60,64 cm.]	$1\frac{3}{4}$ " [4,45 cm.]	$39\frac{1}{2}$ " [100,33 cm.]
4-speed	$1\frac{1}{4}$ " [3,175 cm.]	$28\frac{1}{4}$ " [71,75 cm.]	$1\frac{3}{4}$ " [4,45 cm.]	$34\frac{11}{32}$ " [87,23 cm.]
DJ-3A	$1\frac{1}{4}$ " [3,175 cm.]		$1\frac{3}{4}$ " [4,45 cm.]	$26\frac{15}{32}$ " [67,23 cm.]

UNIVERSAL JOINTS:

Make	Spicer
Type	Cardan Cross
Bearing	Antifriction

FRONT AXLE

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Bendix Universal Joints.....	M-7	Steering Bellcrank.....	M-18
Differential.....	M-3, M-17	Steering Knuckle Oil Seal.....	M-16
Front Axle.....	M-2, M-9, M-20	Steering Knuckle Pivot Pins.....	M-14, M-21
Rzeppa Universal Joints.....	M-8	Steering Tie Rod.....	M-18
Service Diagnosis.....	M-22	Turning Angle.....	M-19
Specifications.....	M-23	Universal Joints.....	M-6
Spicer Universal Joints.....	M-13		

M-1. GENERAL

The front axle for all 'Jeep' Universal models, which have 4-wheel drive, is described in Par. M-2. The front axle for all 'Jeep' Dispatcher models, which have 2-wheel drive, is described in Par. M-20.

M-2. 4-WHEEL-DRIVE FRONT AXLE

- Models CJ-2A, CJ-3A, CJ-3B, CJ-5, CJ-6

The front axle is 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 constant velocity universal joints which revolve in the steering knuckles. The steering knuckle tie rod arm is made integrally with the knuckle (except on Model CJ-2A before Serial No. 22972 on which the arm is attached to the top of the knuckle by studs and nuts) and the knuckles are connected by a divided tie rod to a steering bell

crank. A steering connecting rod connects the bell crank to the steering gear arm. The divided tie rod is adjustable and the toe-in of each front wheel is adjusted independently. 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 "Steering Section."

Note: Whenever an axle is inspected, see if the ring gear lock straps 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. N-10.

M-3. Removing and Overhauling Differential

Adjustment and overhaul of the front axle differ-

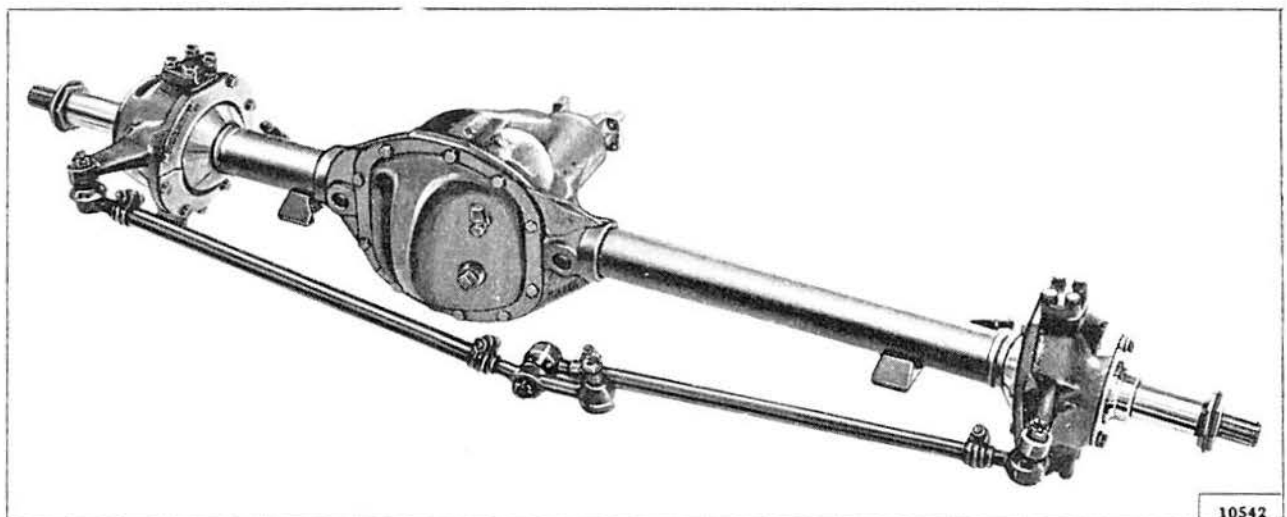


FIG. 215—FRONT AXLE HOUSINGS AND SHAFTS

ential assembly is the same as that of the rear axle. Information covering servicing of the differential is contained in Section N.

M-4. Front Axle Overhaul

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 Section N for full information regarding master gauge used when setting the ring and pinion gears on all front axles.

Note: Effective with Model CJ-3A vehicle Serial No. 62488, a change was made in front axles of Spicer Manufacture. The distance on the pinion shaft from the back face of the gears to the shoulder for the outermost bearing was increased in order to eliminate the bearing spacer. With this change, the shims are placed between the shoulder on the pinion shaft and the bearing. No difficulty will be experienced in service if the bearing spacer is used with the drive pinion having the extended shoulder.

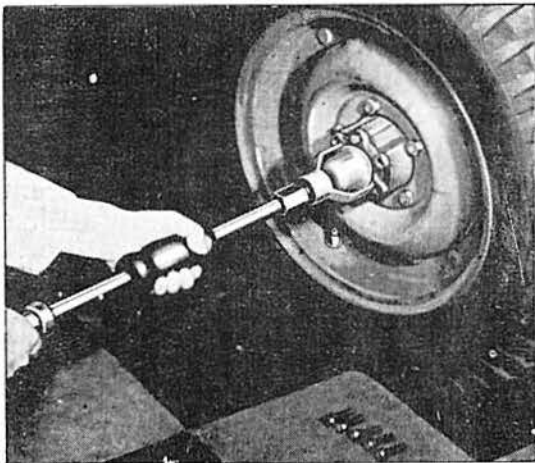


FIG. 216—HUB CAP PULLER

M-5. Front Axle Removal

To remove an axle shaft and universal joint assembly, the following operations must be performed:

- a. Remove the wheel.
- b. Remove the hub cap with a puller as shown in Fig. 216.
- c. Remove the axle shaft driving flange bolts.
- d. Apply the foot brakes and remove the axle shaft flange with puller W-163 which is illustrated in Fig. 217.
- e. Release the locking lip on the lockwasher and remove the outer nut, lockwasher, adjusting nut and bearing lockwasher. Use wrench W-144, Fig.

218, 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.



FIG. 217—AXLE SHAFT DRIVE FLANGE PULLER

M-6. UNIVERSAL JOINTS

The Bendix type and Rzeppa type universal joints illustrated in Fig. 219 and 220 and the Spicer type shown in Fig. 221 are used in production. Service procedure covering all three joints is outlined below.



FIG. 218—WHEEL BEARING NUT WRENCH

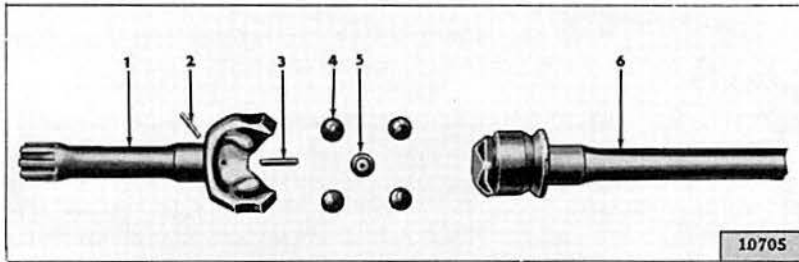


FIG. 219—BENDIX FRONT AXLE UNIVERSAL JOINT

- 1—Outer Shaft
- 2—Lock Pin
- 3—Center Ball Pin
- 4—Universal Joint Ball
- 5—Center Ball
- 6—Inner Shaft

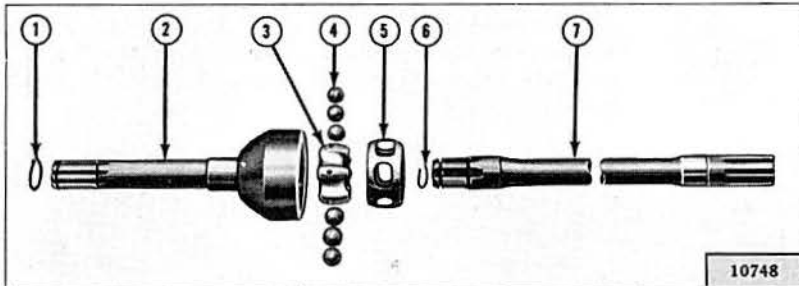


FIG. 220—RZEPPA FRONT AXLE UNIVERSAL JOINT

- 1—Outer Axle Shaft Snap Ring
- 2—Outer Shaft
- 3—Universal Joint Inner Race
- 4—Ball
- 5—Cage
- 6—Axle Shaft Retainer Snap Ring
- 7—Inner Shaft

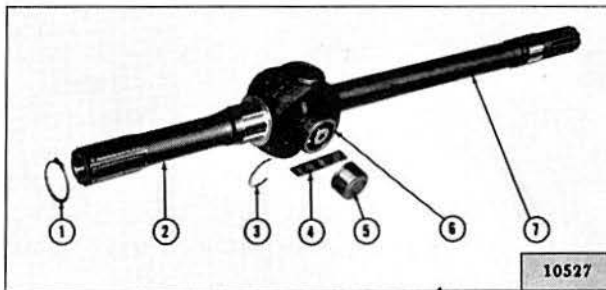


FIG. 221—SPICER FRONT AXLE UNIVERSAL JOINT

- 1—Outer Axle Shaft Snap Ring
- 2—Outer Shaft
- 3—Bearing Retainer Snap Ring
- 4—Bearing Rollers
- 5—Bearing Retainer
- 6—Universal Joint Journal Assembly
- 7—Inner Shaft

M-7. Bendix Universal Joint

With ordinary shop equipment it is nearly impossible to satisfactorily rebuild the Bendix type axle shaft universal and when possible the cost is usually nearly equal to the cost of a new assembly. For this reason the factory no longer supplies component parts. After considerable mileage a joint assembly may pull apart upon removal from the vehicle. This does not necessarily mean that the assembly is no longer serviceable, for usually when it is reassembled as outlined below it will be found satisfactory. After reassembly grasp both ends of the shaft in the hands and twist the ends back and forth. Should excessive wear be indicated by the back lash or lost motion the assembly should be replaced.

The universal joint cannot possibly become disassembled after it is installed in the vehicle. To reassemble the axle shaft and universal joint follow the sequence outlined below:

- a. Place the differential half of the axle shaft in a vise, with the ground portion above the jaws.
- b. Install the center ball (one with hole drilled in it) in the socket in the shaft, with the hole and groove facing you.
- c. Drop the center ball pin into the drilled passage in the wheel half of the shaft.
- d. Place the wheel half of the shaft on the center ball. Then slip three balls into the raceways.
- e. Turn the center ball until the groove lines up with the raceway for the remaining ball. See Fig. 222.

Slip the ball into the raceway and straighten up the wheel end of the shaft.

- f. Turn the center ball until the center ball pin drops into the hole drilled in the ball.
- g. Install the retainer pin (lock pin) and prick punch both ends to securely lock it in place. Always use a new retainer pin if available. See Fig. 223.

M-8. 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.
- 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. Push down on various points of the inner race and cage until the balls can be removed with the



FIG. 222—BENDIX UNIVERSAL JOINT BALLS

help of a small screw driver in the manner illustrated in Fig. 224.

e. There are two large elongated holes in the cage as well as four small holes. Turn the cage so the two bosses in the spindle shaft will drop onto the elongated holes and lift out the cage. See Fig. 225.

f. To remove the inner race, turn it so one of the bosses will drop into an elongated hole in this cage and shift the race to one side and lift it out.

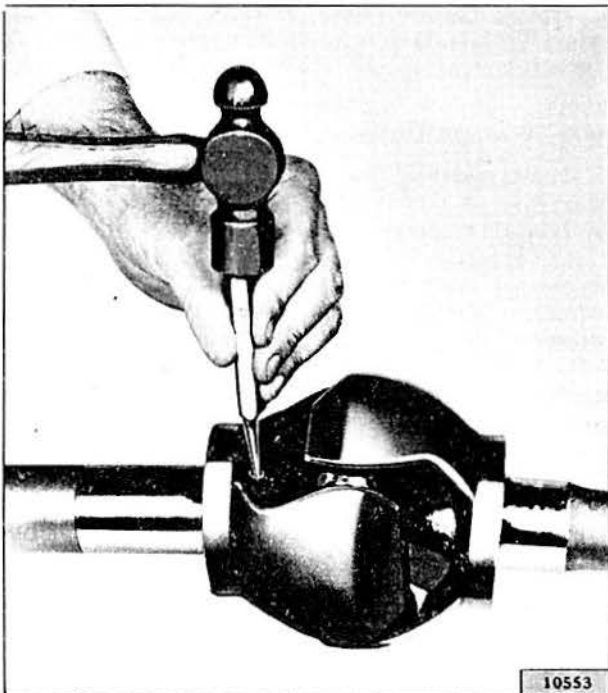


FIG. 223—INSTALLING BENDIX JOINT LOCK PIN

g. Reassembly of the joint is the reverse of dismantling. Be careful not to damage parts and see that they are clean of all dirt and grit.

M-9. Change in 4-Wheel Drive Front Axles

A change in design of the front axle of four-wheel drive vehicles was placed in production effective with Serial No. 37549 on Model CJ-3A. In the new design the front axle shaft outer splined end floats in the wheel driving flange and is not retained by a nut and lockwasher as originally used. With this construction it is no longer necessary to install shims between the driving flange and wheel hub to provide the correct end float of the axle shaft universal joint.

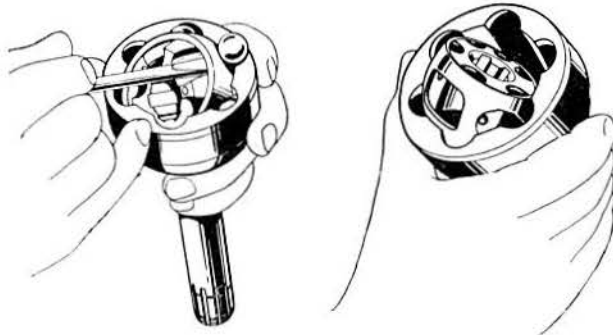


FIG. 224—DISMANTLING RZEPPA JOINT

The new construction, when using the Bendix type axle shaft, is shown in Fig. 226. Note that the end float of the Bendix type joint is predetermined in manufacture by the position and flange thickness of the bushing and the thrust washer shown as solid black areas in Fig. 226. These parts are so positioned and of the correct thickness to provide .088" [2.24 mm.] maximum end float of the universal joint and also to allow the center point of the joint to operate at the center line of the spindle pivot pins. With the correct joint end float controlled by the bushing flange and the thrust washer, it is no longer necessary to install shims between the driving flange and wheel hub, a gasket only being used.

The new type Bendix axle shaft and universal joint may be readily installed in an old type axle by installing the new type flanged bushing. When this is done, discard the shims previously installed between the driving flange and wheel hub, installing a gasket only. The installation of the flange bushing will provide correct clearances and position of the joint. The flanged bushing requires no reaming as it is so designed that when it is pressed into the spindle it will be compressed to provide correct running clearance. Coat the inner surface of the bushing with chassis grease before installing the spindle.

The axle construction is similar for installation of the Rzeppa joint, shown in Fig. 226 or the Spicer Joint shown in Fig. 227. The thrust washer is not necessary although it is installed in all axles to allow installation of the Bendix type shaft if so

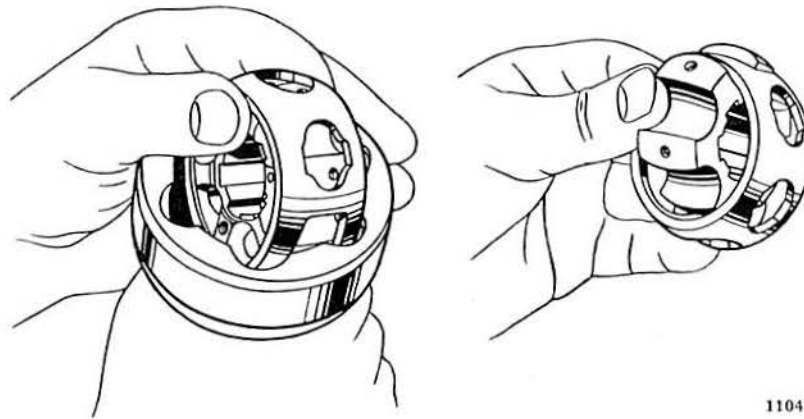
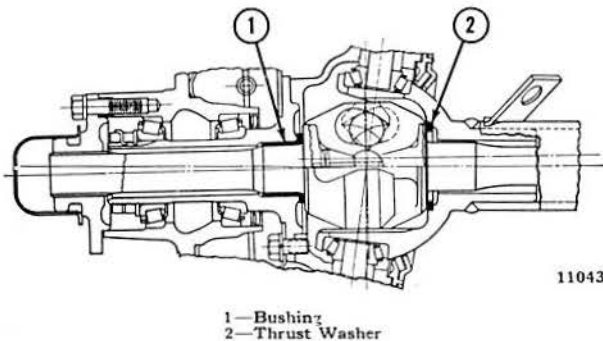


FIG. 225—REMOVING RZEPPA JOINT CAGE

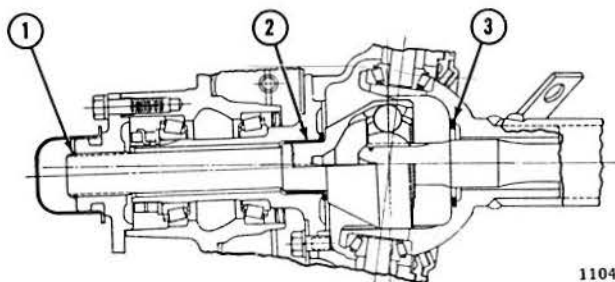
desired. As the thrust washer is not effective, a snap ring is installed at the outer end of the shaft to control end float.

Either Bendix or Rzeppa old type axle shaft may be installed in the new type axle. It is advisable,



11043

1—Bushings
2—Thrust Washer



11044

FIG. 226—BENDIX AND RZEPPA TYPE AXLE SHAFT AND UNIVERSAL JOINT

1—Snap Ring
2—Bushings
3—Thrust Washer

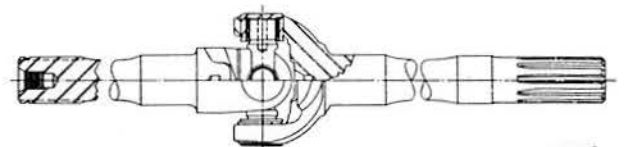
however, to make the installation in the same manner as in the past, installing shims and checking end float as outlined below.

When installing old type axle shafts it is necessary to determine the thickness of the shim pack which must be installed between the driving flange and the wheel hub to provide operating clearance for the universal joint. To do this, first install the drive flange on the axle splines without shims. Install the axle nut and draw it up snugly. Install two opposite flange screws and draw up snug but not tight. Use a feeler gauge to measure the space be-

tween the outer end of the wheel hub and the inner face of the driving flange. This will determine the amount of shims to be installed. In order to have proper clearance in the universal joint, it is necessary to install shims equal to the space as measured by the feeler gauge plus .015" to .050" [0,381 a 1,270 mm.]. Should no clearance be found between the driving flange and hub, install .010" [0,254 mm.] shim.

Remove the driving flange and install the correct amount of shims as determined by this measurement. Replace the driving flange and install the six capscrews. Install the axle shaft nut and recheck to make certain that the proper end float has been obtained. To make this check first back off the axle shaft nut so a .050" [1,270 mm.] thickness gauge will go between the nut and the driving flange. Tap end of shaft with lead hammer which will force the shaft in the amount of the end float. Measure the clearance between the nut and the driving flange. If there is less than .015" add to thickness of shim pack; if more than .050" remove correct amount of shims.

The parts necessary to install the new type axle shaft assemblies in old type axles have been made



10886

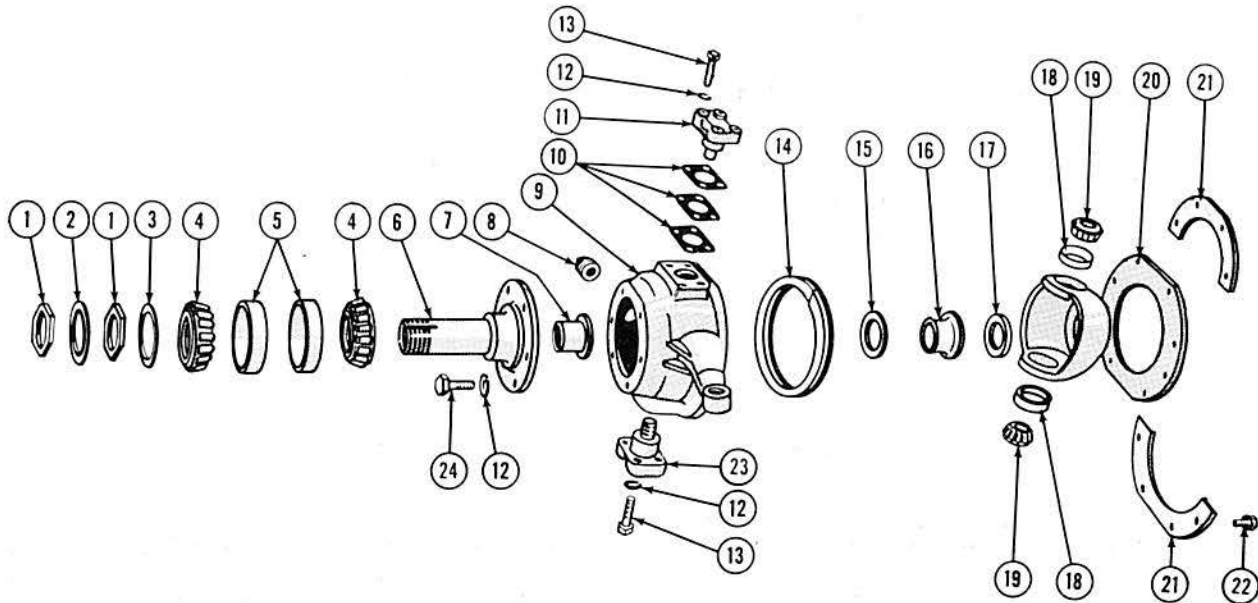
FIG. 227—SPICER UNIVERSAL JOINT

into kits, the part numbers of which are listed below.

Part No.	Models CJ-2A and CJ-3A
800611	Bendix Type Left Assembly
800612	Bendix Type Right Assembly
800613	Rzeppa Type Left Assembly
800614	Rzeppa Type Right Assembly

M-10. Installation — Bendix Type Shaft

To install the Bendix type axle shaft and universal joint assembly in the housing proceed as outlined below.



10554

FIG. 228—STEERING KNUCKLE AND WHEEL BEARINGS

1—Bearing Adjusting Nut
2—Lockwasher
3—Lockwasher
4—Bearing Cone and Rollers
5—Bearing Cup
6—Spindle
7—Bushing
8—Filler Plug

9—Left Knuckle and Arm
10—Shims
11—Upper Bearing Cap
12—Lockwasher
13—Bolt
14—Oil Seal and Backing Ring
15—Thrust Washer
16—Axle Pilot

17—Oil Seal
18—Bearing Cup
19—Bearing Cone and Rollers
20—Oil Seal
21—Retainer
22—Bolt
23—Lower Bearing Cap
24—Bolt

- 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.
- c. Install wheel bearing spindle Fig. 228.
- 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 "Steering" Section.
- j. Bleed the brakes.
- k. Fill the universal joint housing with lubricant through the filler plug opening.

M-11. Installation — Rzeppa Type Joint

- In Early Type Steering Knuckle.

Installation of the Rzeppa-type axle shaft and universal joint in steering knuckles not equipped with spindle bushing Fig. 228, is the same as outlined above for the Bendix-type joint except

the shimming procedure as covered in Par. M-9. When the Rzeppa joint is installed, disregard instructions for shim installation and install .060" [1,524 mm.] shims.

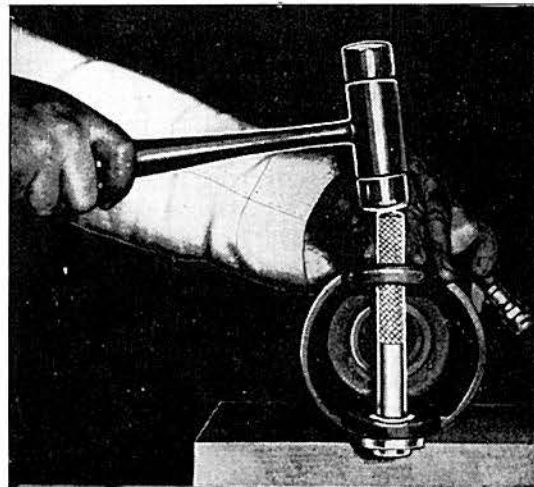


FIG. 229—SPINDLE PIN BEARING CUP DRIVER

M-12. Installation — Rzeppa Type Joint

- In Late Type Steering Knuckle.

Installation is the same as that outlined in Par. M-10 for the Bendix-type joint except that a snap ring is used at the outer end of the shaft to control end float.

M-13. Spicer Universal Joints

The Spicer Universal Joint is shown in Fig. 227 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. 227.

The axle shaft and joint are removed and installed in the same manner as the Rzeppa joints. Service procedures will be found in Section L.

M-14. Steering Knuckle Pivot Pins

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. 228 which hold the oil seal retainer in place.
- b. Remove the four screws holding the lower pivot pin bearing cap.
- c. Remove the four screws holding the upper bearing cap in place (on early Model CJ-2A vehicles, nuts also attach the steering arm). Remove the brake hose shield (on Models CJ-2A and CJ-3A) and the bearing cap. The steering knuckle 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 W-138.

NOTE: On Model CJ-2A shim packs were used under both the top and bottom bearing caps and

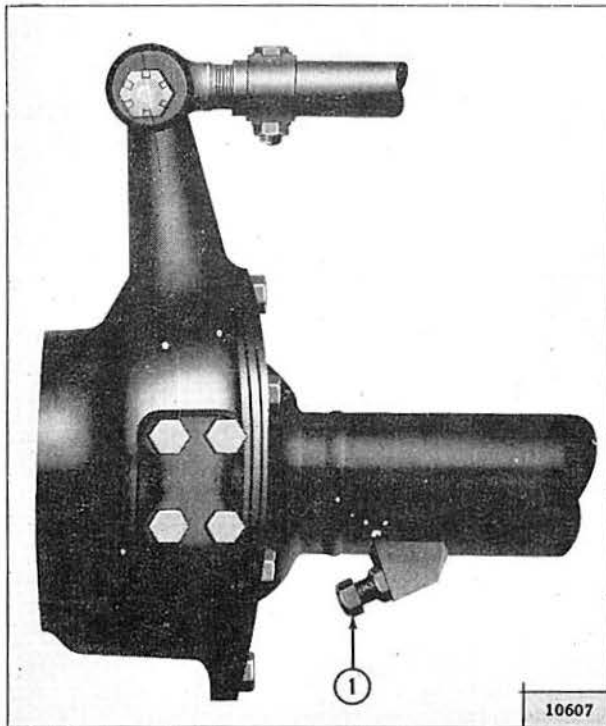


FIG. 230—TURNING ANGLE STOP SCREW
1—Stop Screw

adjustment is made to both shim packs to obtain correct preload, keeping the shim pack thickness the same under each bearing cap.

On Model CJ-3A and later models .058" [1,47 mm.] was added to the bottom face of the king pin boss on the steering knuckles. This eliminated the lower king pin bearing shims and the adjustment is made by shims at the top bearing cap only.

M-15. Reassembly

Reverse the procedure of Par. M-14 to reassemble the unit. When reinstalling the steering knuckle, sufficient shims must be installed under the top bearing cap to obtain correct preload on the bearing. 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. Install the bearing caps, lockwashers, and screws, and tighten securely.

Check the preload on the bearings by hooking a spring scale, Tool C-690, 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 kingpin bearing preload should be 12 to 16 lb. [5,43 a 7,24 kg.] with the oil seal removed. Remove or add shims to obtain a preload within these limits. If all shims are removed and adequate preload is still not obtained, a washer may be used under the top bearing cap to increase preload. When a washer is used, shims may have to be reinstalled to obtain proper adjustment.

M-16. 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.

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.

M-17. Removing and Overhauling Differential

Adjustment and overhaul of the front axle differential assembly is the same as that of the full floating type rear axle used on early type Model CJ-2A vehicles. Information covering dismantling and assembling of this differential is contained in Section N.

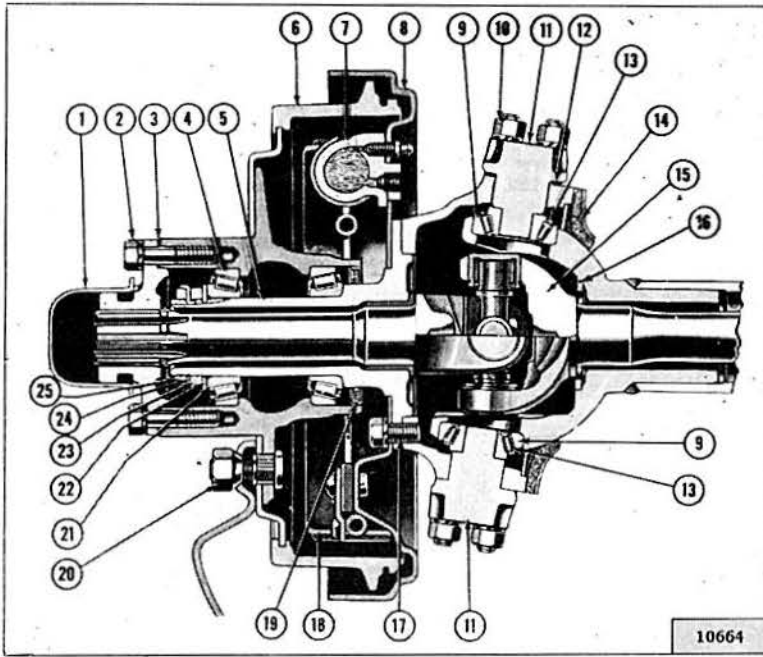


FIG. 231—FRONT STEERING KNUCKLE (With Spicer Universal Joint)

- 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 Seal
- 15—Front Axle Universal Joint
- 16—Thrust Washer
- 17—Brake Backing Plate Screw
- 18—Brake Shoe and Lining
- 19—Hub Oil Seal
- 20—Wheel Hub Bolt Nut
- 21—Wheel Bearing Cone and Rollers
- 22—Wheel Bearing Washer
- 23—Wheel Bearing Retaining Nut
- 24—Wheel Adjusting Nut Lock Washer
- 25—Wheel Bearing Retaining Nut

NOTE: All service replacement axle assemblies are shipped from the factory without lubricant in the differential. Lubricant must be added to the differential before the axles are installed in vehicles. Use the grade and quantity of lubricant specified in the appropriate service manual. After the axle has been installed in the vehicle, check to be sure the lubricant level in the differential is level with the fill plug opening.

When adjusting the ring gear and pinion with the special adjusting fixture use gauge block "D" for all front axles.

M-18. Steering Tie Rod and Bell Crank

These parts of the front axle are covered in the Section O.

M-19. 4-Wheel Drive Turning Angle

Adjustment and service information regarding turning angles is covered in the Section O.

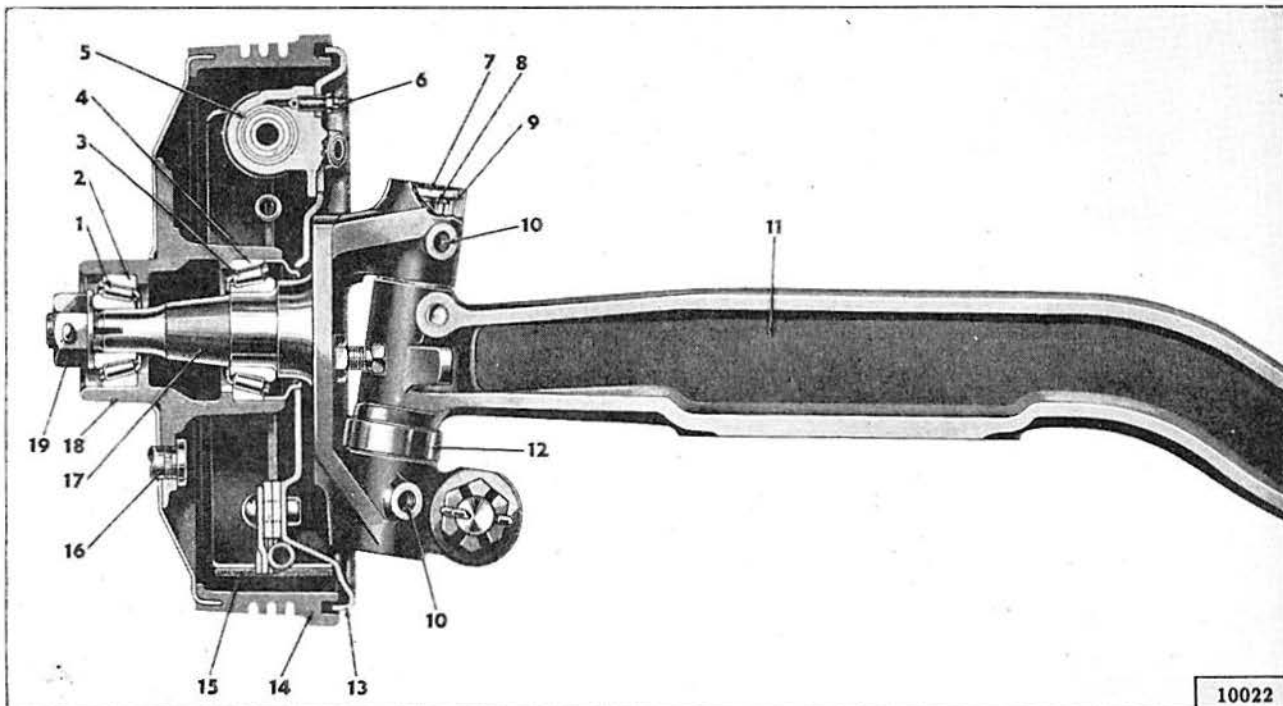


FIG. 232—FRONT AXLE—MODEL DJ-3A.

- | | | |
|----------------------------------|-----------------------------------|------------------------|
| 1—Outer Bearing Cone and Rollers | 7—Upper Pivot Bolt Expansion Plug | 13—Brake Backing Plate |
| 2—Outer Bearing Race | 8—Pivot Bolt | 14—Brake Drum |
| 3—Inner Bearing Cone and Rollers | 9—Steering Knuckle Bushing | 15—Brake Shoe |
| 4—Inner Bearing Race | 10—Lubrication Fitting Opening | 16—Wheel Hub Bolt |
| 5—Wheel Brake Cylinder | 11—Front Axle I-Beam | 17—Spindle |
| 6—Bleeder Screw | 12—Pivot Bolt Thrust Ball Bearing | 18—Front Wheel Hub |
| | | 19—Spindle Nut |

M-20. MODEL DJ-3A FRONT AXLE

The front axle is of the reverse Elliot type. It is a steel forging, heat treated for strength and machined to close limits. 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 with tapered pins and nuts. The knuckles ride on ball thrust bearings for ease of steering. See Fig. 232.

The knuckles are connected by a tie rod which is mounted on ball and socket connections. The tie rod is adjustable to secure correct toe-in of the front wheels. A steering connecting rod connects the left knuckle arm with the steering gear arm. Standard caster and camber of the front wheels are built into the front axle. Wheel camber cannot be changed however, caster can be adjusted by placing tapered shims or wedges between the springs and spring seats. For complete information regarding the steering geometry refer to the Section O.

M-21. Pivot Pin Replacement

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. 232.

- a. Jack up the front of the vehicle to free the wheels. Install axle stands under the front axle for safety's sake.
- b. Remove the hub cap and dust cap.

- c. Remove the wheel retaining cotter pin, nut, and washer.
- d. Remove the wheel with 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. Remove the upper pivot bolt expansion plug.
- i. Drive the pivot bolt and lower pivot bolt expansion plug out through the bottom. When the spindle is disassembled, do not lose the spacing shim between the upper face of the axle and the spindle.
- j. Remove the thrust bearing and bushings.
- k. Assemble in reverse order. Be sure the oil holes in the bushings are aligned with the lubrication fittings. 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 tapered 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 are available in the following thicknesses:

- .011" [0,279 mm.] .035" [0,889 mm.]
- .033" [0,838 mm.]

Do not overlook bleeding the brakes after the axle end has been reassembled.

M-22. 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

M-22. SERVICE DIAGNOSIS—Continued

SYMPTOMS	PROBABLE REMEDY
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	
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.	

M-23. FRONT AXLE SPECIFICATIONS

MODEL:	All Four Wheel Drive Models	DJ-3A
Front Axle:		
Make.....	Spicer	Clark
Model.....	25, 27 or 27A	130097
Capacity.....	2000 lb. [907 kg.]	2000 lb. [907 kg.]
Description.....	Full-floating Hypoid Gears	Reverse Elliot
Universal Joints:		
Standard:		
Make.....	Spicer	
Type.....	Cardan Cross	
Optional:		
Make.....	Bendix	
Type.....	Constant Velocity	
Optional:		
Make.....	Rzeppa	
Type.....	Constant Velocity	
King Pin Bearing Preload.....	12 to 16 lb. [5,44 a 7,25 kg.]	
Differential:		
Drive Pinion Offset.....	1.38" [35,05 mm.]	
Number of Differential Pinions.....	2	
Gear Ratio:		
Standard.....	4.27:1	
Optional.....	5.38:1	
Ring Gear Pitch Diameter.....	7.75" [19,68 cm.]	
Pinion Adjustment.....	Shim	
Pinion Bearing Adjustment.....	Shim	

REAR AXLE

Contents

SUBJECT	PAR.	SUBJECT	PAR.
AXLE SHAFT:		DRIVE PINION:	
Removal.....	N-3, N-4	Adjustment.....	N-10
DIAGNOSIS.....	N-23	Pinion and Ring Gear Setting Gauge.....	N-9
DIFFERENTIAL:	N-5	POWR-LOK DIFFERENTIAL:	
Assembly.....	N-11	Application.....	N-17
Disassembly.....	N-6	Overhaul.....	N-19
DIFFERENTIAL CASE:		Trouble Shooting.....	N-20
Adjusting Differential Side-Gears.....	N-12A	REAR AXLE:	
Adjusting of Differential —		Installation.....	N-13
Preload and Ring Gear Back-Lash.....	N-11	Removal.....	N-2
Assembling Differential Case.....	N-12	REAR WHEEL NOISE.....	N-22A
		SPECIFICATIONS.....	N-24

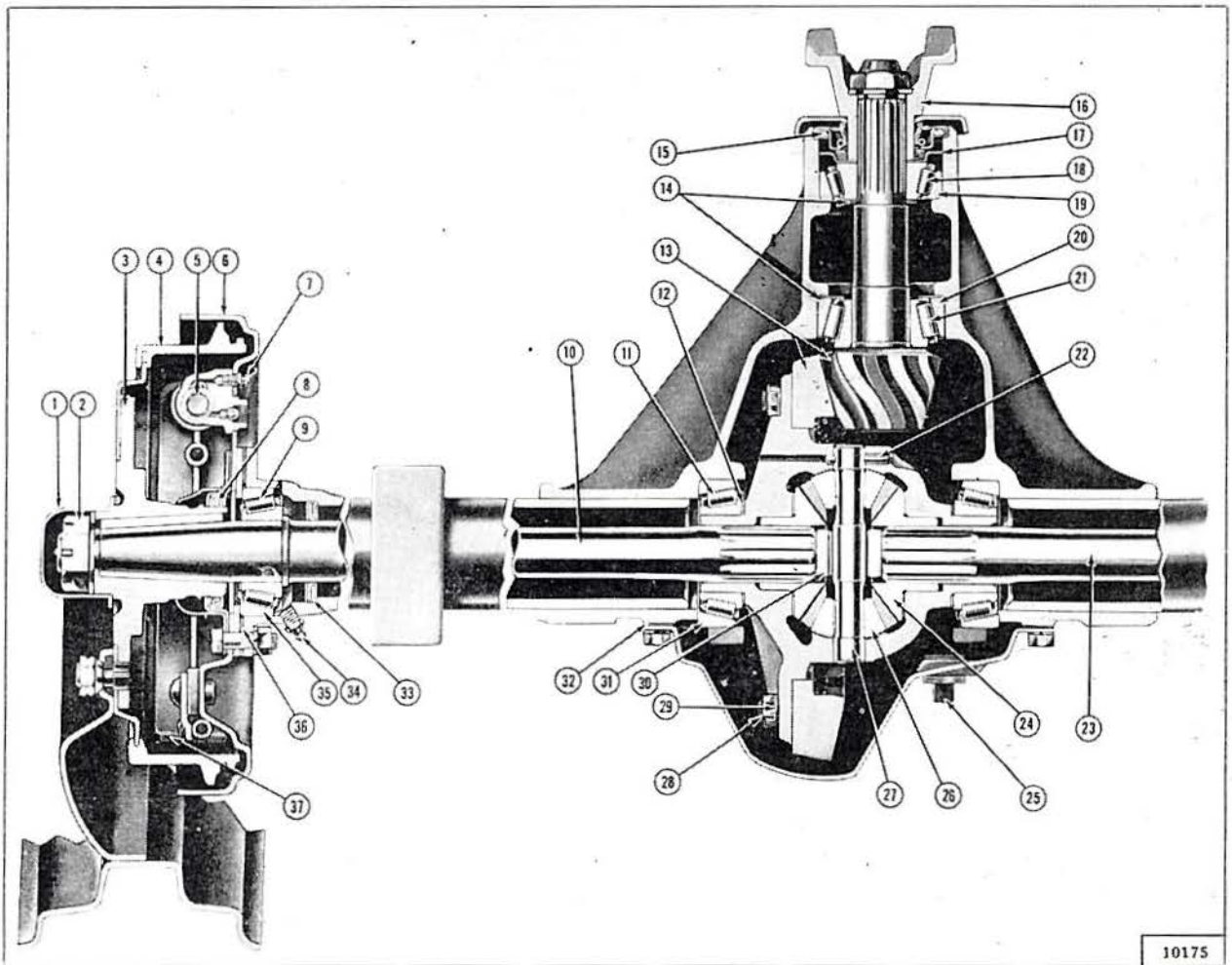


FIG. 233—REAR AXLE

- | | | |
|---|---|-------------------------------------|
| 1—Hub Cap | 14—Pinion Bearing Shims | 25—Pipe Plug (Filler) |
| 2—Hex Nut | 15—Drive Pinion Oil Seal | 26—Pinion Mate |
| 3—Rear Wheel Hub | 16—Universal Joint End Yoke | 27—Pinion Mate Shaft |
| 4—Wheel Brake Drum | 17—Drive Pinion Oil Slinger | 28—Drive Gear Screw |
| 5—Brake Wheel Cylinder | 18—Drive Pinion Outer Bearing Cone and Roller | 29—Drive Gear Screw Strap |
| 6—Backing Plate | 19—Drive Pinion Outer Bearing Cup | 30—Axle Shaft Spacer (Center Block) |
| 7—Brake Cylinder Bleeder Screw | 20—Drive Pinion Inner Bearing Cup | 31—Differential Bearing Cup |
| 8—Axle Shaft Outer Grease Retainer | 21—Drive Pinion Inner Bearing Cone and Roller | 32—Axle Housing Cover Gasket |
| 9—Axle Shaft Bearing Cone and Roller | 22—Pinion Mate Shaft Pin and Lock | 33—Axle Shaft Oil Seal (Inboard) |
| 10—Axle Shaft—Left | 23—Axle Shaft—Right | 34—Lubrication Fitting |
| 11—Differential Bearing Cone and Roller | 24—Side Gear | 35—Axle Shaft Bearing Cup |
| 12—Differential Shims | | 36—Rear Axle Shaft Bearing Shims |
| 13—Axle Drive Gear and Pinion | | 37—Brake Shoe and Lining |

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N-1. GENERAL

The rear axle on all models discussed here is of the semi-floating type with the exception of the Model CJ-2A built previous to Serial No. 13453. All Model CJ-2A vehicles before this serial number are equipped with the full-floating type.

Information for front and rear axle differentials is covered in this section. All models have full-floating hypoid front axles.

For Powr-Lok differential, see the special instructions at the end of this section.

Information for axle shaft adjustment is given in Section Q.

NOTE: Whenever an axle differential is inspected, see if the ring gear lock straps are present. These straps should be installed on those axles without them. See Fig. 238.

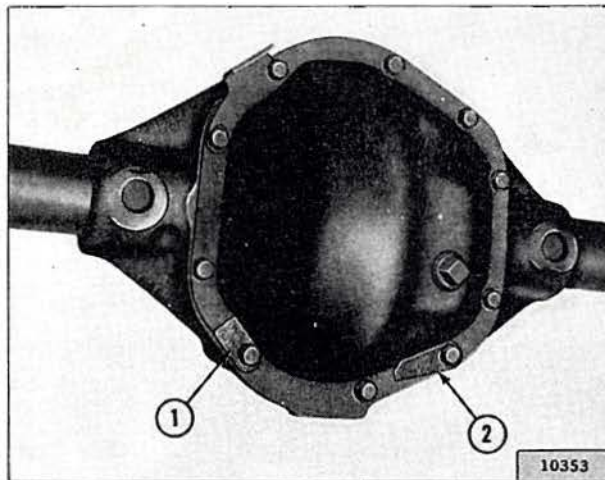


FIG. 234—RATIO AND POWR-LOK DIFFERENTIAL IDENTIFICATION

1—Ratio Tag

2—Powr-Lok Tag

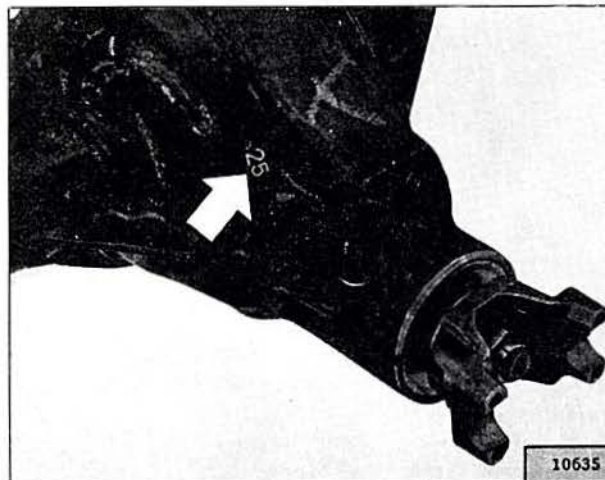


FIG. 235—AXLE MODEL IDENTIFICATION

The axle model number is cast into the axle housing on or near one of the reinforcing webs. See Fig. 235. A metal tag under one of the differential housing cover screws is stamped to identify the number

of teeth in the drive gear and pinion. See Fig. 234. By dividing the larger number (ring gear teeth) by the smaller number (pinion teeth) the axle ratio can be determined. Thus, 47/11 denotes a 4.27:1 ratio.

NOTE: Early production CJ-3B, CJ-5, CJ-6, models have a 5.38 axle ratio with a transmission low-gear ratio of 2.798. Late production models have a 4.27 axle ratio, with a new transmission having a low-gear ratio of 3.339. This transmission can be identified by a threaded gear shift lever for the gear shift knob. Both early and late production transmissions are interchangeable.

N-2. Removing Rear Axle Assembly

Raise the rear 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 shock absorbers at the axle mounting pads. Disconnect the brake hydraulic hose at the tee just forward of the tubing clipped to the axle. Support the axle assembly on a jack, remove the spring to axle U-bolt clips and slide the assembly from underneath the vehicle.

N-3. Full Floating Axle Shaft Removal

- Early Model CJ-2A.

To remove the full-floating axle shaft, it is not necessary to jack up the rear wheel. Removal procedure:

- Remove the six screws holding the driving flange to the wheel hub.
- Screw two flange screws into the threaded holes in the axle flange to loosen the shaft. Remove the shaft.
- If shaft is broken, remove the outer piece of the shaft. Then, loop a piece of stiff wire over the piece of shaft remaining inside the housing. Pull the wire to bind the loop on the shaft piece and remove it.
- Replace the shaft in reverse order. Install the shaft carefully so the inner oil seal at the differential is not knocked out.

N-4. Semifloating Rear Axle Shaft Removal

- Refer to Fig. 233.

To remove axle shafts from an axle follow the sequence below:

- Jack up the wheel and remove the hub cap.
- Remove the axle shaft nut.
- Use a puller (Tool C-319, Fig. 236), to remove the wheel hub.
- Remove the screws attaching the brake dust shield, grease and bearing retainers, and brake assembly. Remove the shield and retainer.
- Pull out the axle shaft with Tool C-637 using care not to lose the adjusting shims. 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" [20,3 cm.] long it will usually be necessary to remove the differential.

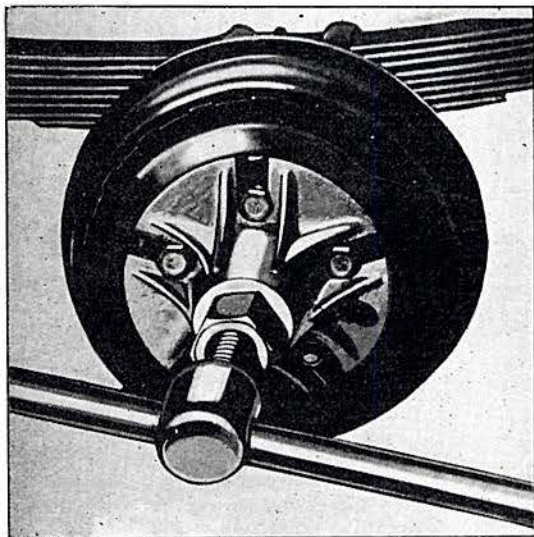


FIG. 236—WHEEL HUB PULLER

To remove the bearing from an axle shaft, use Combination Bearing Puller W-104-B shown in Fig. 245.

If both shafts are to be removed, keep the shims from each shaft separate and replace them on the shaft from which they were removed to maintain correct bearing adjustment.

Assembly is the reverse of disassembly.

Note: Place the hub and drum on the axle shaft taper and then inserting the axle shaft key in the keyway. Never install the key in the keyway before placing the hub and drum assembly on the axle shaft. This procedure holds true on any 'Jeep' vehicle equipped with a semi-floating axle. Further, be sure that the axle shaft nut is torqued to a minimum of 150 lb-ft. [21 kg-m.]

Check the shaft oil seal before installing the axle shaft.

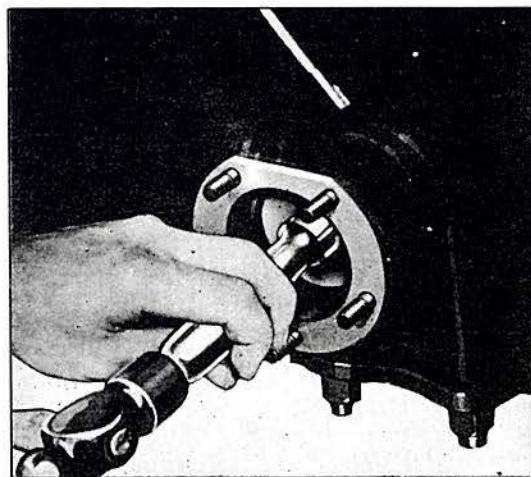
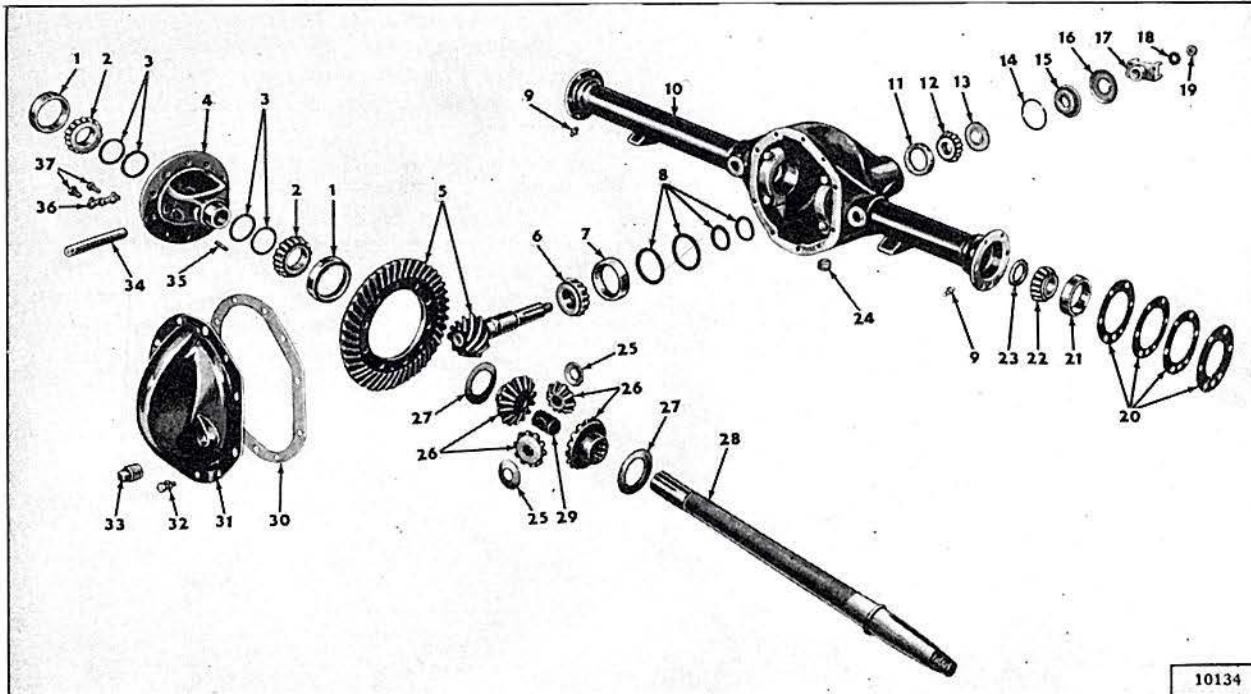


FIG. 237—OIL SEAL DRIVER



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FIG. 238—REAR AXLE

- | | | | |
|----------------------------------|-----------------------------------|-----------------------|-------------------------|
| 1—Bearing Cup | 10—Housing | 19—Pinion Nut | 28—Axle Shaft |
| 2—Cone and Rollers | 11—Outer Bearing Cup | 20—Shims | 29—Spacer |
| 3—Shims | 12—Outer Bearing Cone and Rollers | 21—Cup | 30—Gasket |
| 4—Differential Case | 13—Oil Slinger | 22—Cone and Rollers | 31—Housing Cover |
| 5—Gear and Pinion | 14—Gasket | 23—Oil Seal | 32—Screw and Lockwasher |
| 6—Inner Bearing Cone and Rollers | 15—Oil Seal | 24—Drain Plug | 33—Filler Plug |
| 7—Inner Bearing Cup | 16—Dust Shield | 25—Thrust Washer | 34—Lock Pin |
| 8—Shims | 17—End Yoke | 26—Differential Gears | 35—Pinion Shaft |
| 9—Fitting | 18—Washer | 27—Thrust Washer | 36—Lock Strap |
| | | | 37—Screw |

If replacement is necessary, use Axle Shaft Oil Seal Driver W-186, Fig. 237. Also check the grease retainer and replace it if there is any doubt of its condition.

Adjust the wheel bearings as outlined in Section Q.

N-5. DIFFERENTIAL

Differentials of both front and rear axles are covered here with the exception of Powr-Lok. Powr-Lok differentials are covered starting with Par. N-14. Before disassembling the differential, it is advisable to determine through inspection the cause of difficulty or failure of the parts. Drain lubricant from the differential housing and then remove the differential cover. Wash the differential parts thoroughly with solvent so the parts can be carefully inspected. Should it be determined by this inspection that the differential requires overhauling, the axle must be removed from the vehicle.

N-6. Disassembly

- Refer to Fig. 238.

a. Remove the axle shafts. Refer to Par. N-3 or N-4 for rear axles and Section M for front axles.

b. Remove the housing cover and four screws holding the two differential side bearing caps in position. Make sure there are matching letters or other marks on the caps and the housing so that each cap can be reinstalled in the same position and location from which it is removed.

c. It is necessary to spread the carrier as the differential bearing has initial preload. Use Housing Spreader Tool W-129, as shown in Fig. 239, to spread the housing. Clamp on a dial indicator. From the side, measure the carrier spread. When the spreading force is applied, do not exceed a limit of .020" [0,50 mm.]. Remove the dial indicator. Carefully pry the differential case loose, using pry bars at the heads of the ring gear bolts and carrier casting.

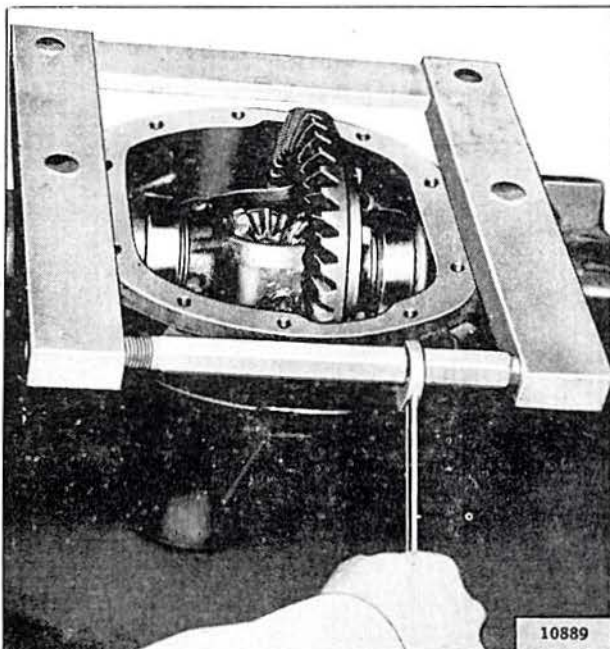


FIG. 239—DIFFERENTIAL CARRIER SPREADER

CAUTION: Remove the spreader tool to prevent the possibility of the carrier taking a set.

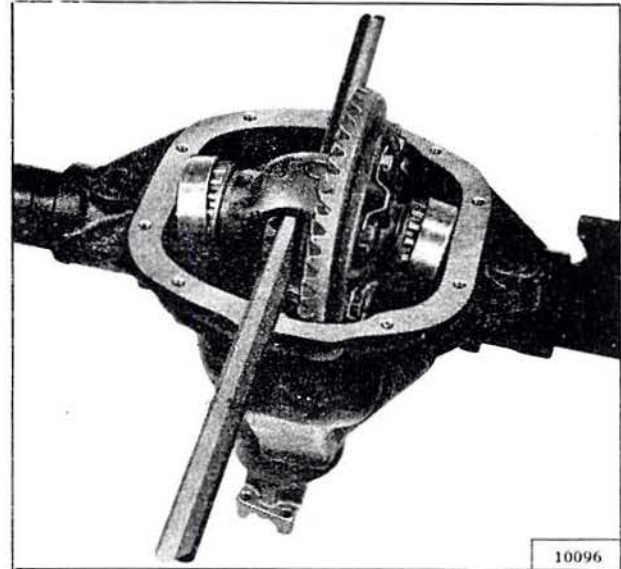


FIG. 240 REMOVING DIFFERENTIAL

d. Should the spreader tool be unavailable, use two pry bars, one on each side of the differential case opening, to pry out the differential as shown in Fig. 240.

e. Turn down the lock strap tabs and remove the screws and lock straps holding the differential ring gear to the differential case.

f. The differential shaft is held in place by a lock pin. Use a small punch as shown in Fig. 241 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. To remove the drive pinion, first remove the universal joint end yoke assembly. Use Tool C-3281 to hold the shaft as shown in Fig. 242 while removing the nut. Use Puller, Tool W-172, or C-452 to remove the end yoke as shown in Fig. 243.

i. Remove the pinion shaft oil seal. Use Puller, Tool W-251 as shown in Fig. 244.

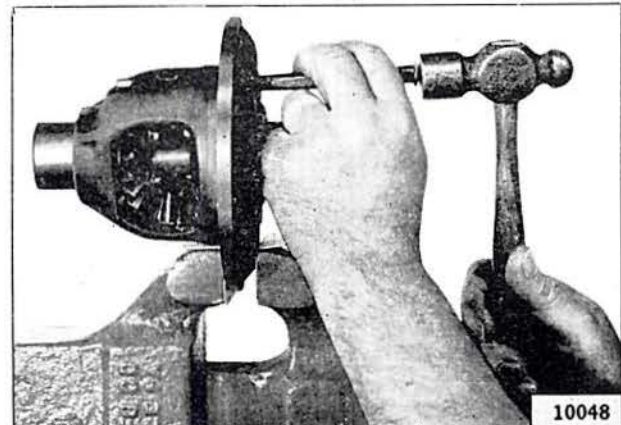


FIG. 241—REMOVING LOCK PIN

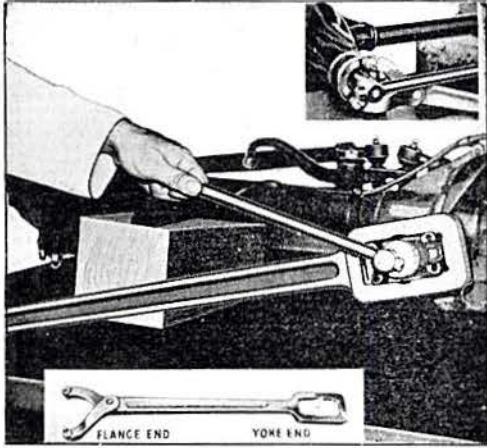


FIG. 242—FLANGE HOLDING WRENCH

j. With a hammer and brass drift, drive on the end of the pinion shaft to force the pinion into the differential housing so it can be removed.

k. Wash all parts in solvent using care not to lose any of the shims (which adjust the pinion shaft bearings or differential side and pinion gears).

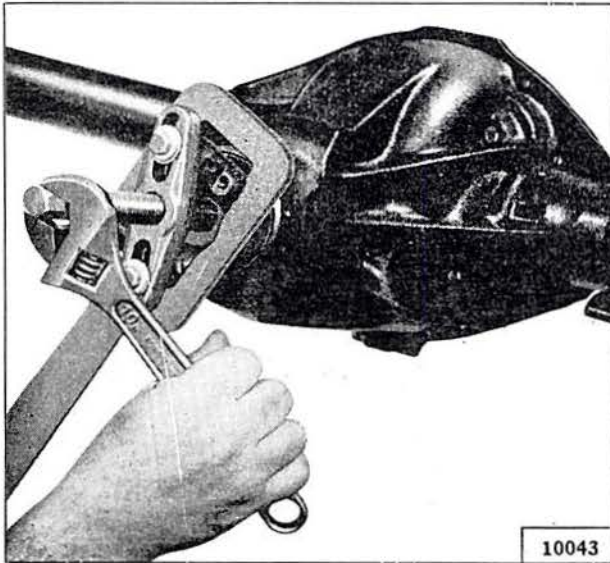


FIG. 243—END YOKE PULLER

N-7. Differential Carrier Bearing Cups

To remove the inner and outer differential carrier bearing cups, use Puller, W-99-B, Fig. 248 and 249 with its adapter plates which are a part of W-99, W-99-A tool kits. Oil the puller screw threads with clean engine or machine oil. Remove the inner bearing cup first.

To replace the bearing cups, Puller W-99-B Tool kit is used to pull the inner bearing cup into the housing. Driver W-126 is used to install the front bearing cup as shown in Fig. 250. Procedure for removal is given below.

a. Remove the hex nuts from each end of the Puller.

b. Carefully insert the round adapter with two

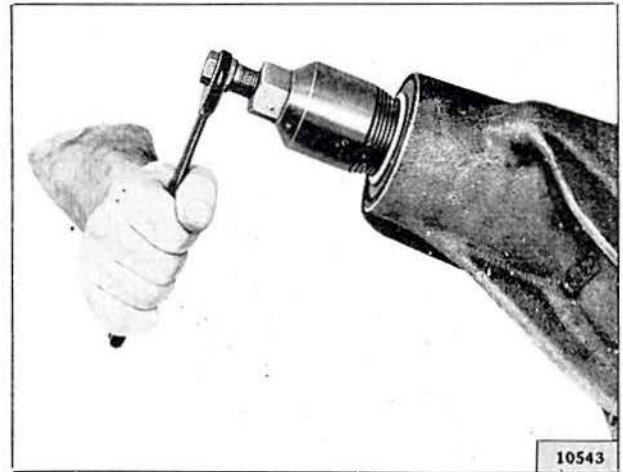


FIG. 244—REMOVING PINION SHAFT OIL SEAL

flat sides through one of the bearing cups and position it behind the inner bearing cup shoulder.

c. Insert the short-threaded end of the main puller screw through the hole in this adapter and secure the adapter with a hex nut.

d. Position the plate across the open face of the differential housing and secure it with a hex nut.

e. Make sure the adapter plate sets flat against the pinion rear bearing cup. Turn down the nut to remove the bearing cup.

f. Reposition the puller to remove the outer bearing cup. The adapter should be seated firmly against the shoulder of the cup with the long-threaded end of the main puller screw through its center. The plate is positioned against the front seat of the differential housing.

g. Make sure the adapter plate sets flat against the pinion outer bearing adjusting shims. Turn down the nut to remove the bearing cup.

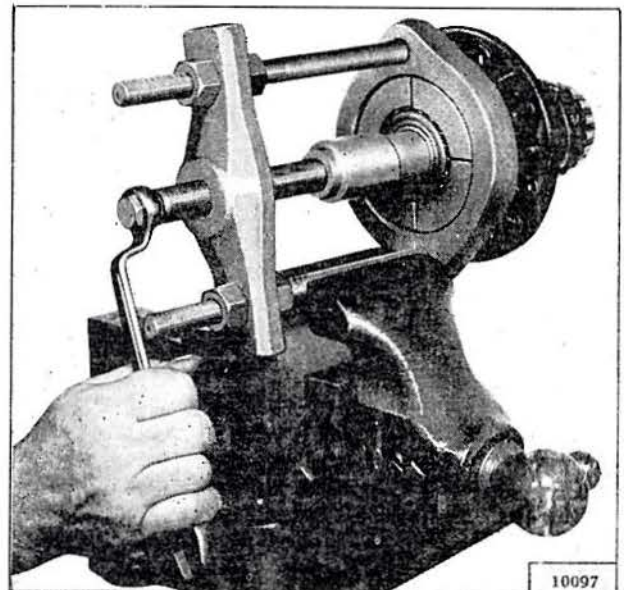


FIG. 245—BEARING PULLER

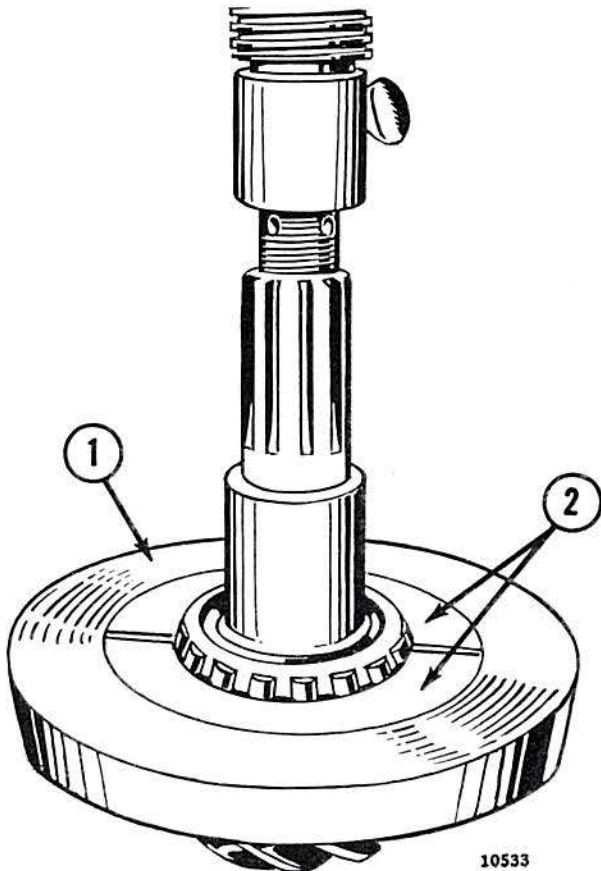


FIG. 246—BEARING PULLER ADAPTER AND HOLDING RING FOR USE WITH ARBOR PRESS
1—Holding Ring 2—Adapter

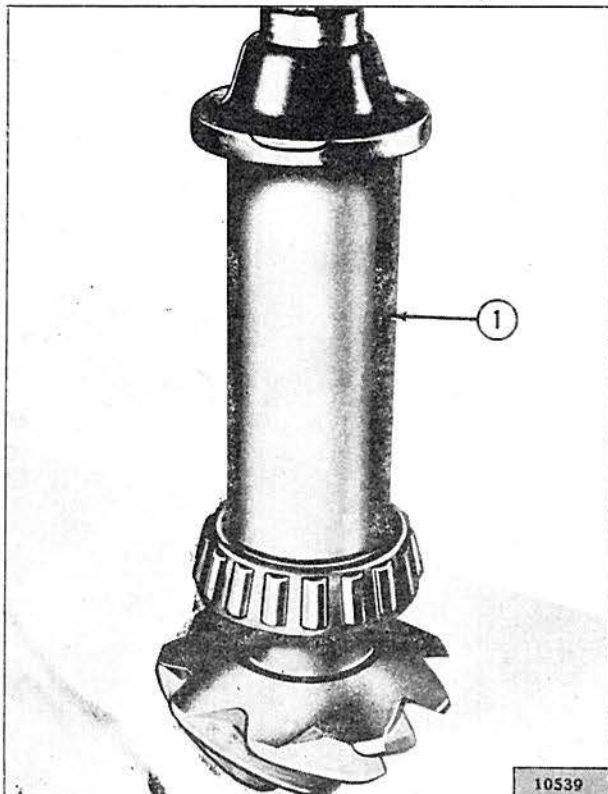


FIG. 247—PINION BEARING INSTALLING SLEEVE
1—Sleeve

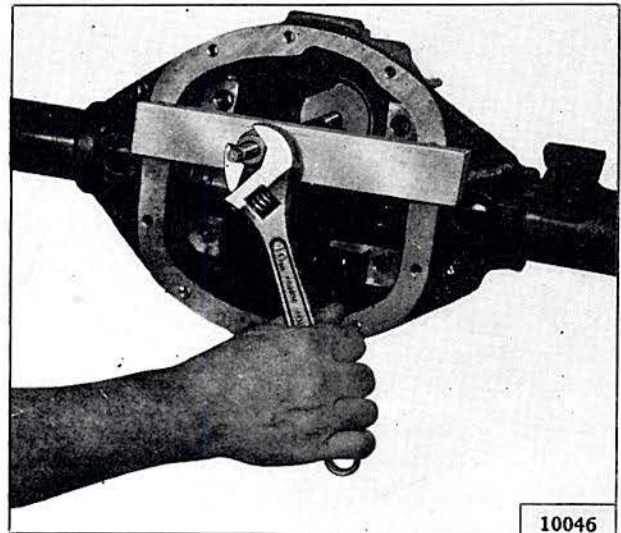


FIG. 248—PULLING PINION SHAFT INNER BEARING CUP

N-8. Removing Pinion and Differential Case Bearings

To remove the differential case bearings and pinion bearings Fig. 238, use Bearing Puller W-104-B as shown in Fig. 245.

Use of the above pullers assures easy removal of bearings without damage to cages or rollers as pulling pressure is applied directly to the bearing cone.

To install the inner pinion bearing on model 44 axle pinions use Installing Sleeve, Tool C-3095 model 27 axle use Tool W-262 as shown in Fig. 247.

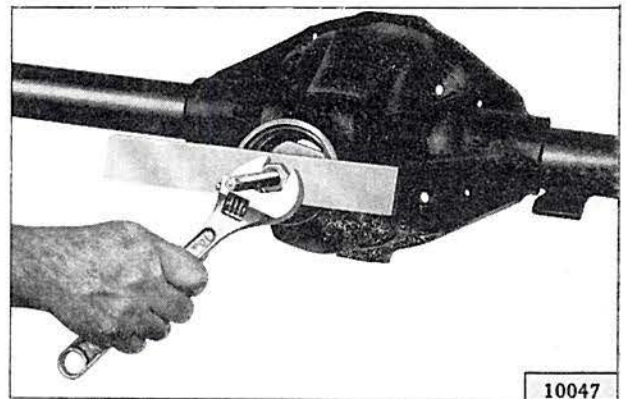


FIG. 249—PULLING PINION SHAFT OUTER BEARING CUP

N-9. Pinion and Ring Gear Setting Gauge Set

For correct and easy adjustment of the drive pinion use a Pinion and Ring Gear Setting Gauge Set W-99-B. This set includes a tool with adapter to remove and install pinion bearing cups, a C-clamp aligning fixture that locks to the pinion shaft and aligns a dial indicator which accurately measures the distance from the pinion head to the bottom of the differential side carrier bore, master gauge blocks, and a dial indicator.

Each C-clamp aligning fixture is embossed with its part number; usage is as follows:

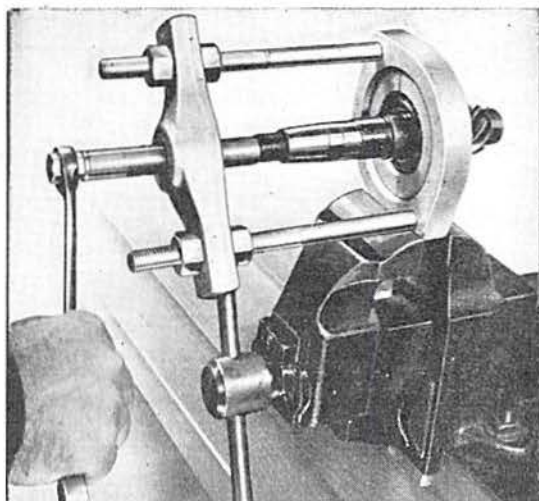


FIG. 250—PINION SHAFT FRONT BEARING CUP DRIVER

W-101-3A (from W-99 kit) for all axles requiring gauge blocks A thru E.

W-101-16-A (from W-99-A kit) for all axles requiring gauge blocks A thru F.

W-101-14A (from W-99-B kit) for all axles requiring gauge blocks A thru G.

Three gauge blocks are currently used:

W-101-11 (in W-99 and W-99-A kits) has A, B, C, D, markings.

W-101-13 (in W-99-A kit; supersedes W-101-9 in W-99 kit and only marked for E gauge) has E and F markings.

W-101-17 (in W-101-21A kit) has G markings.

A supplementary kit, W-101-21A, will adapt either W-99 or W-99-A basic kit to use for model 70 axle used on FC-170 dual-rear-wheel models. It includes spacer W-101-19 needed for model 70 axle used on FC-170 dual-rear-wheel models. This supplementary kit plus W-101-24 gauge block will make a W-99-A kit equal to a W-99-B kit.

Substituting W-101-16A C-clamp aligning fixture for W-101-3A and adding W-101-13 gauge block to the W-99 kit will bring a W-99 kit up to include the same items as a W-99-A kit.

The correct gauge for setting axles covered in this book is indicated in Par. N-10.

N-10. Drive Pinion Adjustment

• Refer to Fig. 252.

Before attempting to adjust the ring gear back lash and run out, 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 inner bearing cup and the housing. These shims are available in these thicknesses:

.003" [0,076 mm.] .010" [0,254 mm.]
.005" [0,127 mm.]

Should it be necessary to remove and replace the pinion shaft bearing cups, this may best be accomplished by using pinion shaft bearing pullers as described in Par. N-7.

When using this gauge do not install the oil seal

until the pinion is adjusted. Use sleeve Tool W-162, 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. Establishing this distance determines the correct amount of shims to be installed to provide the correct positioning 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" [0,076 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 accurately and easily established. The gauge blocks provide eight different standards for different axles. The eight standards are indicated with A, B, C, D, E, F, G, and H markings stamped on the gauge blocks. Use only the blocks listed below for the axles covered here.

Model 23 Axle.....	D
Model 25 Axle (4.27:1 Ratio).....	G
Model 25 (all other ratios).....	D
Model 27 Axle.....	H
Model 44 Axle.....	E

The dial gauge is set to the master gauge for the different axles as shown in Fig. 252. Use the correct master gauge surface for the model axle being adjusted. Hold the dial indicator and gauge as shown 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.

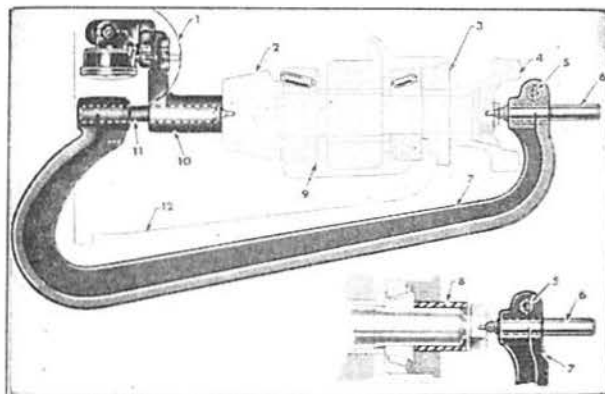


FIG. 251—PINION ADJUSTING FIXTURE

- | | |
|------------------|-------------------------|
| 1—Dial Indicator | 7—C-Clamp |
| 2—Pinion | 8—Sleeve |
| 3—Seal | 9—Bearing |
| 4—Yoke | 10—Housing |
| 5—Thumb Screw | 11—Stationary Guide Pin |
| 6—Guide Pin | 12—Differential Housing |

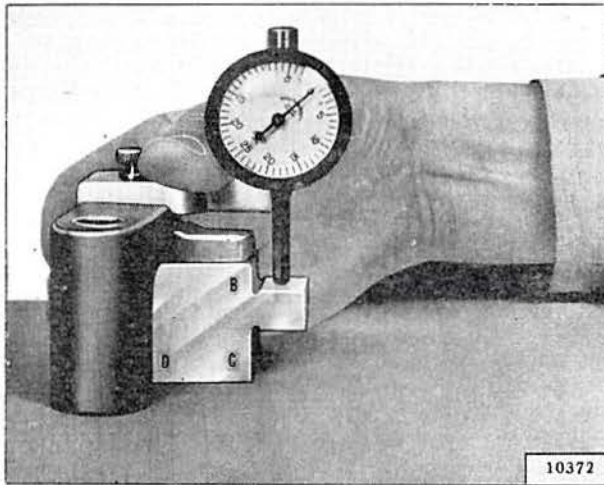


FIG. 252—PINION MASTER GAUGE

Assemble the dial gauge body to the C-clamp by slipping the housing over the stationary guide pin. Hold the gauge head and the large end of the C-clamp in one hand and position it over the pinion. 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 the thumb screw. 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, as shown in Fig. 251, hold the dial gauge housing 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,

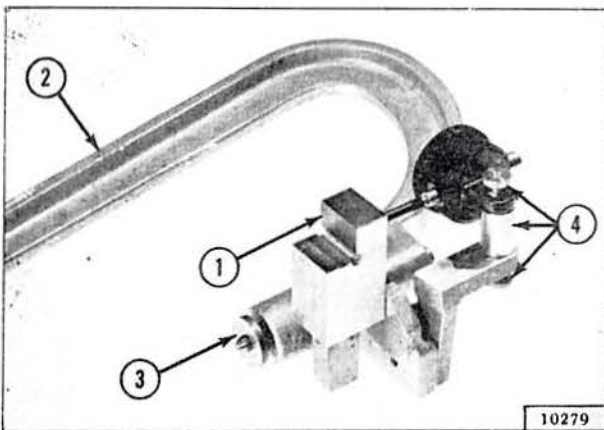


FIG. 253—SETTING DIAL GAUGE TO MASTER GAUGE BLOCK FOR MODEL 70 AXLE

1—Gauge Block
2—C-Clamp
3—Spacer
4—Dial Indicator

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).

NOTE: To increase the dial reading decrease shims; to decrease the dial reading increase shims. Example: With a dial reading of minus .001" and a pinion marking of plus .002" remove .003" shims to obtain a higher dial reading of plus .002".

Recheck the adjustment if any changes are made. Be sure to set the dial to the correct face of the master gauge.

After correctly locating the pinion, adjust the pinion bearing preload. Start with approximately .065" [1,651 mm.] shim pack between the shoulder of the pinion and outer bearing cup. Reassemble the outer bearing, yoke, washer, and nut. Tighten

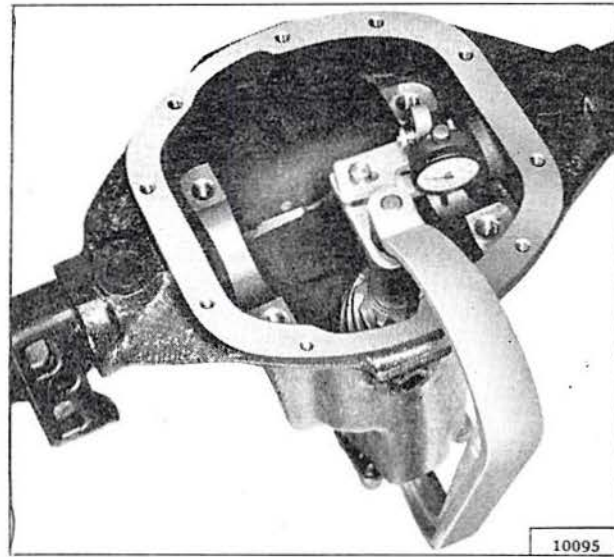


FIG. 254—PINION SETTING GAUGE

to a torque of 200 to 220 lb.-ft. [27,66 a 30,43 kg-m.]. Using an inch-pound torque wrench, check the rotating torque (disregard starting torque). Torque should be 10 to 25 inch-pounds [0,116 a 0,288 kg-m.]. Add or remove shims to obtain the recommended rotating torque.

Do not install the oil seal until the differential has been assembled and the entire unit checked. When

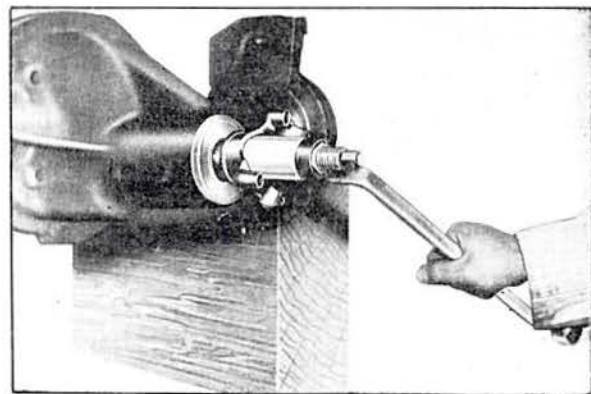


FIG. 255—UNIVERSAL JOINT FLANGE INSTALLING TOOL

installing the universal joint flange, use flange installing Tool W-162, Fig. 255.

N-11. Adjustment of Differential Bearing Preload and Ring Gear Backlash

Numbers in parentheses refer to Fig. 238.

The adjustment of the differential bearings is maintained by the use of shims placed between differential case and the bearing cone and roller. To adjust the differential bearing preload, first install the differential case and bearings in the carrier without shims and with the bearing cups snug.

Holding the ring gear in contact with the pinion, and using a screwdriver blade to move the bearing cups toward the center, insert feeler gauge in between both bearing cups and the carrier. After the shim pack for each bearing has been established, remove the differential assembly, keeping the shim packs separated. Add an additional .015" [0,0381 mm.] thickness of shims to the pack on the tooth side of the ring gear.

There should be only .001" to .002" [0,0254 a 0,0508 mm.] backlash.

Place the differential bearing shim packs on the differential case under each bearing.

Install the bearings with Driver W-142 for models 23 and 25 axles, driver W-188 for model 44 and driver C-3716 for model 27 axles, as shown in Fig. 256.

Note: When overhauling the full-floating type differential used on all front axles of these models, check the inner axle oil seals to determine if they are satisfactory. Should new seals be required install them with Tool W-128 as shown in Fig. 257.

Attach the carrier spreader tool W-129, install a dial indicator, and spread the carrier a maximum of .020" [0,508 mm.]. Remove the indicator, lubricate the bearings, and then place the differential assembly in the carrier. In the absence of tool W-129, the assembly may be installed by cocking the bearing cups slightly when the differential is placed in the carrier. See Fig. 258.

Tap the unit carefully into place, making sure the ring gear teeth mesh with the pinion teeth. Install bearing caps, matching their markings with those on the carrier. Apply sealing compound to the screw threads. Torque the screws 70 to 90 lb-ft. [9,68 a 12,45 kg-m.].

Install indicator to check ring gear backlash. See Fig. 259. Check backlash at two points. Backlash must be held between .005" to .010" [0,13 a 0,25 mm.]. If backlash does not fall within specifications, shims should be interchanged between the two differential bearing shim packs until correct backlash is obtained.

Note: Changing the position of a .005" [.127 mm.] shim from one side to the other will change the amount of backlash approximately .003" [.076 mm.].

Check ring gear for runout. A reading in excess of .006" [0,152 mm.] indicates a sprung differential case, dirt between the case and the gear, or loose ring gear screws.

In order to assist in determining whether the gears are properly adjusted, when the Pinion and Ring Gear Gauge Set No. W-99B, 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

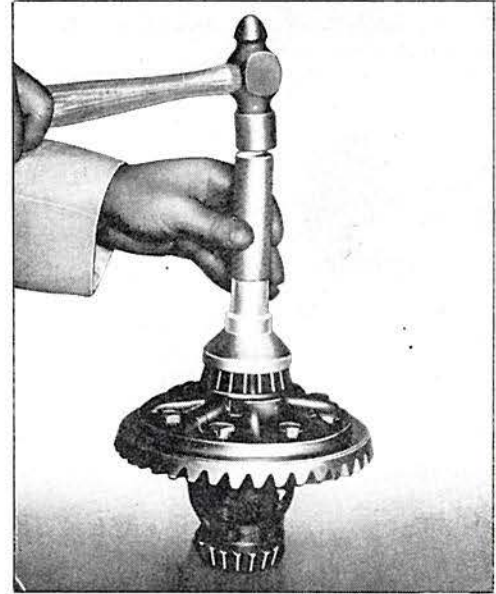


FIG. 256—DIFFERENTIAL BEARING DRIVER

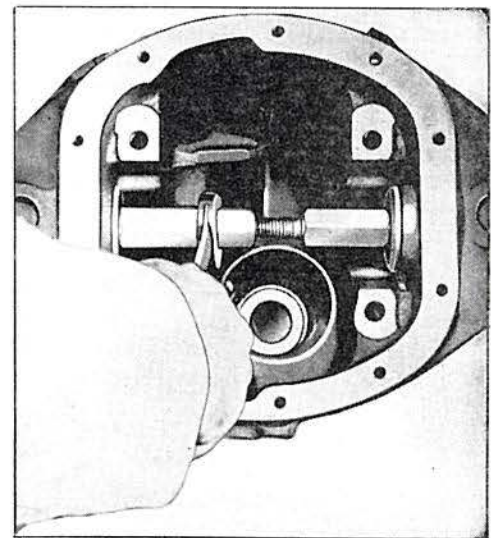


FIG. 257—INNER OIL SEAL INSTALLER

procedure to follow in the event of an unsatisfactory tooth contact is shown in Fig. 260. 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 W-147 shown in Fig. 261.

Install the universal joint yoke with Flange Installing Tool W-162, as described in Par. N-10.

Install pinion nut and cotter pin. Then install axle shafts and differential housing cover.

Note: To drive the latest type pinion shaft oil seal, the diameter of the recess on the driving end of Tool W-147 must be 2.031" [51,59 mm.]. Early production W-147 tools had a recess diameter of 1.975" [50,15 mm.]. If necessary, increase the diameter of the tool as shown in Fig. 262, so that it can be used to drive either type seal without damaging the seal.

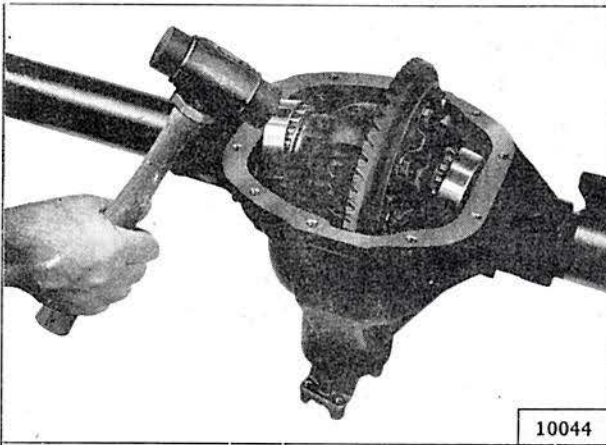


FIG. 258—INSTALLING DIFFERENTIAL

N-12. Assembling Differential Case

The relative assembled position of the internal parts of the differential are shown in Fig. 238. Reassemble the differential pinions, side gears, thrust washers, and shaft in place. Do not overlook installing the differential shaft lock pin.

NOTE: At this time, check differential level side gear clearance and adjust if necessary as described in Par. N-11.

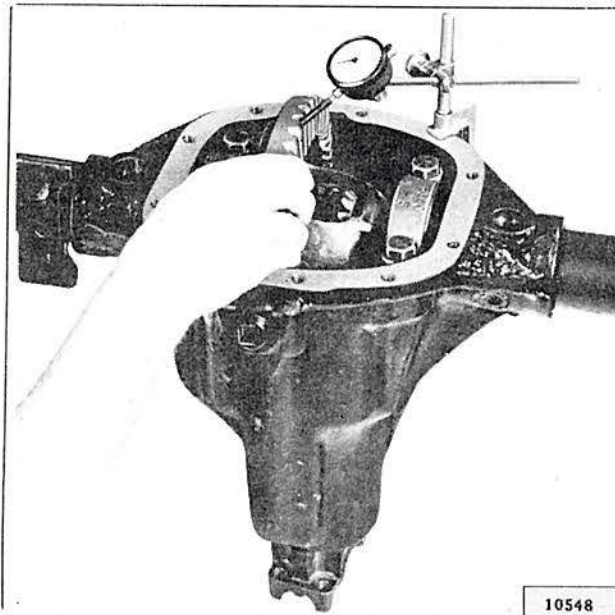


FIG. 259—CHECKING RING GEAR BACKLASH

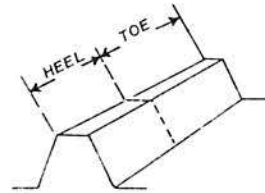
In order to prevent the lock pin from working out, stake it in position with a punch.

Carefully examine the surfaces of the differential case and the ring gear to make sure there are no foreign particles or burrs on the two contacting surfaces. Line up the holes in the ring 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 ring gear to the differential case. Make certain that the screw lock tabs are bent around the heads so there is no possibility of screws working loose. Screws should not be lubricated. Torque screws 35 to 55 lb-ft. [4,84 a 7,60 kg-m.].

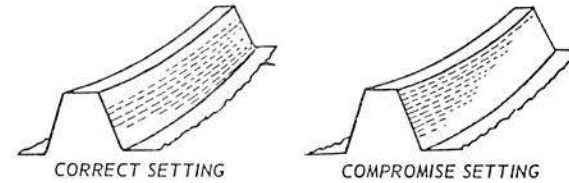
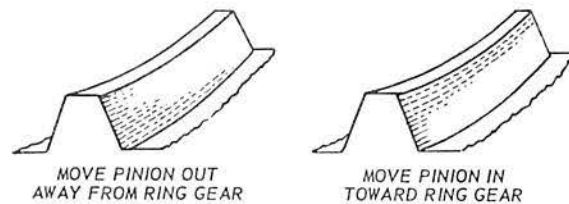
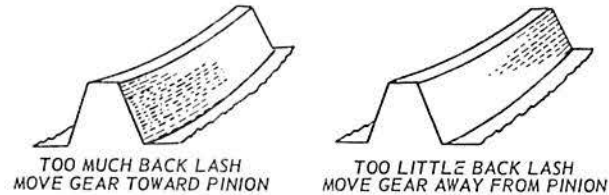
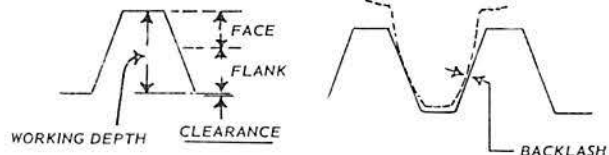
NOTE: If ring gear bolt locking straps (Fig. 238) are not present, install them using longer screws.

N-12A. 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.



THE HEEL OF GEAR TOOTH IS THE LARGE END, AND THE TOE IS THE SMALL END.



10547

FIG. 260—GEAR TOOTH CONTACT

- a. With the differential positioned as shown in Fig. 263, 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.], .006" [0,15 mm.], .008" [0,20 mm.]

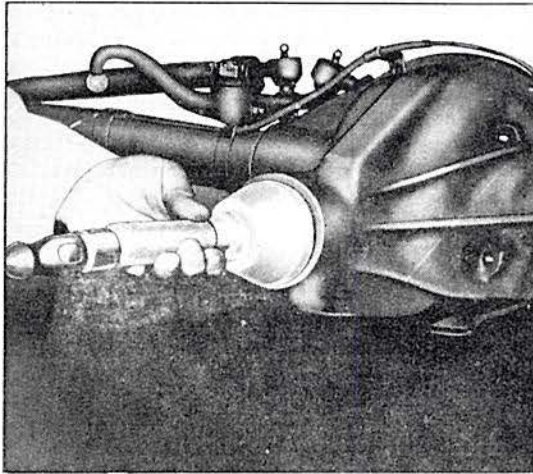
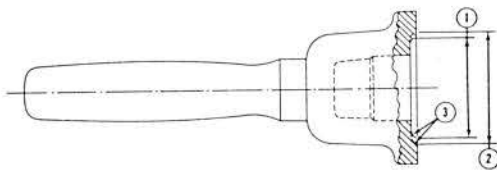


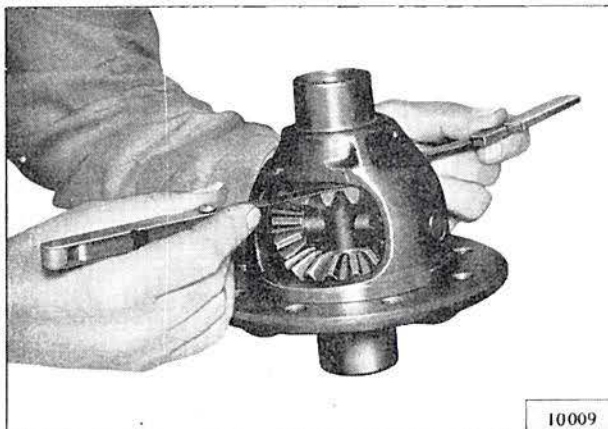
FIG. 261—PINION SHAFT OIL SEAL INSTALLER



10601

FIG. 262—TOOL W-147 MODIFICATION

- 1—Original Diameter 1.975" [50,167 mm.]
- 2—Modified Diameter 2.031" [51,587 mm.]
- 3—Radius $\frac{1}{8}$ " [3,2 mm.]



10009

FIG. 263—CHECKING SIDE GEAR CLEARANCE

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.

N-13. Installing Rear Axle in Vehicle

Note: All service replacement axle assemblies are shipped from the factory without lubricant in the differential. Lubricant must be added to the differential before the axles are installed in vehicles. Use the grade and quantity of lubricant specified in the appropriate service manual. After the axle has been installed in the vehicle, check to be sure the lubricant level in the differential is up to the filler plug opening.

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 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 shock absorbers at the axle mounting pads. 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 axle housing with the proper lubricant. See 'Lubrication Section'.

N-14. POWR-LOK DIFFERENTIAL

Optional equipment.

Identification, application, servicing, and trouble shooting of the Powr-Lok differential are explained in the following paragraphs.

N-15. Identification

Powr-Lok differentials are determined by a brass tag under one of the differential carrier housing cover screws. This tag is usually placed opposite the axle ratio tag as shown in Fig. 234. This tag is stamped either with a letter **T** or with "USE LIMITED SLIP DIFF. LUBE ONLY."

N-16. Powr-Lok Changes

The disc type Powr-Lok differential is currently used on all Powr-Lok axle assemblies. Both the cone type and disc type have been used on vehicles with the Model 44 axle. Only the disc type is now available. However, as the disc type is interchangeable as a complete assembly with the cone type, no service problem is presented.

The disc type also has been produced with two different types of friction plate and disc sets or clutches. In the early disc type, all plates and discs were the flat type. The late disc type assembly order is shown in Fig. 265 and should always be used as the guide to properly assembling the plates.

Note that Fig. 265 shows one side only and the opposite side would be the reverse order when the reference arrow A is pointing toward the case in the opposite direction.

N-17. Application

The Powr-Lok differential can be installed in the axle assembly of some models which did not have Powr-Lok as original equipment. On other models, a complete axle assembly or other related parts will be required to convert to Powr-Lok.

Note: When converting a standard axle to a Powr-Lok axle, if possible fashion a metal tag marked with the letter **T** and install as described under Identification above.

- a. 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.
- b. Model 23, 25 and 27 axles may be converted by installing the proper Powr-Lok differential.
- c. The axle shaft spacer and axle shaft spacer roll pin shown in Fig. 264 are used only with a semi-floating axle. These parts are not present on a Powr-Lok full-floating axle. This means that the spacer and roll pin will be found in the rear Powr Lok axle differential but not in the front Powr Lok axle differential.

N-18. Servicing Powr-Lok

Whenever a replacement or conversion Powr-Lok differential assembly is to be installed in an axle which has been previously 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.

Note: Parts are not available for any cone type Powr-Lok differential. If repair of these differentials is necessary, the complete unit must be replaced.

Note: The only lubricant specified for Powr-Lok differentials is Jeep Powr-Lok Differential Oil, Part No. 94557, furnished in pint cans. Ordinary multipurpose gear lubricant must not be used.

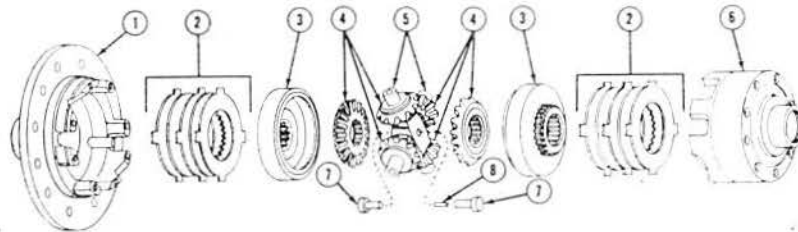
N-19. Powr-Lok Differential Overhaul

The procedure for overhauling disc type Powr-Lok differentials is as follows:

- a. Remove the Powr-Lok differential case assembly from the axle. Do not remove the ring gear or bearing cones unless replacement is to be made. Mark the bearing cups so they may later be reassembled with the same bearing cones. Mark the differential case halves for correct alignment at reassembly. Each pinion mate cross shaft should also be marked so that each pin cam surface will match with the same V-ramp in the case when reassembled.
- b. Separate the case halves.
- c. Remove clutch friction discs and plates. Care should be taken to see how the friction plates and friction discs and dished plates are assembled. The illustration (Fig. 265) shows the arrangement of plates and discs used for current production model Powr-Lok differentials. Earlier production differentials will have a different arrangement, and a different number, of plates and discs. If the plates and discs are not to be replaced, they are to be reinstalled in their original arrangement. If the plates and discs are to be replaced, the new plates and discs are to be installed with the arrangement shown in Fig. 265.

Important — When installing a new plate and disc set (with dished plates) in a Model 25 differential which did not have dished plates as original equipment the $\frac{1}{16}$ " dead plate must be removed (See Fig. 264). In such cases, if there is any indication of differential case wear, complete differential replacement rather than attempted repair is recommended.

- d. Remove the pinion mate cross shafts, bevel pinion mate gears, bevel side gears and side gear rings.



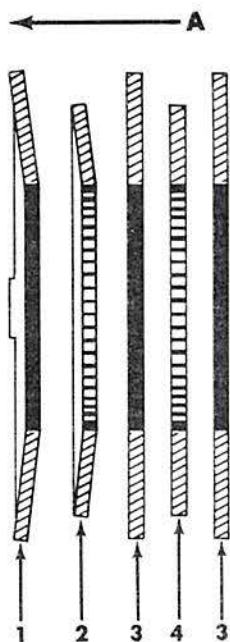
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FIG. 264—POWR-LOK DIFFERENTIAL—CJ-3B, CJ-5, CJ-6, DJ-3A

1—Differential Case Flange Half
2—Disc and Plate Set
3—Side Gear Differential Ring

4—Side Gear and Pinion Mate Gear Set
5—Cross Pinion Mate Shaft
6—Differential Case Button Half

7—Axle Shaft Spacer
8—Axle Shaft Spacer Roll Pin



11307

FIG. 265—PLATE ASSEMBLY ORDER

- A—Toward Case
- 1—Bellville Plate
- 2—Bellville Friction Disc
- 3—Differential Clutch Friction Plate
- 4—Differential Clutch Friction Disc

e. Clean all parts thoroughly in kerosene and dry with compressed air. Inspect all parts and replace any items which appear to be worn or damaged. Inspect the plate surfaces of the case halves, the side gear rings, and the clutch plates and discs for excessive wear and scoring. Inspect the pinion mate shaft V-surfaces, and the ramp surfaces, on the case for excessive wear and pitting. Inspect the side gear and pinion gear teeth. Inspect the pinion gear races that bear on the side gear rings. Inspect the corresponding surfaces on the side gear rings. Inspect the clutch plates and discs for cracks and distortion.

In the event one or more of the clutch plates or discs needs replacing, replace the entire stack of plates and discs on each side of the pinions. These stacks are supplied in sets. Each set contains plates and discs for one differential.

The differential case halves are not serviced. Should replacement be required it will be necessary to replace the complete differential.

f. Assemble the clutch friction plates, clutch friction discs, and dished plates on the splined hub of each bevel side gear. Make sure the plates and discs are installed according to their original arrangement, or Fig. 265 if the new plate and disc set is used. The dished plates in the plate and disc set, are always assembled with the convex side toward the case. As each part is reassembled in its proper position, it is necessary that it be lightly coated with Jeep "Powr-Lok" Differential Oil, Part No. 94557.

g. Axle shaft spacers are installed at the center

of the cross shaft pinion mate on all rear Powr-Lok differentials. One spacer is installed from each side by pressing it onto an axle shaft spacer pin which is first placed in the hole at the center of the cross shaft pinion mate. During any axle repair which requires removal of the axle shaft or shafts, be sure the axle shaft spacers are in place before the shaft or shafts are reinstalled.

h. Hold each differential case half on its side, and install the side gear rings with the plates and discs assembled. The side gear ring will rotate with a slight drag when properly located in the case.

i. With the ring gear flange half of the differential case in an upright position, assemble the bevel side gears, pinion mate cross shafts, and bevel pinion mate gears. Install the remaining case half on the ring gear flange half. Make sure that all markings coincide.

j. Install the differential case bolts and turn them in a few threads. Using axle shafts from the vehicle, align the splines of the side gear and the side gear ring. With these axle shafts in position, tighten the differential case bolts evenly and adequately torque to 35 to 45 lb-ft. [4,84 a 6,22 kg-m.]. Remove the axle shafts.

k. Check for proper assembly. Each pinion mate cross shaft can be tight on its ramp or, in the event there is clearance between the cross shaft and the ramp, the clearance should be only a few thousandths of an inch and it should be equal to all four cross shaft ends.

l. Reinstall the unit in the axle. Other service operations, such as ring gear and pinion replacement, or pinion and bearing adjustments, are performed in the same manner prescribed for standard axles earlier in this section.

N-20. TROUBLE SHOOTING

N-21. Trouble Shooting Powr-Lok

Note: Extreme care must be exercised, on a Powr-Lok equipped vehicle, to be sure the transmission is in the neutral position whenever the engine is started with one wheel jacked up. Otherwise inertia forces in the wheel may acuate the differential causing the vehicle to lurch unexpectedly and fall off the jack.

If trouble is experienced with the operation of a Powr-Lok differential, one or more of three possible conditions probably exists. These conditions and their remedies are discussed in Par. N-21A, N-21D, N-21E.

N-21A. Powr-Lok Torque Tests

Improper operation due to inadequate torque may be determined by two different tests. Test One is for Powr-Lok differentials known to have dished plates; Test Two is for any Powr-Lok differential, but Test One is recommended if the unit has dished plates. These tests are described in the following two paragraphs.

N-21B. Test One

For Powr-Lok Units with Dished Plates.

- a. Place the transmission in neutral.
- b. Raise one wheel off the floor and place a block in front and at the rear of the opposite wheel.
- c. Apply a torque wrench to the axle shaft nut of the elevated wheel.
- d. Turn wheel with torque wrench. Disregard breakaway torque and observe torque required to continuously turn wheel smoothly. Torque should read 40 lb-ft. [5,53 kg-m.] or more.
- e. Disc type differentials that do not pass this test should be overhauled as outlined in Par. N-19; cone type should be replaced.

N-21C. Test Two

For Any Powr-Lok Unit.

- a. Place vehicle on smooth level floor.
- b. Place transmission in neutral.
- c. Place a roller type floor jack under one wheel of the axle to be tested and raise that wheel off the floor.
- d. Tighten brake shoe on the raised wheel until it can barely be moved when the wheel is grasped with both hands and an attempt is made to turn it forward or backwards.
- e. Next, start engine and shift to low gear holding the clutch pedal down. With engine at idle or just above, engage the clutch easily, avoiding sudden engagement or jerk. If the Powr-Lok is operating properly, the vehicle should move forward, causing the jack to roll on the floor.
- f. Disc type differentials that do not pass this test should be overhauled as outlined in Par. N-19; cone type should be replaced.

N-21D. Powr-Lok Chatter

- a. Differential chatter is usually caused by use of the wrong lubricant in the axle differential. To eliminate the chatter, first drain the axle housing thoroughly of the old lubricant. It is necessary to rotate the wheels of the vehicle (by hand only), to allow the lubricant in the Powr-Lok unit itself to drain. Flush the differential, using a light engine oil as the flushing agent. Do not use solvent.
- b. Replace the drain plug. Refill with the correct amount of Jeep Powr-Lok Differential Oil, Part No. 94557.
- c. In the event the above procedure is not effective after 200 miles of operation, overhaul disc type differentials, replace cone type.

N-21E. Powr-Lok Backlash

Excessive lost motion, or backlash in the vehicle drive line, might be the result of excessive backlash in the transmission, propeller shaft spline, universal joint, ring gear and pinion, the axle shaft spline, or the differential.

The lost motion in the differential can be measured as follows:

- a. Jack up one rear wheel.
- b. Put the transmission in gear.
- c. Measure the travel of the jacked-up wheel on a 10" radius from the wheel center. This total

movement should not exceed $1\frac{1}{4}$ " in a new unit. In order to restrict the backlash to the axle only, make sure that the axle and yoke of the propeller shaft does not move during the check.

- d. If all causes of backlash mentioned above have been eliminated, with the exception of the differential and differential backlash exceeds that given in subparagraph c, overhaul the disc type differential or replace the cone type.

N-22. Vehicle Vibrations**• Model DJ-3A**

See also Service Diagnosis in the Clutch and Body Section for other possible causes.

In some instances, a secondary vibration or chatter will appear simultaneously with the one described under TROUBLE SHOOTING at the end of the Clutch Section. If this vibration is experienced after the clutch disc has been replaced as described there, proceed as follows to attempt correction.

- a. Drive the vehicle for approximately 20 miles [32 km.] to heat the rear axle. Before the axle can cool, raise the vehicle on a lift or jack up the vehicle so that both rear wheels are off the ground and install axle stands for safety.
- b. Disconnect the propeller shaft at the rear universal joint and slowly turn the pinion shaft by turning the companion flange. If the pinion shaft does not turn freely and the motion does not feel perfectly smooth, the preload on the pinion bearings is at fault. There is either an insufficient shim pack under the front pinion bearing or the front pinion bearing cup is cocked. For correcting either condition, it will be necessary to remove the rear axle from the vehicle.
- c. To check the front pinion bearing cup for positive seating in the housing, insert a .0015" [0,0038 cm.] feeler gauge or piece of shim stock between the bottom of the cup and the seat in the housing. If the cup is squarely seated, it will not be possible to insert the feeler at any point. Pinion bearing cones and cups should be closely examined and replaced if streaking, brinelling, or other damage is evident.
- d. If examination discloses that the front bearing cup is squarely seated in the housing, check the pinion bearing preload. The pinion shaft should have no end play and should turn with a slight drag (without grease seal installed) after the companion flange has been installed and securely tightened. Usually, the addition of a .003" [0,076 cm.] shim to the shim pack under the front pinion bearing brings the desired result.

N-22A. Rear Wheel Noise

Looseness of the rear axle shaft nut on semi-floating rear axles may produce a clicking or creaking noise. This noise can usually be stopped by torquing the nut 150 to 175 lb-ft. [20,7 a 24,2 kg-m.]. If the condition has continued for some time, slight wear may have resulted allowing the noise to persist. In this case, coat the hub, key, and key-way with white lead and torque the nut as specified. If the noise persists after this treatment, replace the worn parts.

N-23. 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
Wrong Lubricant Being Used (Powr-Lok Differential).....	See "Differential Chatter" under "Trouble Shooting Powr-Lok" in this Section.
 Axle Noisy on Pull	
Pinion and Bevel Gear Improperly Adjusted.....	Adjust
Pinion Bearings Rough.....	Replace
Pinion Bearings Loose.....	Adjust
 Axle Noisy on Coast	
Excessive Back Lash in Bevel Gear and Pinion.....	Adjust
End Play in Pinion Shaft.....	Adjust
Improper Tooth Contact.....	Adjust
Rough Bearings.....	Replace
 Back Lash	
Worn Differential Pinion Gear Washers.....	Replace
Excessive Back Lash in Bevel Gear and Pinion.....	Adjust
Worn Universal Joints.....	Replace
 Vehicle Vibration (Model DJ-3A).....	 See "Trouble Shooting" on preceding page.

N-24. REAR AXLE SPECIFICATIONS

MODEL:	CJ-2A Before Serial No. 13453	CJ-2A After Serial No. 13453
Rear Axle:		
Type	Full-Floating	Semi-Floating
Make	Spicer	Spicer
Model	23-2	41-2
Drive	Thru Springs	Thru Springs
Road Clearance	8 ⁵ / ₈ " [21.9 cm.]	8 ³ / ₄ " [22.2 cm.]
Differential:		
Type	Hypoid	Hypoid
Ratio	5.38:1	5.38:1
Bearings	2	2
Differential Pinion Gears	2	2
Adjustment	Shims	Shims
Pinion Shaft:		
Bearings	2	2
Adjustment	Shims	Shims
Bevel & Pinion Gears:		
Back Lash .....	.005"-.007" [.127-.178 mm.]	.004"-.008" [.120-.203 mm.]
Adjustment	Shims	Shims
MODEL:	DJ-3A	CJ-3A, CJ-3B, CJ-5, CJ-6
Make	Spicer	Spicer
Model	23 or 27	44
Capacity	2000 lb. [907 kg.]	2500 lb. [1134 kg.]
Description	Semifloating Hypoid Gears Powr-Lok Opt.	Semifloating Hypoid Gears Powr-Lok Opt.
Drive Pinion Offset	1.38" [35 mm.]	1.50" [38 mm.]
No. of Diff. Pinions	2	2
Gear Ratio:		
Standard	4.10:1	4.27:1
Optional		5.38:1
Ring Gear Pitch Dia.	7.75" [19,68 cm.]	8.50" [21,59 cm.]
Pinion Adjustment	Shim	Shim
Pinion Bearing Adjustment	Shim	Shim

STEERING SYSTEM

Contents

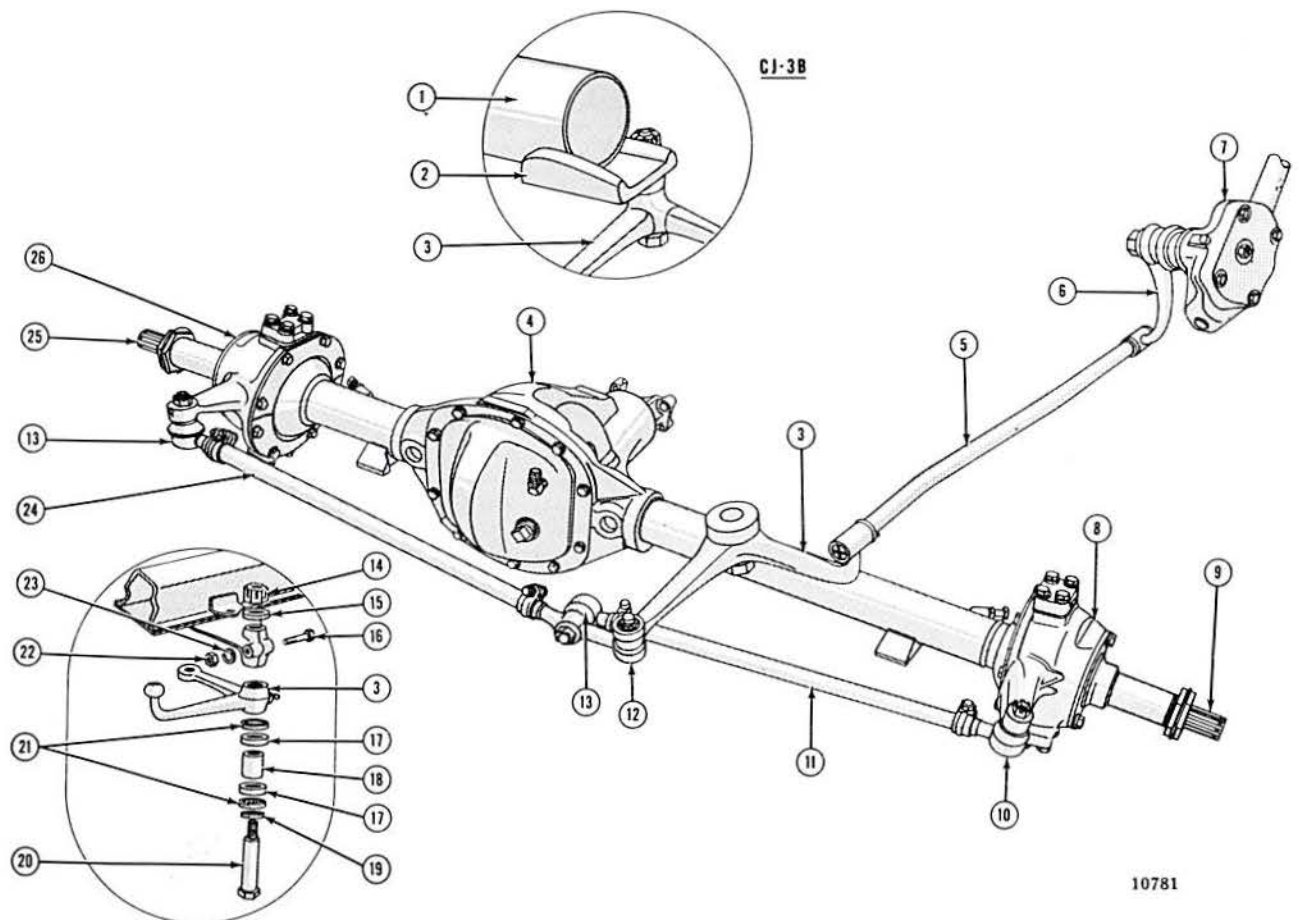
SUBJECT	PAR.	SUBJECT	PAR.
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O-1. GENERAL

The stability and proper functioning of the steering system, Fig. 266, 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 sug-

gested that the following sequence be used:

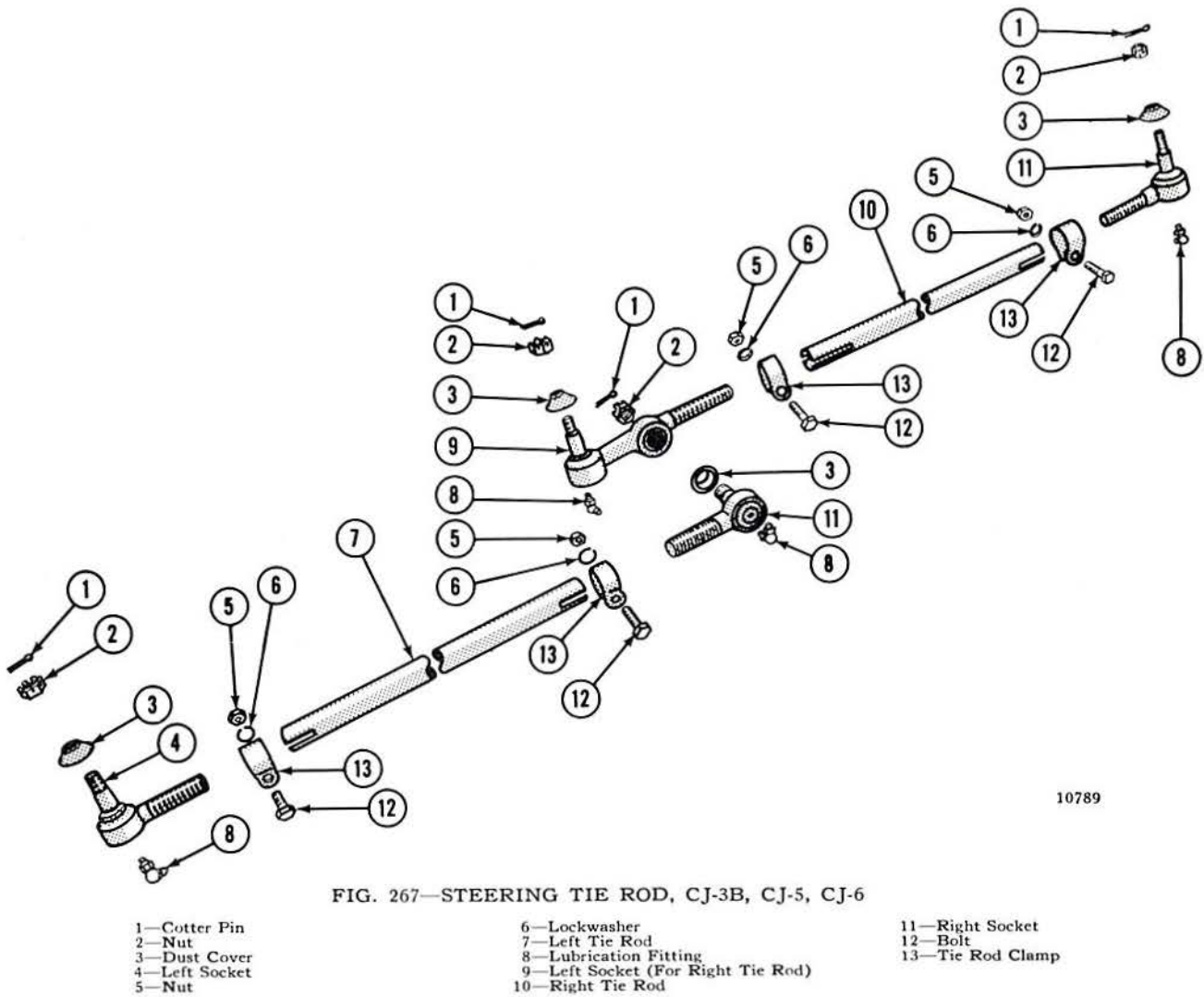
- a. Equalize tire pressures and level vehicle.
- b. Inspect spindle pivot pins and wheel bearing looseness.
- c. Check wheel runout.
- d. Test wheel balance and bearing adjustment.
- e. Check for spring sag.



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FIG. 266—STEERING SYSTEM—MODEL CJ-3B, CJ-5, CJ-6

- | | | |
|--------------------------------------|--------------------------|------------------------------------|
| 1—Frame Cross Tube (CJ-3B) | 10—Left Tie Rod Socket | 19—Washer |
| 2—Steering Bellcrank Bracket (CJ-3B) | 11—Left Steering Tie Rod | 20—Bellcrank Shaft |
| 3—Steering Bellcrank | 12—Left Tie Rod Socket | 21—Bearing Seal |
| 4—Front Axle Assembly | 13—Right Tie Rod Socket | 22—Nut |
| 5—Steering Connecting Rod | 14—Bellcrank Nut | 23—Lockwasher |
| 6—Steering Gear Arm | 15—Washer | 24—Right Steering Tie Rod |
| 7—Steering Gear | 16—Bolt | 25—Right Shaft and Universal Joint |
| 8—Left Steering Knuckle and Arm | 17—Bellcrank Bearing | 26—Right Steering Knuckle and Arm |
| 9—Left Shaft and Universal Joint | 18—Bearing Spacer | |



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FIG. 267—STEERING TIE ROD, CJ-3B, CJ-5, CJ-6

- f. Inspect brakes and shock absorbers.
- g. Check steering assembly and the steering connecting rod.
- h. Check caster.
- i. Check toe-in.
- j. Check toe-out on turns.
- k. Check camber.
- l. Check king pin inclination.
- m. Check turning angle
- n. Check tracking of front and rear wheels.
- o. Check frame alignment.

O-2. Adjustment

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 steering gear to frame bolts use a torque wrench pull of 45 to 55 lb-ft. [6,2 a 7,6 kg-m.] on the $\frac{7}{16}$ " bolts and 30 to 40 lb-ft. [4,15 a 5,5 kg-m.] on the $\frac{3}{8}$ " bolts.

Note: If the steering-gear-to-frame bolts are not properly torqued, they will eventually loosen during operation of the vehicle. Loose bolts will result in elongated bolt holes making maintenance of bolt torque difficult, and may allow position of the steering columns to be misaligned. Therefore, proper torquing is extremely important.

Do not tighten the steering gear to dampen out steering trouble. Adjust the steering only to remove lost motion or play within the unit.

O-3. Steering Gear Adjustment

The cam and lever steering gear is illustrated in Fig. 268. It consists of a spiral cam, and a cross shaft and lever assembly with two lever studs. When the steering wheel is turned, the cam moves the studs, causing rotary movement of the cross shaft, which in turn causes angular movement of the steering arm.

Two adjustments of the steering gear are necessary: up and down play of the steering shaft, and adjustment of the lever studs (tapered pins) in the cam groove.

Adjustment of the ball thrust bearings 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 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. 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.

O-4. Steering Gear Removal

It is necessary to pass the steering gear down through the floor pan.

- a. Remove the left front fender.
- b. On model DJ-3A and early CJ-2A models equipped with remote control, disconnect the remote control rods from the transmission control levers.
- c. Remove the horn button and steering wheel.
- d. Remove the steering post bracket at the instrument panel.
- e. On model DJ-3A and early CJ-2A models equipped with remote control, remove the gear shift lever.
- f. Remove the exhaust pipe from the manifold.
- g. Remove the steering column cover plate on the floor board.
- h. On model DJ-3A and early CJ-2A models equipped with remote control, remove two screws attaching remote control housing to the steering column.

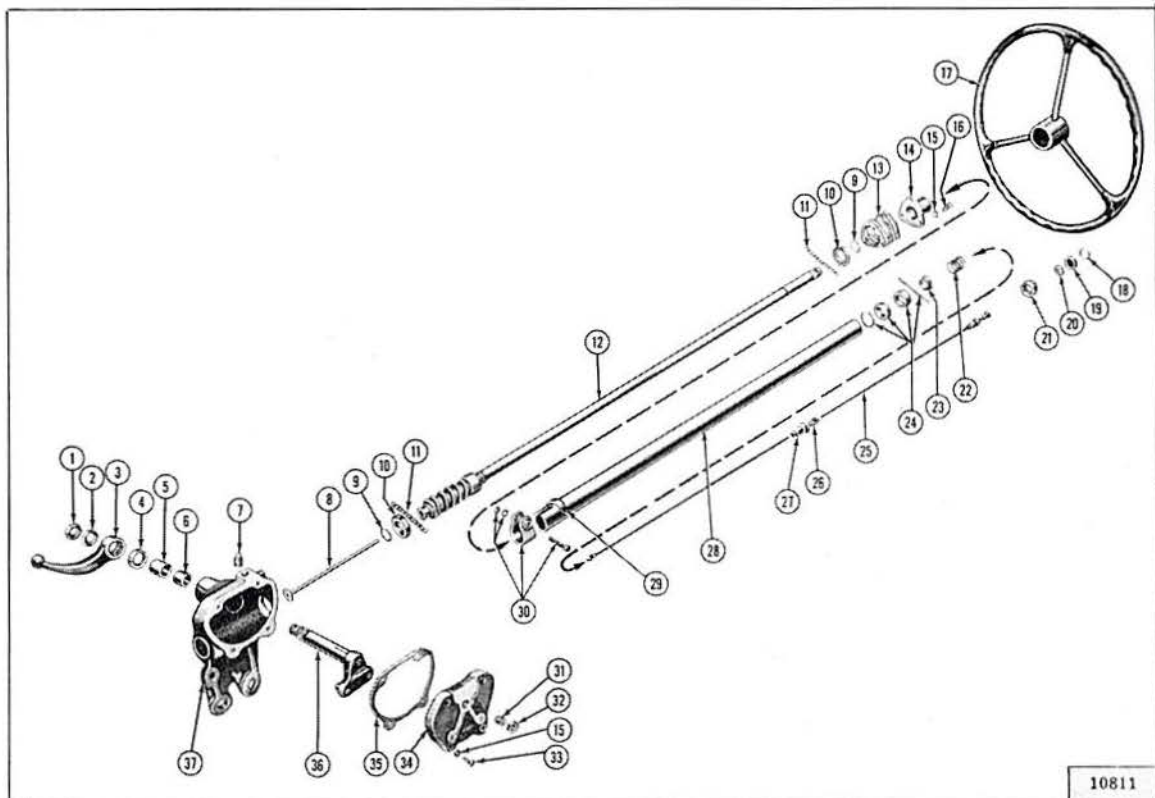


FIG. 268—STEERING GEAR

- | | | | |
|-------------------------|-------------------------|-----------------------|--------------------|
| 1—Nut | 11—Ball (Steel) | 21—Nut | 31—Adjusting Screw |
| 2—Lockwasher | 12—Tube and Cam | 22—Spring | 32—Nut |
| 3—Steering Gear Arm | 13—Shims | 23—Spring Seat | 33—Bolt |
| 4—Lever Shaft Oil Seal | 14—Upper Cover | 24—Bearing | 34—Side Cover |
| 5—Outer Housing Bushing | 15—Lockwasher | 25—Horn Cable | 35—Gasket |
| 6—Inner Housing Bushing | 16—Bolt | 26—Horn Button Spring | 36—Shaft and Lever |
| 7—Filler Plug | 17—Steering Wheel | 27—Spring Cup | 37—Housing |
| 8—Cover and Tube | 18—Horn Button Retainer | 28—Steering Column | |
| 9—Ball Retaining Ring | 19—Horn Button | 29—Oil Hole Cover | |
| 10—Cup | 20—Horn Button Cap | 30—Clamp | |

- i. On model CJ-2A, remove the horn wire contact brush. On all other models, disconnect the horn wire.
- j. On model DJ-3A and early CJ-2A models equipped with remote control, lower the remote control assembly down through the floor.
- k. Remove the steering connecting rod (drag link) from the steering gear arm ball.
- l. Remove bolts attaching the steering gear housing to the frame.
- m. Remove the steering gear assembly by bringing it down through the floor pan and over the outside of the frame side rail.

O-5. 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 rods as outlined in the "Transmission" Section.

top of the remote control shift shaft upper bracket. If the distance is more than 2", steering gear 647694 and steering column 914076 should be used; if under 2", steering gear 812066 and steering column 923716 should be used.

Note: When dismantling the model CJ-2A steering assembly the horn cable contact ring on the steering wheel tube, on vehicles built before Serial No. 178361, must be removed when the upper cup or upper cover plate requires replacement. To do this unsolder the horn cable from the ring and pull cable from the tube. Mark on wheel tube the location of the ring and then press ring from the tube.

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

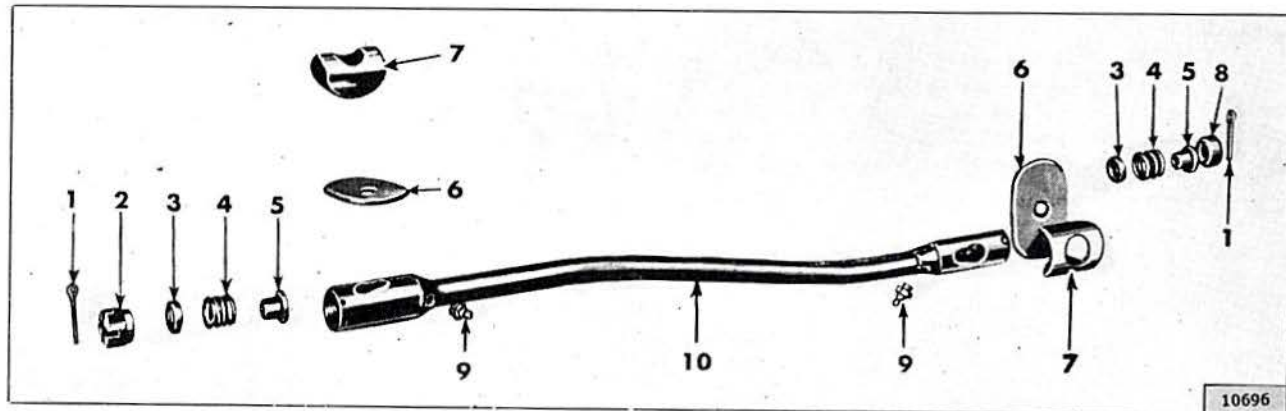


FIG. 269—STEERING CONNECTING ROD (DRAG LINK), CJ-3B, CJ-5, CJ-6

- 1—Cotter Pin
- 2—Large Plug
- 3—Ball Seat
- 4—Ball Seat Spring
- 5—Spring Plug

- 6—Dust Cover
- 7—Dust Shield
- 8—Small Adjusting Plug
- 9—Lubrication Fitting
- 10—Connecting Rod

O-6. Steering Gear Overhaul

When the steering gear arm is installed on early production vehicles, the line across the face of the arm and the end of the shaft should be in alignment. On later production vehicles, blind splines on the lever shaft and in the steering gear arm ensure correct positioning of the arm.

- a. Remove the steering gear arm (Fig. 268) with a puller C-3646.
- b. Loosen the lock nut and unscrew the adjusting screw two turns.
- c. Remove the side cover screws and washers. Remove the side cover and gasket.
- d. Remove lever shaft.
- e. Remove upper cover plate screws. Remove cam, wheel tube, and bearing assembly from the housing.

Note: On model DJ-3A, vehicles with serial numbers 56337-16414 to 56337-16659 were equipped with different steering gears and steering columns. When making replacements, make sure correct parts are obtained. Measure the space between the bottom edge of the steering wheel hub and the

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 and solder the horn cable to the ring (Model CJ-2A before Serial No. 178361 only). Assemble cam, wheel tube and bearing assembly in housing, seating the lower bearing ball cup Fig. 268, in the housing.

With adjusting shims in place, assemble upper cover and adjust the cam bearings.

Assemble lever shaft in housing and with gasket in place assemble the side cover and set adjusting screw 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 $\frac{1}{2}$ 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 on lever shaft Fig. 269, with the ball end down. When installed the line across the face of the arm and end of shaft should be in alignment. Do not overlook adjustment of the transmission remote control shift rods as outlined in the "Transmission" Section on Model DJ-3A and early Model CJ-2A.

O-6A. STEERING LINKAGE

The steering linkage must maintain constant toe-in and good steering control under all driving conditions. This requires ball joints at each end of the tie rods and steering connecting rod. All joints in the steering linkage must be kept well lubricated for easy operation and long life. Should the joints be worn, allowing excessive free motion in the linkage, the joints must be replaced. Whenever ball joints are replaced, toe-in must be reset. Because some members of the steering system may have become bent or distorted, a periodic inspection should be made.

O-7. 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 is shown in Fig. 269. 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 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 wheel 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.

O-8. 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 arm.

'Jeep' Universal and Dispatcher models are equipped with a divided tie rod connected to a bell-crank mounted on the frame cross member. With this type construction the toe-in of each wheel is adjusted independently. See heading "Toe-in adjustment".

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.

O-9. 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.

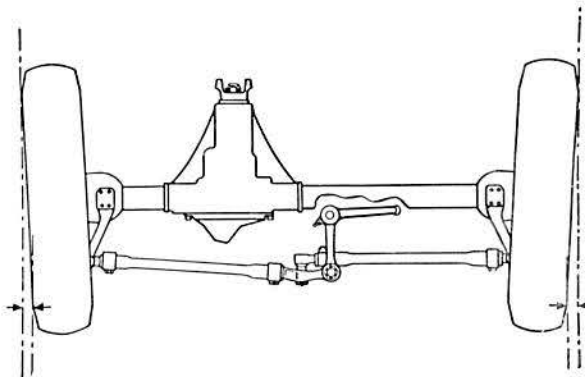


FIG. 270—FRONT WHEEL TOE-IN

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. O-11.

O-10. Front Wheel Toe-In

Toe-in as illustrated in Fig. 270, is necessary to offset the effect of camber as shown in Fig. 271.

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.

The correct toe-in of these models is found in the specifications of this section.

O-11. Toe-In Adjustment

The toe-in may be adjusted with a line or straight edge as the vehicle tread is the same in front and rear. To set the adjustment both tie rods must be adjusted as outlined below:

Set the tie rod end of the steering bell-crank at right angles with the front axle. Place a straight edge or line against the left rear wheel and left front wheel to determine if the wheel is in a straight ahead position. If the front wheel tire does not touch the straight edge at both the front and rear, it will be necessary to adjust the left tie rod by loosening the clamps on each end and turning the rod until the tire touches the straight edge.

Check the right hand side in the same manner, adjusting the tie rod if necessary, making sure that the bell-crank remains at right angles to the axle. When it is determined that the front wheels are in the straight ahead position, set the toe-in by shortening each tie rod approximately one-half turn.

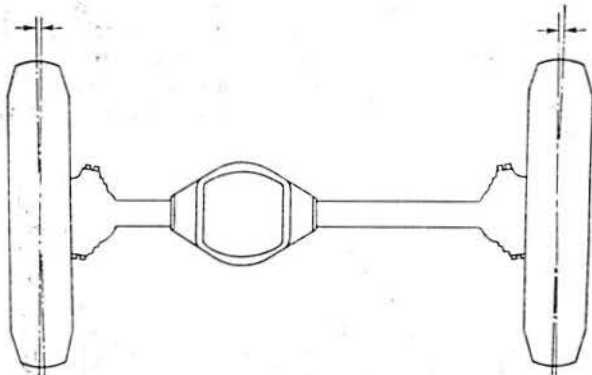


FIG. 271—WHEEL CAMBER

O-12. Front Wheel Camber

The purpose of camber Fig. 271, 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.

Correct wheel camber 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.

O-13. Axle Caster

Caster angle is established in the axle design by tilting the top of the kingpin toward the rear and the bottom of the kingpin forward so that an imaginary line through the center of the kingpin would strike the ground at a point ahead of the point of tire contact.

The purpose of caster Fig. 272, is to provide steering stability which will keep the front wheels in the straight ahead position and 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.

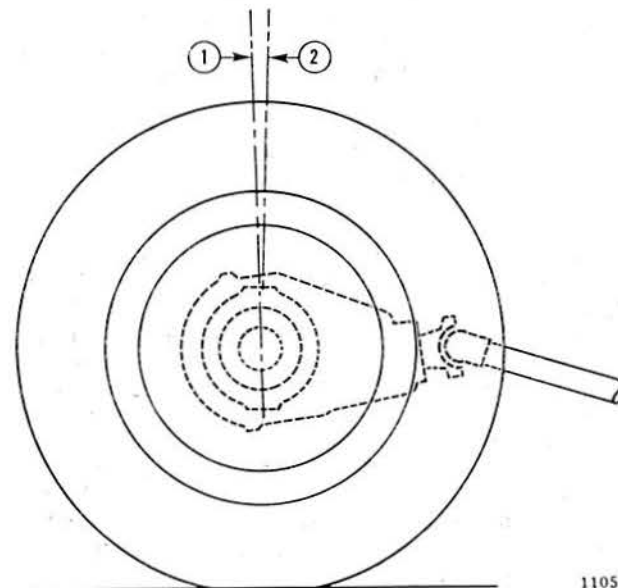


FIG. 272—AXLE CASTER

1—Vertical Line
2—Caster Angle

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If the camber and toe-in are correct and it is known the 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 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.

O-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 to prevent the tire on the inside wheel from being scuffed sideways. This angle for toe out on turns is designed to permit both front wheels to turn on a common center by having the ends of the steering knuckle arms closer together than the king-pins.

If a forged steering arm should be accidentally bent, it can be straightened cold if the bend is not excessive; otherwise, the arm should be replaced.

Should a later model steering arm of the type which is manufactured as an integral part of the knuckle housing become bent, the entire housing must be replaced. It is not safe to straighten this type steering knuckle arm.

O-14A. 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. Wearing away of the upset edge on the spindle housing bolt which contacts the stop screw will increase the turning angle to the point where the universal joints may be damaged.

The turning angle of 'Jeep' Universal models was changed effective with the following vehicle serial numbers: CJ-3B, 57348-35326; CJ-5, 57548-48284; CJ-6, 57748-12497. All models CJ-2A, CJ-3A, and vehicles with serial numbers lower than the above should have a turning angle of not more than 23° both left and right if equipped with Bendix joints, and not more than 29° if equipped with Rzeppa joints. On vehicles with serial numbers higher than the above, the turning angle should be not more than 27½°.

The different joints on vehicles with serial numbers lower than those listed above can be readily identified by removing one of the front hub caps. The Rzeppa joint has a snap ring near the end of the shaft; the Bendix does not.

The stop screw for setting the turning angle is shown in Fig. 273. 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.

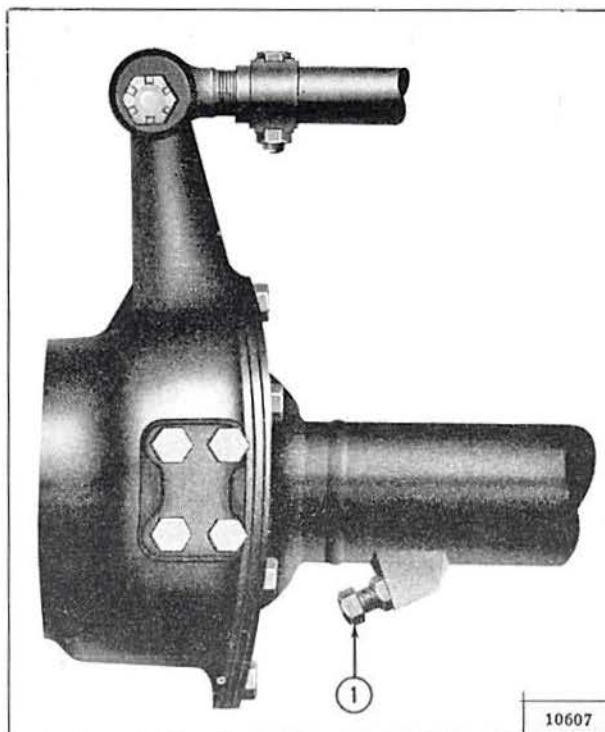


FIG. 273—TURNING ANGLE STOP SCREW

1—Stop Screw

O-15. Steering Bell Crank

All 'Jeep' Universal and Dispatcher models utilize a steering bell crank, Fig. 266, which is mounted on the frame front cross tube (or cross member on Models DJ-3A, CJ-5 and CJ-6) and swivels on two needle bearings. The mounting shaft is removable from the frame bracket by driving out a tapered lock pin.

Should the bell crank become bent or damaged, install a new part.

Note: Effective with Model CJ-2A, Serial No. 199079, a new steering bell crank and mounting was placed in production. The new bell crank assembly is shown in Fig. 266. The bell crank support pin was increased from ¾" to 7/8" [19.05 to 22.22 mm.] and a floating hardened sleeve was placed between the pin and the needle bearings. A new arm, was added with the ball extending up instead of down and with improved bearing seals.

To install this new steering bell crank assembly on CJ-2A models before Serial No. 199079, a new bracket is required. When removing the old bracket from the frame cross member with a welding torch, be careful not to burn the life out of the metal in the cross member.

After removing the old bracket the new bracket must be correctly positioned on the cross member. The center of the hole for the shaft must be 3 15/16" [100.01 mm.] to the left side of the center of the vehicle or of the hole in the bracket on the front side of the cross member. When correctly posi-

tioned, the center of the shaft hole will be $2\frac{1}{16}$ " [68.26 mm.] to the rear and extend $4\frac{35}{64}$ " [115.49 mm.] below the center of the cross member. In this position the bracket should be carefully welded to the cross member at the front and rear edge. See Fig. 274.

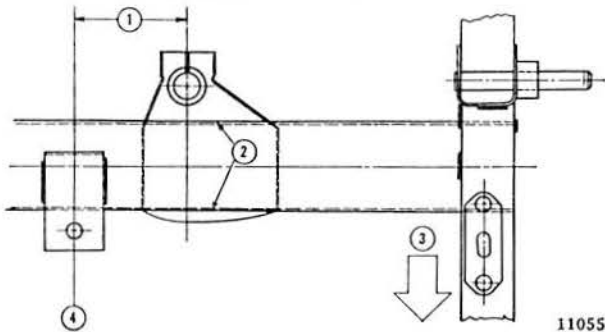


FIG. 274—POSITION OF STEERING BELL CRANK BRACKET

1— $3\frac{1}{8}$ "
2—Weld
3—Front of Vehicle
4—Center Line of Car

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O-16. TROUBLE SHOOTING

O-17. 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. Check the wheel bearings for looseness. Be sure that the inner wheel bearing race is not too loose on the spindle.

c. Remove both steering knuckles and carefully inspect the upper and lower king pin bearings. Inspect the bearing cups for evidence of brinelling, pitting, or fretting. Any bearings that show the slightest imperfection must be replaced. Reassemble and lubricate the front axle and steering linkage, installing new steering knuckle oil seals if present seals show any wear.

d. On Model CJ-5 vehicles the following inspection should be made. With full weight on the front wheels and one man working the steering play with the steering wheel, a second man should closely observe the steering bell crank for any rocking motion and the double tie rod socket for any rocking motion or looseness at both points. Replace the complete bell crank assembly if it has even the slightest rocking motion. The same applies to the double tie rod socket.

e. Check wheel run-out. This check should include radial run-out and wheel looseness on the hub.

f. Test wheel balance—check for blowout patches, uniform tire tread, vulcanized tires, mud on inside of wheels, and tires creeping on the rims.

g. Try switching front wheels and tires to the rear, criss-crossing them in this operation.

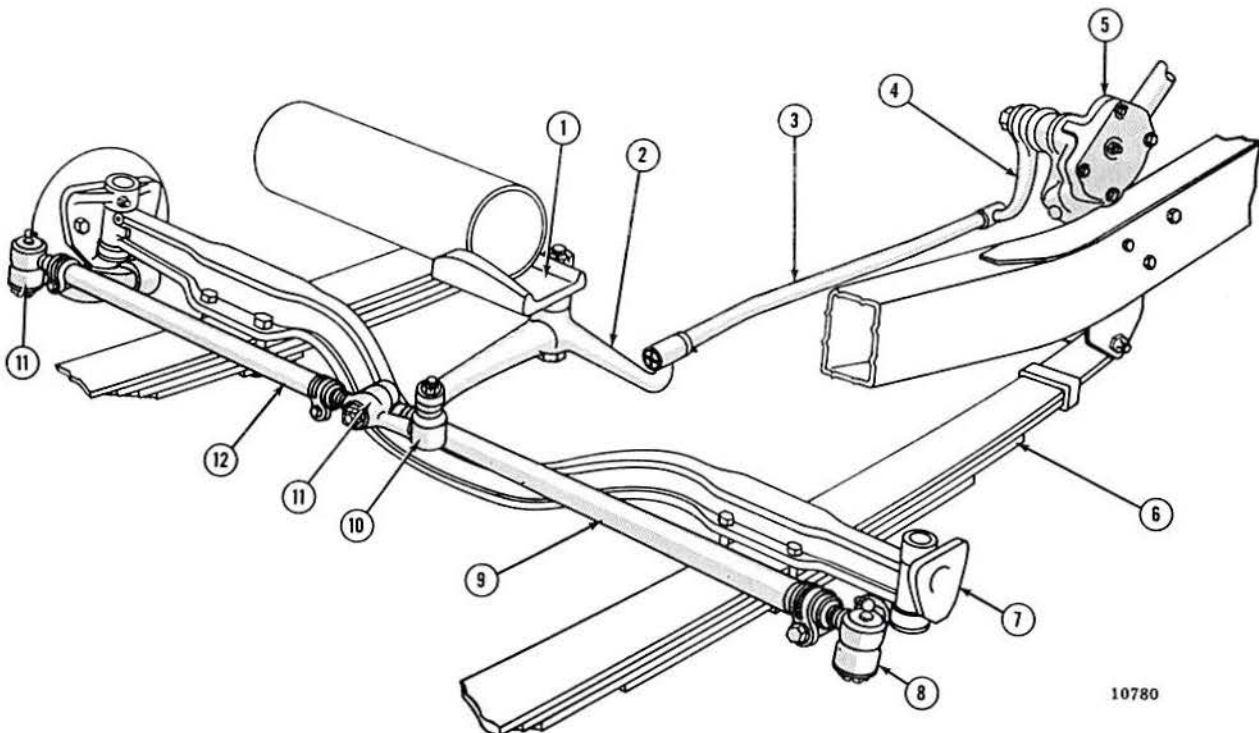


FIG. 275—STEERING SYSTEM—DJ-3A

1—Steering Bellcrank Bracket
2—Steering Bellcrank
3—Steering Connecting Rod
4—Steering Gear Arm
5—Steering Gear
6—Front Spring
7—Axle
8—Left Tie Rod Socket
9—Left Tie Rod
10—Left Tie Rod Socket (For Right Tie Rod)
11—Right Tie Rod Socket
12—Right Tie Rod

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h. 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.

i. Check brakes to make sure that one does not drag.

j. Check the steering assembly and steering connecting rod. 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. Adjust the steering connecting rod (drag link) to maximum safe tightness at both ends. Examine the steering bellcrank bearings, the shaft in the mounting bracket, and the mounting bracket on the frame cross member.

k. 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.

l. Check the front wheel toe-in. See Specifications.

m. 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.

n. Check wheel camber. This should be the same on both wheels as shown on the Specifications.

o. Check the king pin inclination. See Specifications.

p. Check the tracking of the front axle and frame alignment, which may be incorrect due to an accident.

O-18. 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.
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O-19. STEERING SPECIFICATIONS

	'Jeep' Universal DJ-3A
STEERING GEAR:	
Make	Ross
Type	Cam and Lever
Model	T-12
Ratio	14-12-14 to 1
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
Wheel Dia.	17 $\frac{1}{4}$ " [438 mm.]
Wheel Turns	2.58
STEERING GEOMETRY:	
King Pin Inclination	7 $\frac{1}{2}$ $^{\circ}$
Toe-In	$\frac{3}{64}$ " to $\frac{3}{32}$ " [1,2 a 2,3 mm.]
Camber (All CJ Models (DJ-3A)	1 $\frac{1}{2}$ $^{\circ}$
Caster	1 $^{\circ}$
Turning Angle:	
CJ Models	23 $^{\circ}$ or 27 $\frac{1}{2}$ $^{\circ}$
DJ-3A Models	27 $^{\circ}$
Turning Radius with 23$^{\circ}$ Angle:	
CJ-2A, CJ-3A	17' [5,2 mm.]
CJ-3B, CJ-5	19' 6" [5,9 mm.]
CJ-6	25' 2" [7,7 mm.]
Turning Radius with 27$\frac{1}{2}$$^{\circ}$ Angle:	
CJ-3B, CJ-5	17' 6" [5,3 mm.]
CJ-6	22' 10" [7,0 mm.]
Turning Radius with 27$^{\circ}$ Angle:	
DJ-3A	17' 6" [5,3 mm.]
Outside Wheel Angle with Inside Wheel at 20$^{\circ}$:	
'Jeep' Universal	20 $^{\circ}$
DJ-3A	22 $^{\circ}$

BRAKES

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Bleeding Brakes	P-4	Hand Brake Adjustment	P-8, P-9
Brake Adjustment	P-6	Master Cylinder	P-12
Brake Pedal Adjustment	P-5	Relining Brakes	P-10, P-11
Brake Service	P-3	Wheel Cylinder	P-13
Hand Brake	P-7		

P-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 DJ-3A system is illustrated in Fig. 276.

P-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.

The piston in the master cylinder, Fig. 278 and Fig. 279, 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 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 pos-

sible 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. 280 and Fig. 281, 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

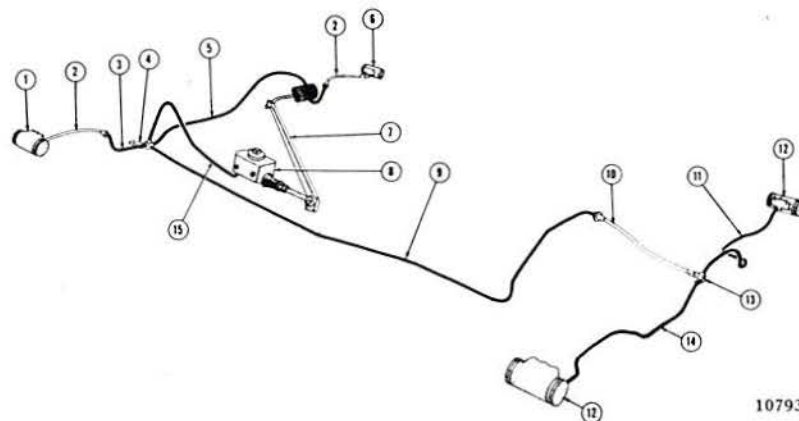
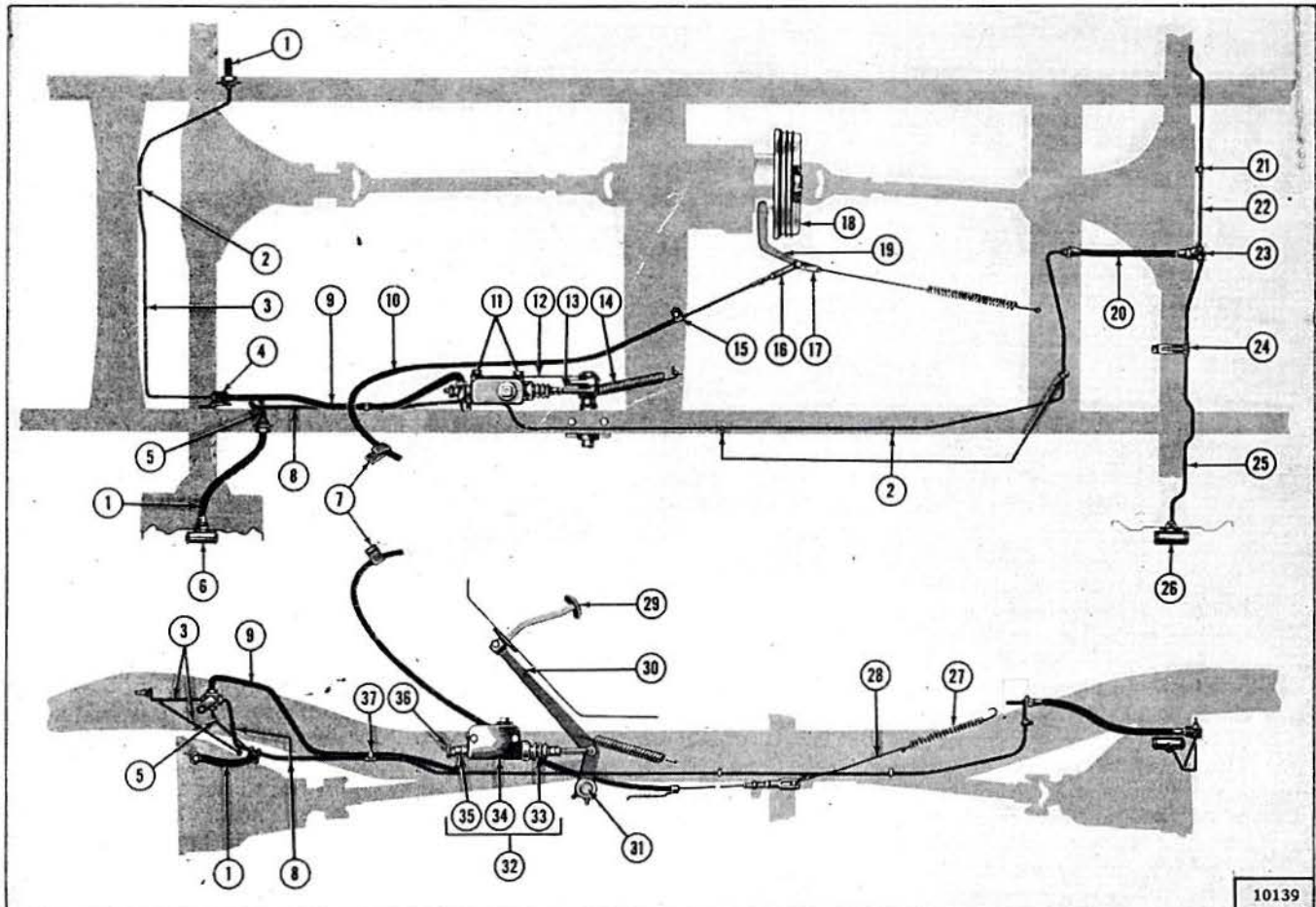


FIG. 276—BRAKE SYSTEM—MODEL DJ-3A

- | | |
|--------------------------------------|--|
| 1—Wheel Brake Cylinder (Left Front) | 9—Brake Tube (Tee to Rear Hose) |
| 2—Brake Hose (Front) | 10—Brake Hose (Rear) |
| 3—Brake Tube (Left Front) | 11—Brake Tube (Right Rear) |
| 4—Brake Tube Tee (4-Way) | 12—Brake Cylinder (Rear) |
| 5—Brake Tube (Right Front) | 13—Brake Tube Tee (3-Way) |
| 6—Wheel Brake Cylinder (Right Front) | 14—Brake Tube (Left Rear) |
| 7—Brake Pedal | 15—Brake Tube (Master Cylinder to Tee) |
| 8—Master Cylinder | |



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FIG. 277—HYDRAULIC BRAKE SYSTEM, CJ-3B, CJ-5, CJ-6

- | | | |
|-------------------------------|----------------------------------|---------------------------------|
| 1—Brake Tube | 14—Brake Pedal Retracting Spring | 27—Hand Brake Retracting Spring |
| 2—Clip | 15—Clamp | 28—Retracting Spring Link |
| 3—Brake Tube | 16—Clevis | 29—Brake Pedal Pad |
| 4—4-Way Tee | 17—Clip | 30—Brake Pedal |
| 5—Brake Tube | 18—Brake Drum | 31—Brake Pedal Shaft |
| 6—Wheel Cylinder | 19—Hand Brake Operating Lever | 32—Master Cylinder |
| 7—Clip | 20—Brake Hose | 33—Bolt |
| 8—Brake Tube | 21—Clip | 34—Supply Tank |
| 9—Brake Tube | 22—Brake Tube | 35—Outlet Fitting |
| 10—Cable and Conduit Assembly | 23—Tee | 36—Stop Light Switch |
| 11—Screw and Lockwasher | 24—Clip | 37—Clip |
| 12—Master Cylinder Tie Bar | 25—Brake Tube | |
| 13—Eye Bolt | 26—Wheel Cylinder | |

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.

P-3. Brake Service

To service the brakes, follow the procedure below:

- Check the fluid level in the brake master cylinder. See Lubrication Section B.

- Check brake pedal adjustment. See Par. P-5.

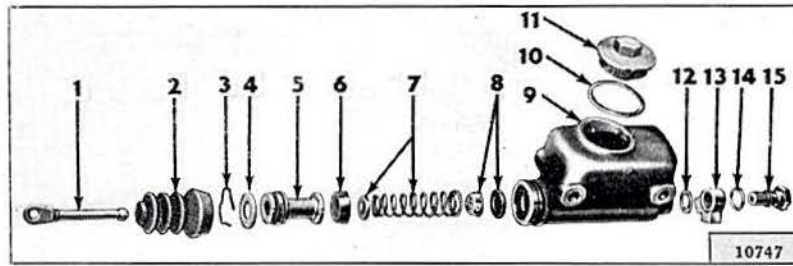


FIG. 278—MASTER BRAKE CYLINDER

- | | | |
|-------------------------|-------------------------|-------------------------------|
| 1—Push Rod | 6—Master Cylinder Cup | 11—Filler Cap |
| 2—Boot | 7—Valve Spring Assembly | 12—Outlet Fitting Gasket |
| 3—Piston Stop Lock Wire | 8—Valve Seat | 13—Outlet Fitting |
| 4—Stop Plate | 9—Supply Tank | 14—Outlet Fitting Bolt Gasket |
| 5—Piston | 10—Filler Cap Gasket | 15—Outlet Fitting Bolt |

c. Check brake pedal travel. If the pedal travels more than halfway to the floor, the brakes may need adjusting to compensate for lining wear or they may need relining. How much lining is left can only be determined by a visual lining inspection. See Par. P-6 for brake adjustment; Par. P-11 for relining brakes.

d. If the brakes pull to one side after adjustment, check tire pressures. All tires must be inflated to recommended pressures to ensure even braking. If the condition persists, examine the brake linings for foreign material and clean as necessary. If cleaning does not correct the condition the linings should be replaced. If the side pull persists, check front wheel alignment and balance.

e. Check the brake system for leaks by applying a steady pressure on the brake pedal. A leak in the system will allow the pedal to "fall away". If the pedal "falls away" check for a leaking wheel cylinder. Remove wheels and drums and carefully check each cylinder. Also examine all lines and fittings. Rebuild or replace all wheel cylinders (Par. P-13) if one is defective as they are all probably in poor condition. If the leak has allowed brake fluid to get on the linings, the linings will have to be replaced.

f. A "spongy" brake pedal indicates the pressure of air in the hydraulic system. This condition must be corrected by bleeding the brakes. See Par. P-4.

g. Should the brakes become locked so that the vehicle cannot be moved, the brakes may be released by opening the bleeder screw on any one of the wheel cylinders. Before the vehicle is driven, correct the cause of the condition. The cause may be either a defective master cylinder or the use of low grade brake fluid which has expanded because of heat.

P-4. 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 brakes, bleed at that wheel with the longest line from the master

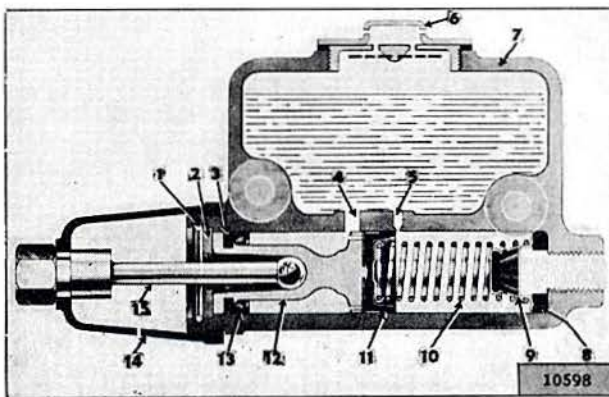


FIG. 279—BRAKE MASTER CYLINDER

- | | |
|-------------------|------------------|
| 1—Retainer Spring | 9—Check Valve |
| 2—Piston Stop | 10—Return Spring |
| 3—Cup Ring | 11—Primary Cup |
| 4—Intake Port | 12—Piston |
| 5—By-Pass Port | 13—Secondary Cup |
| 6—Fill Cap | 14—Boot |
| 7—Supply Tank | 15—Link |
| 8—Valve Seat | |

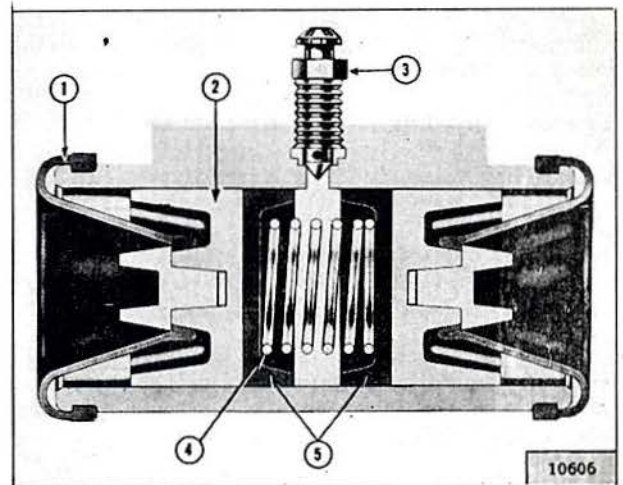


FIG. 280—BRAKE WHEEL CYLINDER

- | |
|-----------------|
| 1—Cylinder Boot |
| 2—Piston |
| 3—Bleeder Screw |
| 4—Cup Spring |
| 5—Cylinder Cup |

cylinder first, the next longest second, etc. During the bleeding operation the master cylinder must be kept at least $\frac{3}{4}$ 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. 283.

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 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.

Do not re-use the liquid which has been removed from the lines through the bleeding process because of air bubbles and dirt.

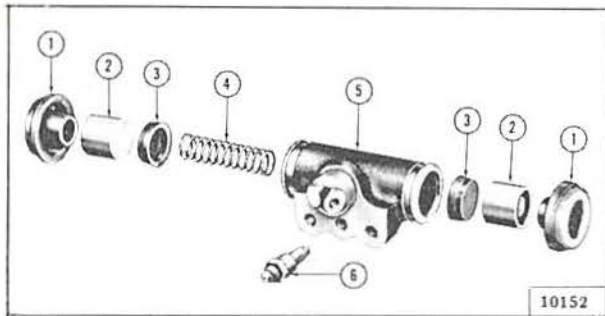


FIG. 281—WHEEL BRAKE CYLINDER

- | | |
|----------------|---------------|
| 1—Boot | 4—Spring |
| 2—Piston | 5—Cylinder |
| 3—Cylinder Cup | 6—Bleed Screw |

P-5. Brake Pedal Adjustment

There should always be at least $\frac{1}{2}$ " [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 Fig. 277. 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.

Note: Some older 'Jeep' vehicles may develop side movement of the clutch and brake pedals resulting from wear of the pedals, shafts, and bushings. One way to compensate for this wear is to install a pedal slack adjuster kit, Part No. 921936.

P-6. Brake Adjustment

The locations of the brake adjusting eccentrics are shown in Fig. 284 and 286.

First be certain that the brake pedal has $\frac{1}{2}$ " [12.7 mm.] free travel.

Jack up the wheels to clear the floor. Adjustment is made by rotating the brake shoe eccentric, Fig. 286. With a wrench loosen the lock nut for the forward brake shoe, hold the lock nut and with brake wrench W-213 turn the eccentric towards the front of the vehicle until the brake shoes strikes the drum, then while turning the wheel with one hand release eccentric until the wheel turns freely. Hold the eccentric in position and fasten the lock nut.

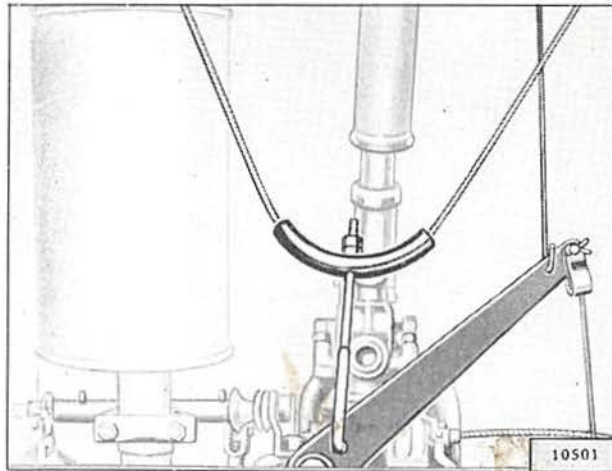


FIG. 282—HAND BRAKE ADJUSTMENT
MODEL DJ-3A

To adjust the reverse shoe, repeat this operation only turn the eccentric towards the back of the vehicle. Do this on all four brakes. Check the fluid level in the master cylinder.

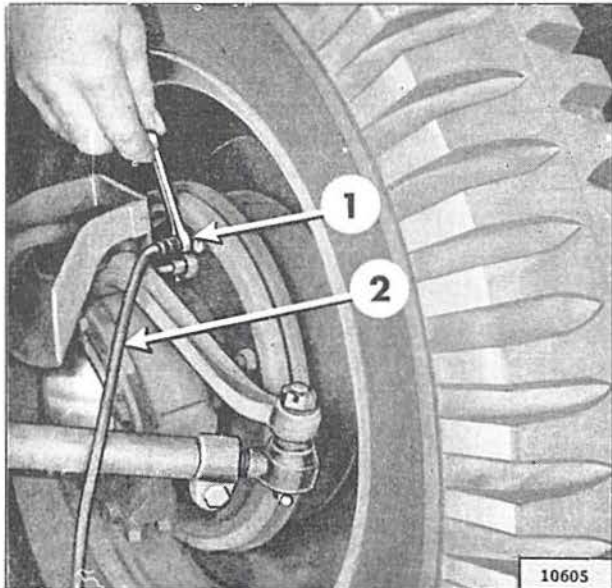


FIG. 283—BLEEDING BRAKES

- | |
|-----------------|
| 1—Bleeder Screw |
| 2—Bleeder Hose |

On Models CJ-2A and CJ-3A, if additional adjustment is required or when relining the brakes, reset the anchor pins as follows:

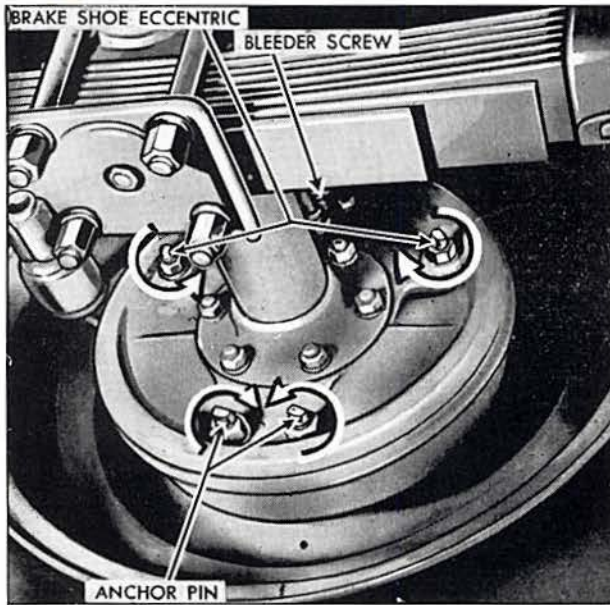


FIG. 284—BRAKE ADJUSTMENTS—
MODELS CJ-2A AND CJ-3A

With the shoe and lining assemblies installed and the brake drum in place loosen the anchor pin lock nuts at the bottom of the backing plate. Adjustment is made by turning the eccentric anchor pins toward each other, Fig. 284, and down until the shoes are set to the proper clearance as determined by feeler gauges. The recommended shoe setting is .005" [.127 mm.] clearance at the heel (lower end), and .008" [.203 mm.] at the toe (upper end) of the brake shoe lining. On early models, a slot was provided in the brake drum for checking these clearances. This slot was eliminated in later models.

P-7. Hand Brake

The hand brake is mechanically operated through a cable and conduit and is an internal expanding

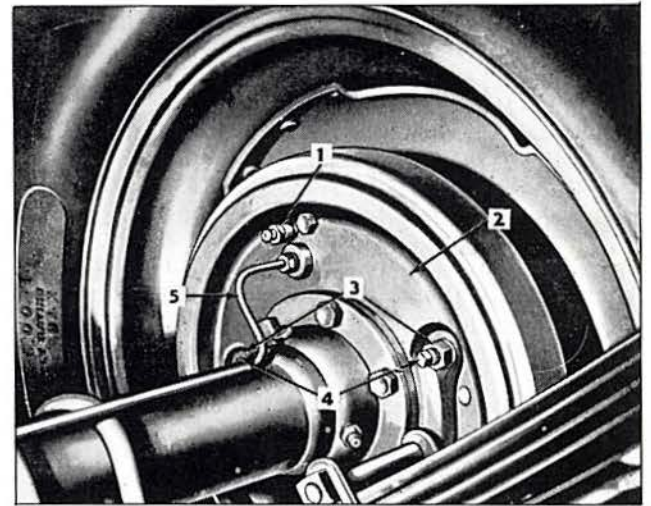


FIG. 286—BRAKE ADJUSTMENTS
—MODELS DJ-3A, CJ-3B, CJ-5
AND CJ-6

- 1—Bleeder Screw
- 2—Brake Backing Plate
- 3—Eccentric Lock Nut
- 4—Eccentric Adjusting Screw
- 5—Brake Fluid Line

type unit mounted on the propeller shaft directly back of the transfer case.

On Model DJ-3A the rear brake shoes are operated through cables and conduits to form the hand or parking brake. A brake cable equalizer and adjusting rod, Fig. 284, is located directly back of the frame center cross member.

P-8. Hand Brake Adjustment

• Model CJ-2A, CJ-3A, CJ-3B, CJ-5, CJ-6

The hand brake is located on the propeller shaft at the rear of the transfer case, see Fig. 285. The brake is operated by a cable connection from the brake handle mounted on the instrument panel.

To adjust the hand brake, the following sequence should be followed:

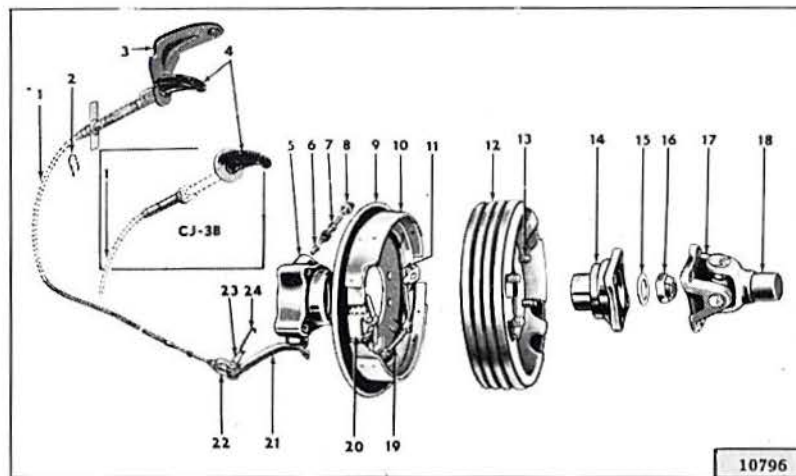


FIG. 285—HAND BRAKE, CJ-3B, CJ-5, CJ-6

- 1—Cable and Conduit
- 2—Hand Brake Clip
- 3—Hand Brake Bracket
- 4—Hand Brake Handle Assembly
- 5—Rear Cap
- 6—Drive Gear Bushing
- 7—Driven Gear
- 8—Driven Gear Sleeve

- 9—Backing Plate
- 10—Shoe and Lining
- 11—Lever End Return Spring
- 12—Brake Drum
- 13—Bolt
- 14—Rear Companion Flange
- 15—Washer
- 16—Nut

- 17—Propeller Shaft Flange Yoke
- 18—Rear Propeller Shaft
- 19—Adjusting End Spring
- 20—Adjusting Screw Bracket
- 21—Operating Lever
- 22—Clevis
- 23—Retracting Spring Clip
- 24—Retracting Spring Link

Make sure that the brake handle on the instrument panel is fully released. Give due attention to the cable and operating linkage to see that they do not bind. If necessary free up the cable and lubricate it. Rotate the brake drum until one pair of the three sets of holes are over the shoe adjusting screw wheels in the brake. Use the edge of the holes in the brake drum as a fulcrum for suitable adjusting tool or a screwdriver, rotate each notched adjusting screw by moving the handle of the tool away from the center of the drive shaft until the shoes are snug in the drum. Back off seven notches on the adjusting screw wheels to secure proper running clearance between the shoes and the drum.

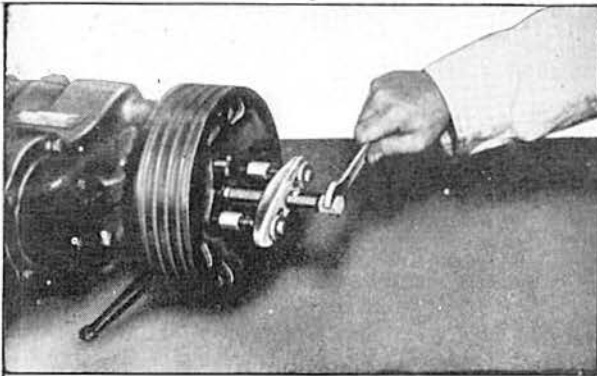


FIG. 287—BRAKE DRUM PULLER

P-9. Hand Brake Adjustment

- Model DJ-3A.

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.

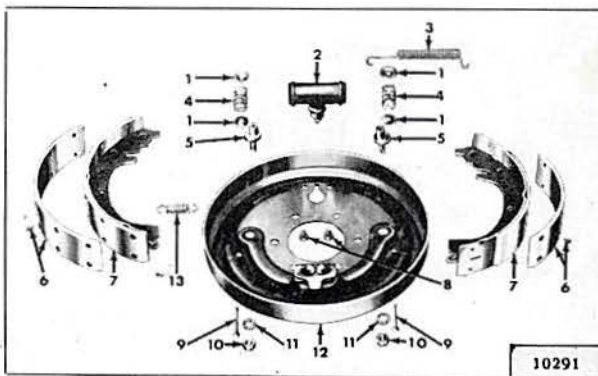


FIG. 288—WHEEL BRAKE

- | | |
|--------------------|------------------------|
| 1—Spring Cup | 8—Screw and Lockwasher |
| 2—Wheel Cylinder | 9—Pin |
| 3—Return Spring | 10—Nut |
| 4—Hold Down Spring | 11—Lockwasher |
| 5—Eccentric | 12—Backing Plate |
| 6—Brake Lining Set | 13—Return Spring |
| 7—Brake Shoe | |

P-10. Relining Hand Brake

- Model CJ-2A, CJ-3A, CJ-3B, CJ-5, CJ-6

To reline the brake shoes and make a major adjustment, first remove the four universal joint attaching nuts and lower the propeller shaft. Remove the retracting spring clevis pin and the spring clip. Remove the hug lock nut, the nut and washer from the transfer case output shaft. Both the universal joint companion flange and the brake drum may be readily removed by using puller Tool No. W-172 which is illustrated in Fig. 287. Remove the two brake shoe retracting springs and the shoes.

Clean all parts with a suitable cleaning solution and examine them for damage or wear.

Brake shoes may be distorted by improper lining installation and the lining 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.

To reassemble, first turn both adjusting screw wheels away from the center to "all off" position.

Place a light film of grease on the brake actuating cam and install the shoes. Install the black shoe return spring next to the cam and the yellow spring next to the notch adjusting wheel screw. Place the brake drum and universal joint flange in position and install the transfer case output shaft washer, nut and hug lock nut.

Rotate the drum until one pair of holes in the drum are opposite the two adjusting screw wheels in the brakes. Use the edge of the holes as a fulcrum and with a suitable tool or screwdriver for adjusting, rotate the adjusting screw wheels, moving the handle of the tool away from the drum until the shoes are snug in the drum.

Examine the brake operating cable to be sure that it is not worn or damaged. Free it up thoroughly and lubricate it. Make sure the operating handle on the instrument panel is fully released. Adjust the clevis on the brake end of the operating cable until the clevis pin will just go through the hole in the clevis and brake operating lever without slack in the cable. Tighten the clevis lock nut.

After the cable is connected back off seven notches on each adjusting screw wheel which will give the proper running clearance between the lining and the drum.

Reconnect the propeller shaft. Install retracting spring clip, clevis pin and the cotter pin, also, install the retracting spring link and spring.

The position of the brake operating lever, Fig. 289, must be correctly set. The position of this lever (see arrow in Fig. 289), is determined by the adjustment of the cam or brake operating link, which spreads the two shoes. The operating link is adjusted by means of the special ball nut to set the operating lever with $\frac{3}{32}$ " [2.38 mm.] clearance between the closest point of the lever and the brake backing plate.

The position of this lever should be checked when making a major adjustment or when relining the

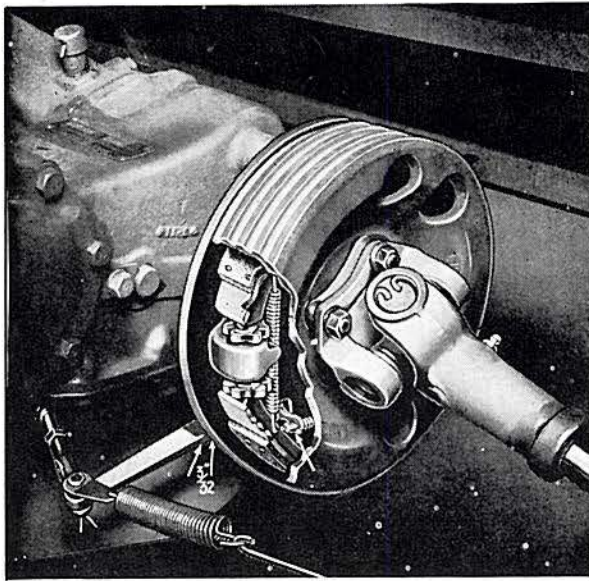


FIG. 289—HAND BRAKE

brakes and if found incorrect readjust it to give this clearance before adjusting the brake cable clevis.

P-11. Relining Wheel 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, Fig. 288. 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. If equipped with anchor pins remove the anchor pin nuts, lock washers and anchor pins from the backing plate.

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.

Inspect the oil seals in the wheel hubs. If the condition of any oil seal is doubtful, replace it. Install the oil seal carefully to prevent damage to sealing surfaces.

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 or shoe 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.

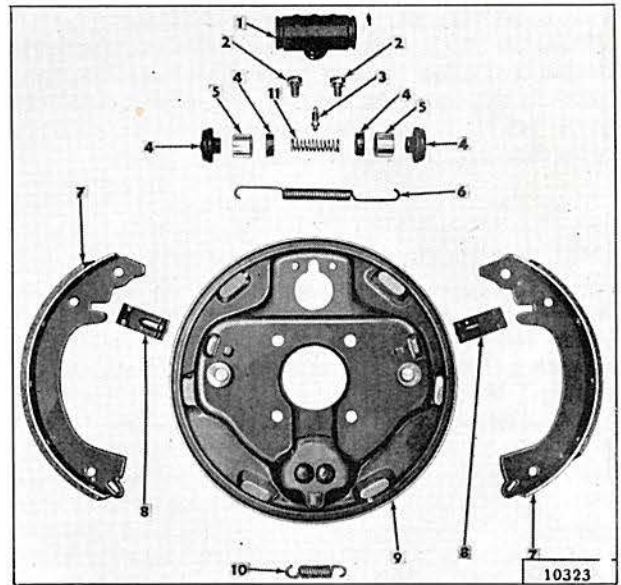


FIG. 290—FRONT WHEEL BRAKES—DJ-3A

- | | |
|-------------------------|------------------------|
| 1—Wheel Cylinder | 7—Shoe and Lining |
| 2—Screw and Lockwasher | 8—Hold Down Spring |
| 3—Bleed Screw | 9—Backing Plate |
| 4—Boot and Cup | 10—Spring (Anchor End) |
| 5—Piston | 11—Cylinder Cup Spring |
| 6—Spring (Cylinder End) | |

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 cov-

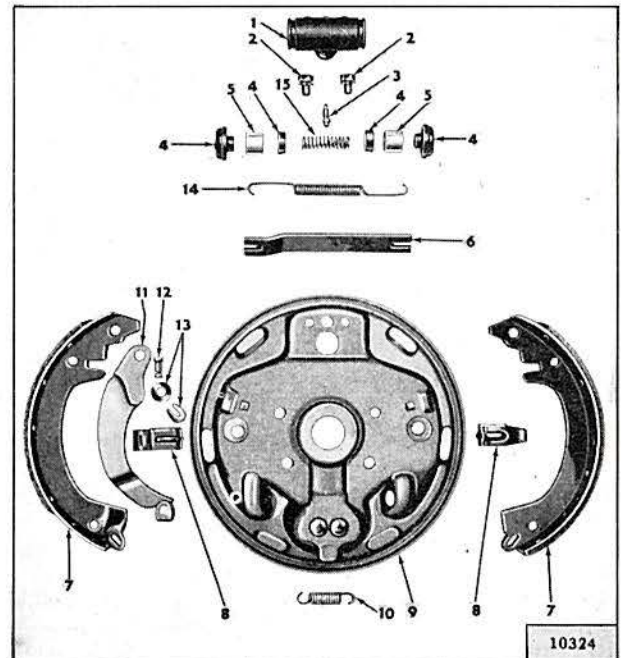


FIG. 291—REAR WHEEL BRAKES—DJ-3A

- | | |
|------------------------|-------------------------------|
| 1—Wheel Cylinder | 9—Backing Plate |
| 2—Screw and Lockwasher | 10—Return Spring (Anchor End) |
| 3—Bleed Screw | 11—Lever |
| 4—Boot and Cup | 12—Pin |
| 5—Piston | 13—Retainer |
| 6—Lever Strut | 14—Spring (Cylinder End) |
| 7—Shoe and Lining | 15—Cylinder Cup Spring |
| 8—Hold Down Spring | |

ered under the heading, "Wheel Cylinders."

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.

P-12. Hydraulic Brake Master Cylinder

Should it be necessary to recondition the master cylinder, the method of removal is obvious.

After the master cylinder 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 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-33) 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 $\frac{1}{2}$ " [1,3 cm.] below the top of the fill hole. Make the necessary connections and adjust pedal clearance to $\frac{1}{2}$ " [1,3 cm.] free play

Bleed the brake lines as instructed in Par. P-4.

Recheck the entire hydraulic brake system to make sure there are no leaks.

P-13. Wheel Cylinder

Some vehicles are equipped with 1" [25 mm.] diameter front wheel brake cylinders, others with $1\frac{1}{8}$ " [29 mm.] diameter cylinders. Both front wheel cylinders and both rear wheel cylinders must have the same diameter or unequal braking will result. Make sure a replacement brake cylinder has the same part number as the original 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. 281.

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 brake if required.

P-14. Keep Grease and Oil off Brakes

No brake can be expected to work well when grease or oil is allowed to leak into the drum from the axle. Little braking 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.

P-15. TROUBLE SHOOTING

P-16. 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.

P-17. 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.

P-18. SERVICE DIAGNOSIS

SYMPTOMS	PROBABLE REMEDY
Brakes Drag	
Brake Shoes Improperly Adjusted.....	Adjust
Piston Cups Enlarged.....	} Flush all lines with Alcohol. Install new cups in wheel and Master Cylinders
Mineral Oil or Improper Brake Fluid in System....	
Improper Pedal Adjustment.....	Adjust Master Cylinder Eye Bolt
Clogged Master Cylinder By-Pass 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 — Vehicle Pulls to One Side	
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
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 Rear Shoes misinstalled
Tires Under-Inflated.....	Inflate
Tires Worn Unequally.....	Replace or Rotate
Glazed or Worn Lining.....	Replace Linings
Restricted Brake Line.....	Locate and Repair
Excessive Pedal Travel	
Normal Lining Wear.....	Adjust
Lining Worn Out.....	Replace
Leak in Brake Line.....	Locate and Repair
Scored Brake Drums.....	Replace or Re grind
Incorrect Brake Lining.....	Replace
Air in Hydraulic System.....	Fill Master Cylinder — Bleed Lines
Spongy Brake Pedal	
Air in Lines.....	Bleed Lines
Brake Shoe Adjustment Incorrect.....	Adjust
Insufficient Brake Fluid.....	Fill Master Cylinder
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 Re grind
Glazed or Worn Lining.....	Replace Linings
Restricted Brake Line.....	Locate and Repair
Faulty Brake Cylinder.....	Repair or Replace
Insufficient Brake Fluid.....	Fill Master Cylinder
Squeaky Brakes	
Shoes Warped or Drums Distorted.....	Replace
Lining Loose.....	Replace
Dirt Imbedded in Lining.....	Wire Brush or Replace
Improper Adjustment.....	Adjust
Oil or Grease on Lining.....	Replace Linings
Glazed or Worn Lining.....	Replace Linings
Drum Scored.....	Turn Drum and Replace Linings

P-19. BRAKE SPECIFICATIONS

	'Jeep' Universal	DJ-3A
TYPE	Hydraulic Internal Expansion Non-Servo Floating Shoe	Hydraulic Internal Expansion Non-Servo Floating Shoe
EFFECTIVE AREA	102.65 sq. in. [662 cm ²]	117.42 sq. in. [757 cm ²]
TOTAL AREA	117.8 sq. in. [759 cm ²]	132.81 sq. in. [856 cm ²]
DRUM DIA.:		
Front.....	9" [209 mm.]	9" [209 mm.]
Rear.....	9" [209 mm.]	9" [209 mm.]
LINING MATERIAL	Molded Asbestos Riveted	Molded Asbestos Riveted
LINING SIZE:		
Front Shoe		
Front Wheel.....	10.219x1.75x.211 [26,0-4,4-0,536 cm.]	9.875x2x.214 [25,1-5,1-0,541 cm.]
Rear Wheel.....	10.219x1.75x.211 [26,0-4,4-0,536 cm.]	9.875x2x.214 [25,1-5,1-0,541 cm.]
Rear Shoe		
Front Wheel.....	6.609x1.75x.211 [16,8-4,4-0,536 cm.]	7.688x1.75x.214 [19,5-4,4-0,541 cm.]
Rear Wheel.....	6.609x1.75x.211 [16,8-4,4-0,536 cm.]	7.688x1.75x.214 [19,5-4,4-0,541 cm.]
WHEEL CYLINDER BORE:		
Front.....	1" [25 mm.]	1 1/8" [29 mm.]
Rear.....	3/4" [19 mm.]	13/16" [21 mm.]
MASTER CYLINDER BORE	1" [25 mm.]	1" [25 mm.]
AVAILABLE PEDAL TRAVEL	6 1/2" [165 mm.]	6 3/4" [171 mm.]
Pedal Free Travel.....	1/2" [12,7 mm.]	1/2" [12,7 mm.]
LINE PRESSURE @ 100 lb. PEDAL LOAD	490 psi. [34,5 kg.-cm ²]	650 psi. [45,7 kg.-cm ²]
PARKING BRAKES:		
Type of Control.....	Hand Lever and Cable	Hand Lever and Cable
Location of Control		
CJ-3B.....	Rt. of Str. Col.	.....
CJ-5, CJ-6.....	Lt. of Str. Col.	.....
DJ-3A.....	.....	Rt. of Str. Col.
Operates on.....	Rear Propeller Shaft	Rear Service Brakes
Type.....	Internal	.....
Drum Dia.....	8" [203 mm.]	.....
Lining Size (2).....	8.125x1.75x.211 [20,6-4,4-0,536 cm.]	.....
Lining Area.....	28.43 sq. in. [183 cm ²]	.....

WHEELS

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Brakes Drums.....	Q-9	Rear Wheel Bearings.....	Q-5
Front Wheel Bearings.....	Q-2	Rear Wheel Bearing Adjustment.....	Q-6
Front Wheel Bearing Adjustment.....	Q-3	Tires.....	Q-10
Maintenance of Wheel Bearings.....	Q-8	Trouble Shooting.....	Q-11

Q-1. GENERAL

The front wheels of Model DJ-3A and all the Jeep Models including the rear wheels of early Model CJ-2A vehicles, equipped with the full floating type rear axles, are carried on two opposed tapered bearings as shown in Fig. 292 and Fig. 293. Refer to heading "Change in Four-Wheel Drive Front Axles" in the Front Axle Section and to Fig. 228 for information on adjusting the end float of the front axle universal joints used on the earlier Jeep Models. The rear wheels of Model DJ-3A and all Jeep models except early CJ-2A equipped with the semi-floating rear axle, are carried on a single tapered

roller bearing mounted on each axle shaft. See Fig. 294.

These bearings are adjustable for wear and their satisfactory operation and long life depends upon periodic attention and correct lubrication.

To check the wheel bearings for adjustment, brakes must be free and in fully released position.

Q-1A. Wheel Balancing

Wheel balancing with the wheel on the vehicle is recommended with one exception. The wheels from any Powr-Lok axle should always be removed for balancing.

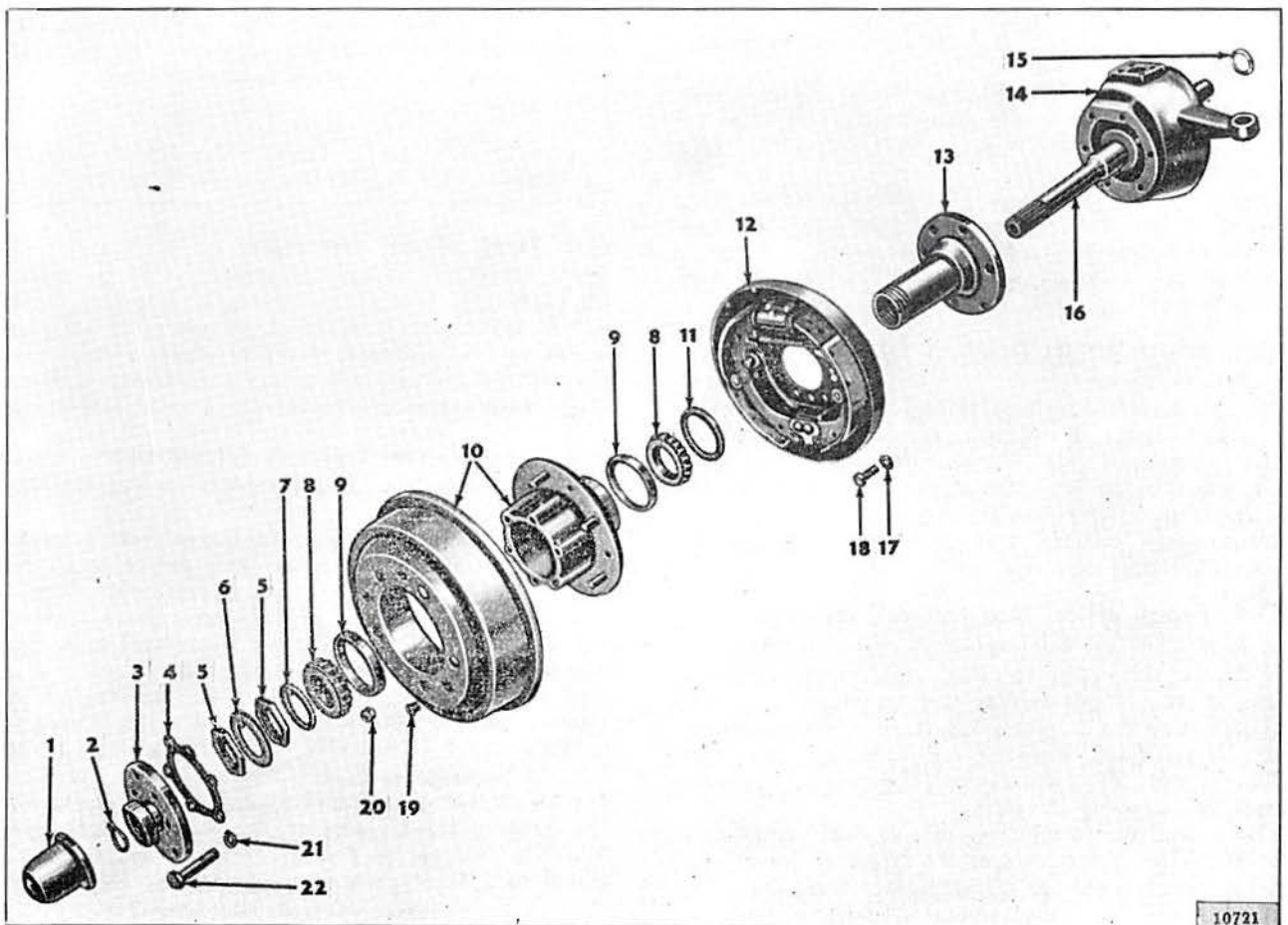


FIG. 292—FRONT WHEEL AND ATTACHING PARTS

- | | | | |
|----------------|---------------------|--------------------------|---------------|
| 1—Hub Cap | 7—Lockwasher | 13—Spindle and Bushing | 19—Screw |
| 2—Snap Ring | 8—Cone and Rollers | 14—Left Knuckle and Arm | 20—Nut |
| 3—Drive Flange | 9—Cup | 15—Thrust Washer | 21—Lockwasher |
| 4—Gasket | 10—Hub and Drum | 16—Universal Joint Shaft | 22—Bolt |
| 5—Nut | 11—Oil Seal | 17—Lockwasher | |
| 6—Lockwasher | 12—Left Front Brake | 18—Bolt | |

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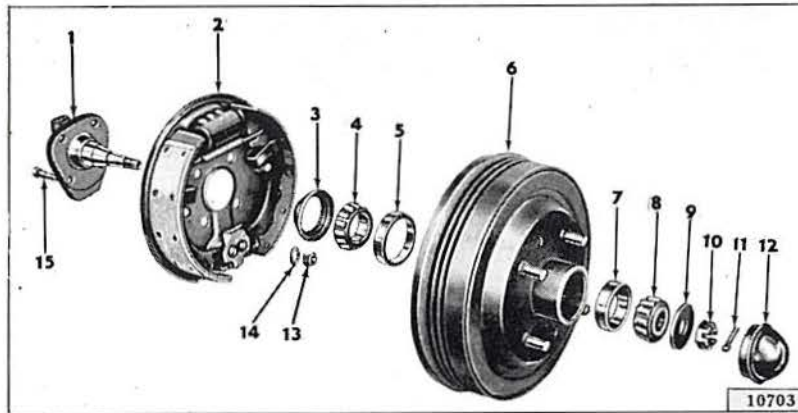


FIG. 293—FRONT WHEEL—DJ-3A

- 1—Steering Knuckle
- 2—Brake
- 3—Hub Grease Seal
- 4—Inner Bearing Cone
- 5—Inner Bearing Cup
- 6—Hub and Drum
- 7—Outer Bearing Cup
- 8—Outer Bearing Cone
- 9—Tongue Washer
- 10—Nut
- 11—Cotter Pin
- 12—Grease Cap
- 13—Nut
- 14—Lockwasher
- 15—Bolt

Q-2. Front Wheel Bearings

Adjustment of the front wheel bearings is critical because it establishes the running clearance of the wheel bearings. Wheel bearing adjustment that is too tight preloads the bearings and causes them to run hot. Loose wheel bearings permit the drum hub to shift its position on the bearings as thrust loads vary with accelerating, braking, and cornering. Loose bearings also cause erratic braking.

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 cause excessive wear and possible noise.

If this test indicates, adjustment is necessary, proceed as follows:

Q-3. Front Wheel Bearing Adjustment

• Model DJ-3A

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.

Q-4. Front Wheel Bearing Adjustment

• Model CJ-2A, CJ-3A, CJ-3B, CJ-5, CJ-6

With the vehicle on the jack, remove the hub cap, axle shaft nut and washer or snap ring and driving flange. Use front axle shaft driving flange puller, Tool No. W-163, Fig. 220, and hub cap puller Tool No. W-161, Fig. 219. Wheel bearing adjustment nuts will then be accessible.

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.

Note: Front tire and wheel must be rotated by hand as the adjusting nut is tightened to ensure positive seating of the bearing.

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.

Note: New front wheel hub and drum assemblies that have been released on models CJ-3B, CJ-5, CJ-6 may be identified by the new bearings and oil seals which differ in size to the earlier bearings and oil seals. Identification is given below.

Description	Early	Late
Cone	11 ¹ / ₁₆ " width	13 ¹ / ₁₆ " width
Cup	2.875" O.D.	2.892" O.D.
Oil Seal	2 ⁷ / ₈ " O.D.	3." O.D.

Q-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:

Q-6. Rear Wheel Bearing Adjustment

• All Models Excepting CJ-2A with Full-floating Axle

The bearing adjusting shims are placed between the brake backing plate and axle flange as shown in Fig. 296. 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 .001" to .006" [0,025 a 0,152 mm.] end float of the axle shaft.

On all earlier model semi-floating type rear axles, the bearing shim packs are installed at both axle housing flanges to provide adjustment at each wheel hub. Shims are installed at one axle flange only on later model axles. In this case it is in order to add shims at either flange to properly adjust end float of the shafts.

Q-7. Rear Wheel Bearing Adjustment

• Model CJ-2A with Full-floating Axle.

First remove the axle shaft driving flange screws and

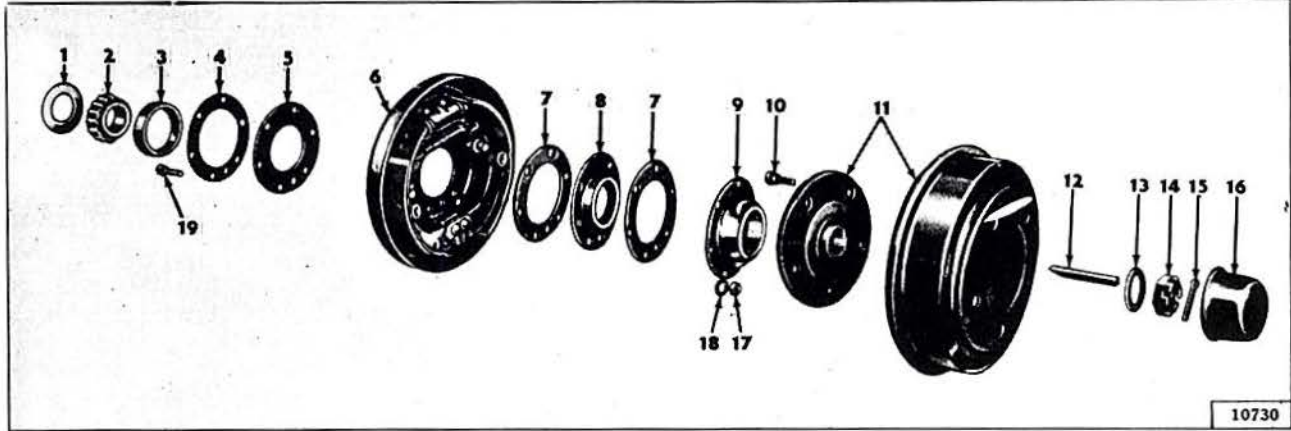


FIG. 294—REAR WHEEL AND ATTACHING PARTS

- | | | | |
|--------------------|--------------------|-----------------|---------------|
| 1—Oil Seal | 6—Brake | 11—Hub and Drum | 16—Hub Cap |
| 2—Cone and Rollers | 7—Gasket | 12—Shaft Key | 17—Nut |
| 3—Cup | 8—Grease Retainer | 13—Oil Seal | 18—Lockwasher |
| 4—Shims | 9—Grease Protector | 14—Nut | 19—Bolt |
| 5—Bearing Retainer | 10—Bolt | 15—Cotter Pin | |

axle shaft. Bend the lip of the lockwasher so that the locknut and lockwasher can be removed. Rotate the wheel and at the same time tighten the inner adjusting nut until the wheel binds. Back off the inner nut about one-sixth turn or more if necessary until the wheel turns freely. Replace the lockwasher and locknut and be sure to bend over the lockwasher lip. Replace the axle shaft with a new flange gasket and install the screws. When replacing the axle shaft, guard against damaging the inner oil seal.

Q-8. Maintenance of Wheel Bearings

Under normal operating conditions the front wheel hub bearings and dual rear wheel bearings require lubrication only every 6000 miles [9.600 km.]. It is necessary to disassemble and remove the bearings from all front wheels to properly lubricate them (also rear wheels of those CJ-2A models with full-floating axles). Rear wheels are equipped with lubrication fittings. When front wheel hubs and bearings are removed for lubrication, they should be thoroughly washed in a suitable cleaning solvent. The bearings should be thoroughly dried and then given a thorough cleaning and inspection. Use a clean stiff brush to remove all particles of old lu-

bricant 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 of the disassembly. Test the bearing adjustment as outlined in Par. Q-6 or Q-7. When installing the hubs and drums, the hubs with the right-hand threaded studs are placed on the right side of the vehicle; the left-hand threaded studs are placed on the left side of the vehicle.

Q-9. 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

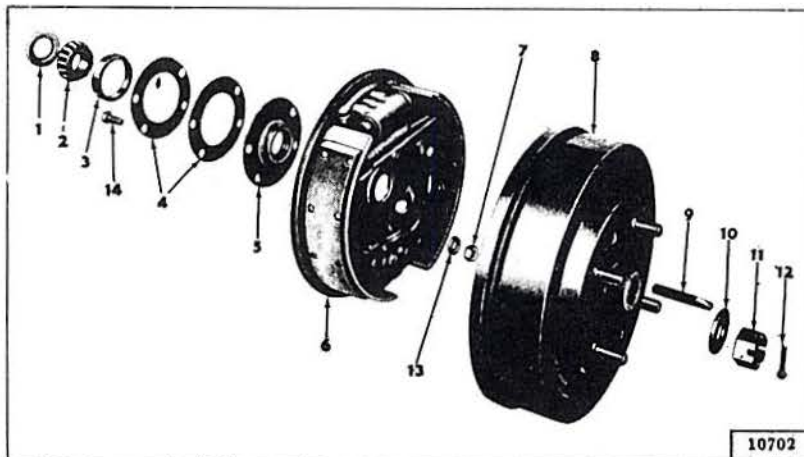


FIG. 295—REAR WHEEL—DJ-3A

- | | | |
|---------------------|------------------|---------------|
| 1—Oil Seal | 6—Brake | 10—Washer |
| 2—Bearing Cone | 7—Nut | 11—Nut |
| 3—Bearing Cup | 8—Hub and Drum | 12—Cotter Pin |
| 4—Shim Set | 9—Axle Shaft Key | 13—Lockwasher |
| 5—Retainer and Seal | | 14—Bolt |

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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 .030" [0,76 mm.]. If the runout is found to be greater than .030", it will be necessary to reset the bolts to correct the condition.

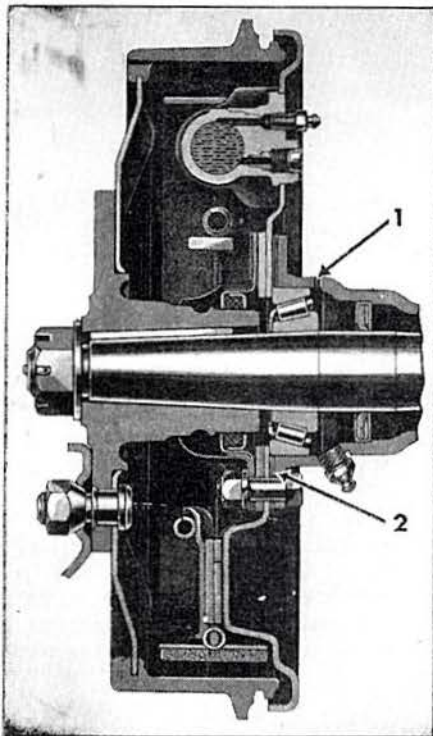


FIG. 296—REAR WHEEL HUB AND BEARING

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, or by the word "LEFT" on the face.

Hubs containing the left hand threaded hub bolts are installed on the left hand side of the vehicle. Do not overpack wheel bearings. Wheel bearing grease may dry out if bearings are overpacked. Overfilling the bearings and space between them in the hub will cause churning of the grease and generation of heat from the turning action of the bearings. The excessive heat may drive out the oils in wheel bearing grease and leave a dry, flaky residue that has no lubricating properties.

Q-10. TIRES

Tires each consisting of a tube and casing are standard on all models.

Q-10A. Tire Care

Tire pressure, tire rotation, wheel balance, and wheel alignment are the four vital factors that influence the extent of tire life and the ease and safety of vehicle control. Four of the most common tire troubles are:

- a. Excessive wear around the outer edges resulting from under-inflation.
- b. Excessive wear in the center of the tread resulting from over-inflation.
- c. Tire tread worn on one side indicating wheels need realigning.
- d. Cuplike depressions on one side of the tread indicating wheels need balancing.

If the vehicle normally carries a full load, two to four pounds [0,14 a 0,28 kg-cm²] can be added to the recommended pressures. But, remember that adding air with a light load means a harsher ride, doesn't help tires, and wears out shock absorbers. Cross-switch the tires every 5000 miles [8.000 km.].

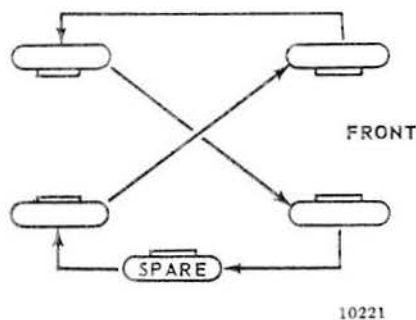


FIG. 297—TIRE ROTATION

See Fig. 297. This practice will even out differences in wear and make a set of tires last longer than they would without cross switching. When a method of tire rotation is selected, it should be used consistently or the full benefits of tire rotation may be lost.

Q-10B. Removing and Installing Tires

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 re-tighten the nuts.

Q-11. TROUBLE SHOOTING

Q-12. Rear Wheel Noise

Looseness of the rear axle shaft nut on semifloating rear axles may produce a clicking or creaking noise. This noise is audible when the vehicle is just start-

ing from a dead stop. The noise can usually be stopped by torquing the nut 150 to 175 lb.-ft. [20,7 a 24,2 kg.-m.]. If the condition has continued for some time, slight wear may have resulted allow-

ing the noise to persist. In this case, coat the hub, key, and keyway with white lead and torque the nut as specified. If the noise persists after this treatment, replace the worn parts.

Q-13. WHEEL AND TIRE SPECIFICATIONS

	'Jeep' Universal	DJ-3A
WHEELS:		
Make.....	Kelsey-Hayes	Kelsey-Hayes
Type.....	Disc	Disc
Material.....	Steel	Steel
Rim Size.....	16 x 4.50	13 x 4.00
Flange Type.....	E	J
Attachment		
Type.....	Stud	Stud
Circle Dia.....	5.50	4.50
Number.....	5	4
Size.....	1/2-20	1/2-20
Rear Axle Shaft End Float.....	.001"-.006" [0,025 a 0,152 mm.]	.001"-.006" [0,025 a 0,152 mm.]
TIRES:		
Size.....	6.00-16	6.50-13
Ply Rating.....	4	4
Revolutions per Mile @ 30 mph.....	730	712
Inflation Pressure		
Front.....	26 psi [1,828 kg-cm ²]	24 [1,687 kg-cm ²]
Rear.....	28 psi [1,968 kg-cm ²]	24 [1,687 kg-cm ²]

FRAME

Contents

SUBJECT	PAR.
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Frame Alignment	R-2
Frame Dimensions	R-3
Front Axle Alignment	R-5
Straightening Frame	R-4

R-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. Fig. 298 and 300 illustrate the subject models.

Vehicles which may have been in an accident of

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, 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

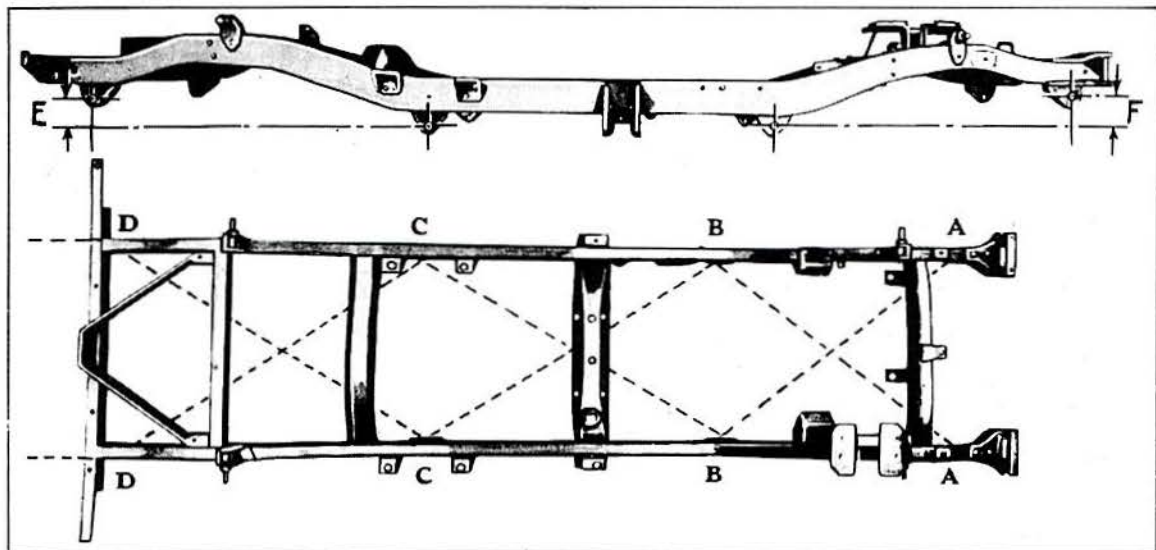


FIG. 298—FRAME ASSEMBLY—MODELS CJ-2A, CJ-3A, DJ-3A, CJ-3B

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.

R-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. Figs. 293 and 300 illustrate 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

corresponding marks on the floor. If widths correspond to specifications given below, 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 $\frac{1}{8}$ " [3,175 mm.], that part of the frame included between points of measurements may be considered as satisfactory alignment. These diagonals should also in-

tersect 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.

R-3. Frame Dimensions

Points for measuring frame alignment are shown in Fig. 298 and 300. 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.

CJ-2A, CJ-3A, DJ-3A, CJ-3B

A-B.....	44.31"	[112.54 cm.]
C-D.....	48.48"	[123.14 cm.]
Width Front.....	29 $\frac{1}{4}$ "	[74.3 cm.]
Width Rear.....	29 $\frac{1}{4}$ "	[74.3 cm.]
"E" above.....	3 $\frac{7}{32}$ "	[8.17 cm.]
"F" above.....	4 $\frac{5}{32}$ "	[10.56 cm.]

CJ-5, CJ-6

A-B.....	47.08"	[119.58 cm.]
C-D.....	52.37"	[133.02 cm.]
Width Front.....	29 $\frac{1}{4}$ "	[74.3 cm.]
Width Rear.....	29 $\frac{1}{4}$ "	[74.3 cm.]
"E" above.....	3 $\frac{7}{32}$ "	[8.17 cm.]
"F" above.....	51"	[1.30 cm.]

R-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.

R-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.

R-6. Draw Bar

Fig. 299, shows method of attachment and bracing of the Jeep draw bar. The braces and the reinforcement installed in the frame rear cross-member channel provide even distribution of the stresses when moving a heavy load.

The draw bar plate may be shifted to any one of nine positions for alignment on the draw bar and may be used with the offset up or down to change the height of attachment. Check the attaching bolts periodically to be sure they are tight at all times.

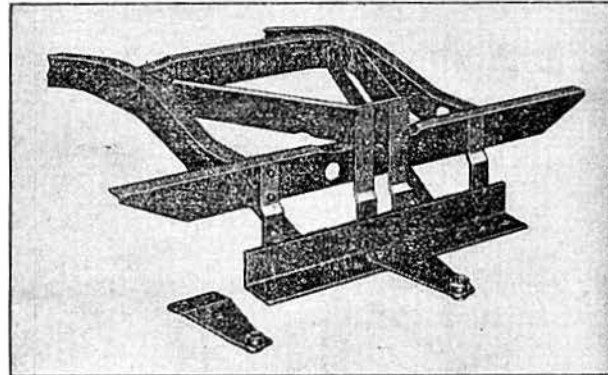


FIG. 299—DRAW BAR MOUNTING

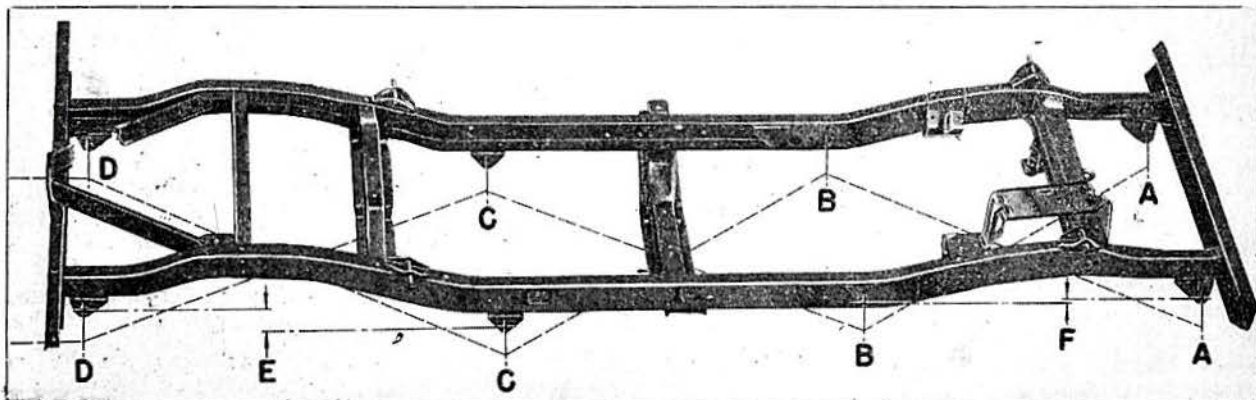


FIG. 300—FRAME ASSEMBLY—MODEL CJ-5 AND CJ-6 (MODEL CJ-5 SHOWN)

R-7. FRAME SPECIFICATIONS

Type — All Models		Ladder with Steel Channel Side Members			
Vehicle	Number of Cross Members	Overall Length	Width		Section Modulus
			Front	Rear	
CJ-2A & CJ-3A.....	4 Intermediate Front Bumper Bar Rear K-member	122 ²¹ / ₃₂ " [311,54 cm.]	29 ¹ / ₄ " [74,3 cm.]	29 ¹ / ₄ " [74,3 cm.]	1.493 in. cu.
CJ-3B.....		122 ²¹ / ₃₂ " [311,54 cm.]	29 ¹ / ₄ " [74,3 cm.]	29 ¹ / ₄ " [74,3 cm.]	1.493 in. cu.
CJ-5.....		128 ⁷ / ₁₆ " [326,23 cm.]	29 ¹ / ₄ " [74,3 cm.]	29 ¹ / ₄ " [74,3 cm.]	1.493 in. cu.
CJ-6.....		148 ⁷ / ₁₆ " [377,03 cm.]	29 ¹ / ₄ " [74,3 cm.]	29 ¹ / ₄ " [74,3 cm.]	1.493 in. cu.
DJ-3A.....	5	122 ²¹ / ₃₂ " [311,54 cm.]	29 ¹ / ₄ " [74,3 cm.]	29 ¹ / ₄ " [74,3 cm.]	1.493 in. cu.

SPRINGS AND SHOCK ABSORBERS

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Pivot Bolts.....	S-3	Spring Removal.....	S-4
Shock Absorbers.....	S-7	Spring Shackles.....	S-2
Spring Installation.....	S-5	U-Shackles.....	S-6

S-1. GENERAL

Semielliptical leaf springs are used for all models. The springs are hung longitudinally from the frame side rails by means of brackets welded to the rails. All axles, except DJ-3A front axles, are firmly attached to the springs by U-bolts (spring clips), spring saddles welded to the underside of the axles, and spring plates under the springs. Model DJ-3A front axles are attached to the springs with conventional bolts and spring plates. Spring center bolts are inserted in the axle spring saddles to prevent shifting of the axle.

All front springs, except as noted below, are provided with shackles at the front ends of the springs and pivot bolts at the rear ends of the springs. Model CJ-5 up to Serial No. 44437 and Model CJ-6 up to Serial No. 11981 are provided with shackles at the rear ends of the front springs, and pivot bolts at the front ends.

All rear springs are provided with shackles at the rear end and pivot bolts at the front end.

Springs should be examined periodically 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 clips or bolts must be

tight. It is suggested that they be checked at each vehicle inspection and torqued 45 to 55 lb-ft. [6,2 a 7,6 kg-m.].

S-2. Spring Shackles

Rubber-bushed shackles are provided on all current production vehicles. The steel-backed rubber (silent bloc) bushings are pressed into the spring eyes and mounting brackets. The shackle bolts tighten the side plates against the inner steel backing of the bushings. Oscillation of the springs is taken in the rubber bushings.

All vehicles produced before early 1957 were equipped with U-shackles and threaded core bushings. See Par. S-6 for service information on U-shackles.

S-3. Pivot Bolts

Models DJ-3A, CJ-2A, CJ-3A, and CJ-3B are equipped with bronze bushings, pivot bolts, and lubrication fittings. The bolts are secured with castellated nuts and cotter pins. See Fig. 302.

Models CJ-5 and CJ-6 are equipped with rubber (silent bloc) bushings, bolts, and locknuts or lockwashers and nuts. See Fig. 304. See Par. S-2 for additional description.

S-4. Remove Spring

To remove a spring, proceed as follows:

- a. Raise the vehicle with a jack under the axle.

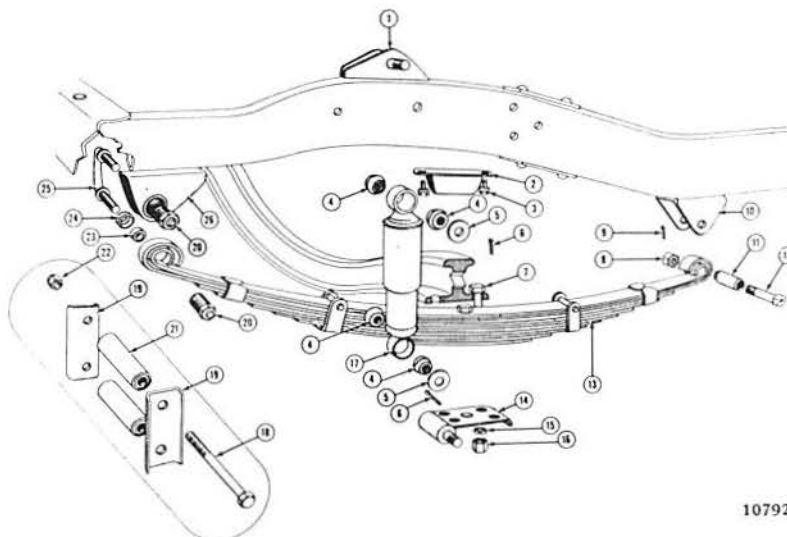


FIG. 301—FRONT SPRING AND SHOCK ABSORBER—DJ-3A

- 1—Bracket and Shaft
- 2—Axle Bumper
- 3—Bolt and Lockwasher
- 4—Bushing
- 5—Washer
- 6—Cotter Pin
- 7—Bolt
- 8—Nut
- 9—Cotter Pin
- 10—Bracket
- 11—Bushing
- 12—Bolt
- 13—Spring
- 14—Plate and Shaft (Left)
- 15—Lockwasher
- 16—Nut
- 17—Shock Absorber
- 18—Bolt
- 19—Plate
- 20—Bushing
- 21—Bearing
- 22—Nut
- 23—Grease Seal
- 24—Grease Retainer
- 25—Spring Shackle
- 26—Spring Shackle Bracket

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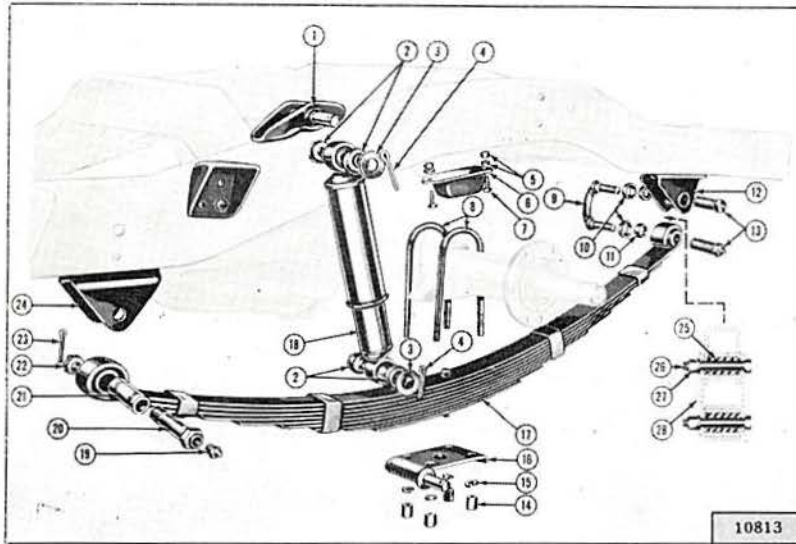


FIG 302—REAR SPRING AND SHOCK ABSORBER DJ-3A

- 1—Bracket and Shaft
- 2—Bushing
- 3—Washer
- 4—Cotter Pin
- 5—Nut and Lockwasher
- 6—Axle Bumper
- 7—Bolt
- 8—Spring Clip
- 9—Spring Shackle
- 10—Grease Retainer
- 11—Grease Seal
- 12—Bracket
- 13—Bushing
- 14—Nut
- 15—Lockwasher
- 16—Plate and Shaft
- 17—Spring
- 18—Shock Absorber
- 19—Lubricating Fitting
- 20—Bolt
- 21—Bushing
- 22—Nut
- 23—Cotter Pin
- 24—Bracket
- 25—Bearing
- 26—Bolt
- 27—Nut
- 28—Plate

Place a stand jack under the frame side rail. Then lower the axle jack so that the load is relieved from the spring with the wheels resting on the floor.

b. Remove nuts securing spring clip bolts. Remove the spring plate and clip bolts. Free the spring from the axle by raising the axle jack (by lowering the axle jack on DJ-3A front axles).

c. Remove the pivot bolt nut and drive out the pivot bolt. Disconnect the shackle either by removing the lower nuts and bolts on rubber-bushed shackles, or by removing the threaded bushings on U-shackles (see Par. S-6).

S-5. Install Spring

To install a spring, first install the pivot bolt. Then, connect the shackle using the following procedure:

a. On bronze-bushed pivot bolts, install the bolt

and nut and tighten the nut. Then back it off two cotter pin slots and install the cotter pin. The nut must be drawn up tightly but must be sufficiently loose to allow the spring to pivot freely. Otherwise spring breakage may result.

b. On rubber-bushed pivot bolts, install the pivot bolt and locknut (or lockwasher and nut) only tightly enough to hold the bushings in position until the vehicle is lowered from the jack.

c. Connect the shackle. On rubber-bushed shackles install the bolts as in subparagraph b above. For U-shackles see Par. S-6 installation instructions.

d. Move the axle into position on the spring by lowering (or raising) the axle jack. Place the spring center bolt in the axle saddle. Install the spring clip bolts, spring plate, lockwashers, and nuts. Torque the nuts 50 to 55 lb-ft. [3,73 a 4,15 kg-m.].

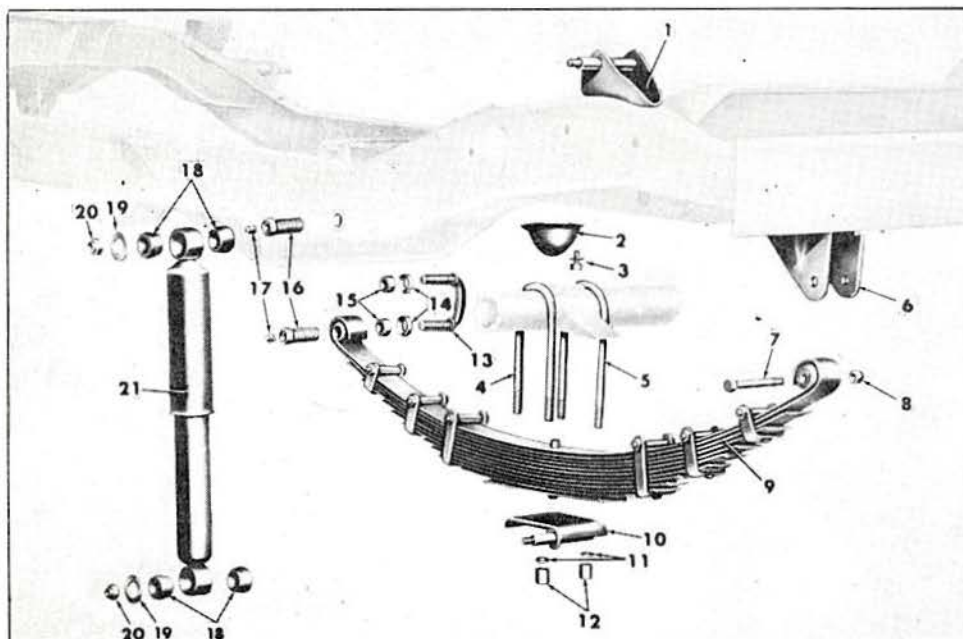


FIG. 303—FRONT SPRING AND SHOCK ABSORBER EARLY CJ-5 and CJ-6

- 1—Front Shock Absorber Bracket
- 2—Front Axle Bumper
- 3—Bolt
- 4—"U" Bolt
- 5—"U" Bolt
- 6—Spring Pivot Bracket
- 7—Pivot Bolt
- 8—Nut
- 9—Front Spring Assembly
- 10—Front Spring Clip Plate
- 11—Lockwasher
- 12—"U" Bolt Nut
- 13—Shackle
- 14—Retainer
- 15—Grease Seal
- 16—Threaded Shackle Bushing
- 17—Lube Fitting
- 18—Mounting Pin Bushing
- 19—Washer
- 20—Lock Nut
- 21—Shock Absorber Assembly

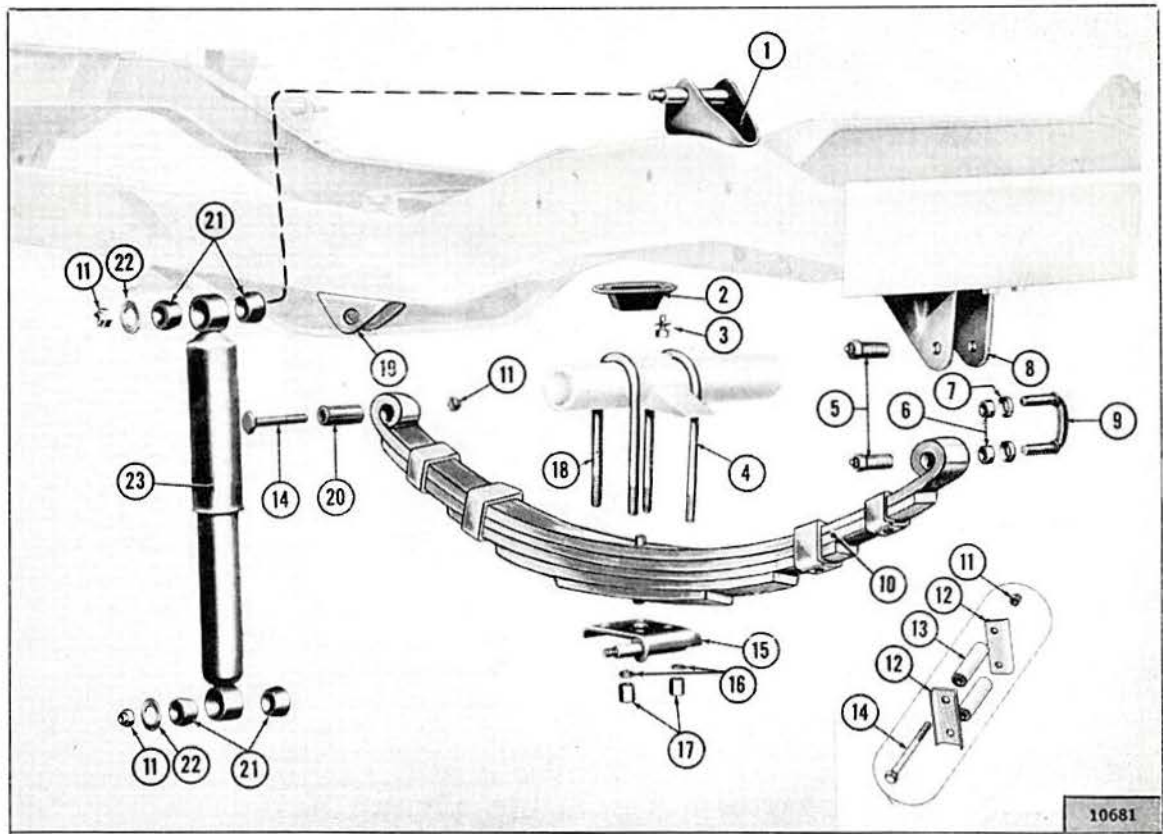


FIG. 304—FRONT SPRING AND SHOCK ABSORBER—LATE CJ-3B, CJ-5, CJ-6

- | | | | | |
|-----------------------|-------------------|--------------------|---------------------|-------------------|
| 1—Bracket and Shaft | 6—Grease Seal | 11—Nut | 16—Lockwasher | 21—Bushing |
| 2—Axle Bumper | 7—Grease Retainer | 12—Plate | 17—Nut | 22—Washer |
| 3—Bolt and Lockwasher | 8—Bracket | 13—Bearing | 18—Spring Clip | 23—Shock Absorber |
| 4—Spring Clip | 9—Spring Shackle | 14—Bolt | 19—Bracket | |
| 5—Bushing | 10—Spring | 15—Plate and Shaft | 20—Bushing (Spring) | |

Avoid over-tightening. Be sure the spring is free to oscillate at both ends.

e. Remove both jacks. On rubber-bushed shackles and pivot bolts, allow the weight of the vehicle to

seat the bushings in their operating positions. Then torque the nuts to 27 to 30 lb-ft. [3,73 a 4,15 kg-m.].

S-6. U-Shackles

The threaded bushings of the U-shackles, used to

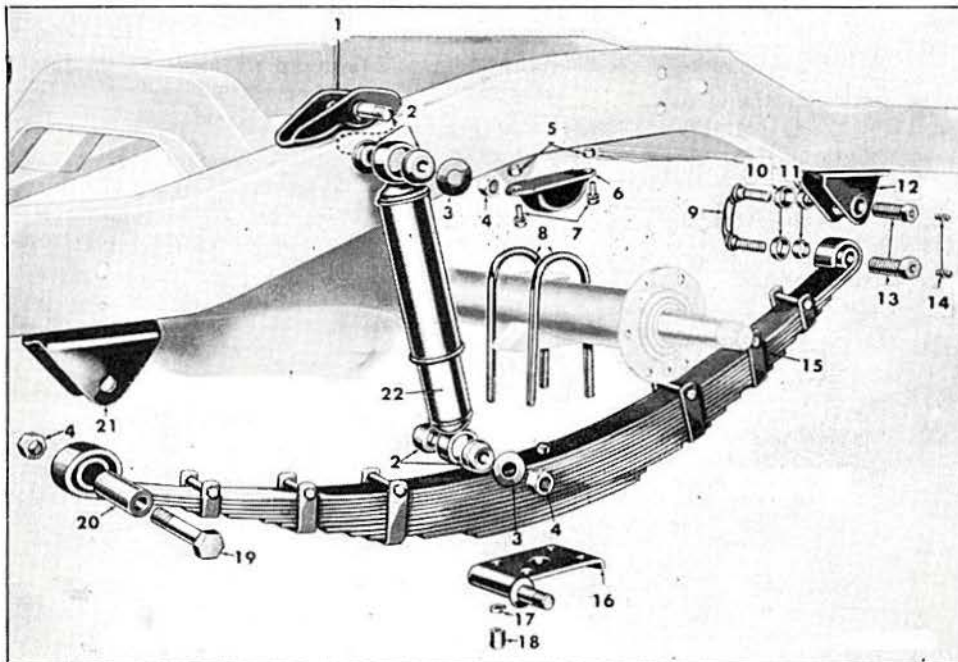


FIG. 305—REAR SPRING AND SHOCK ABSORBER—EARLY CJ-5 AND CJ-6

- | | |
|-----------------------------|-----------------------------|
| 1—Shock Absorber Bracket | 10—Retainer |
| 2—Mounting Pin Bushing | 11—Grease Seal |
| 3—Washer | 12—Bracket |
| 4—Lock Nut | 13—Threaded Shackle Bushing |
| 5—Nut | 14—Lube Fitting |
| 6—Rear Axle Bumper | 15—Rear Spring Assembly |
| 7—Bolt | 16—Rear Spring Clip Plate |
| 8—"U" Bolt | 17—Lockwasher |
| 9—Shackle | 18—"U" Bolt Nut |
| 10—Retainer | 19—Pivot Bolt |
| 11—Grease Seal | 20—Rubber Bushing |
| 12—Bracket | 21—Spring Pivot Bracket |
| 13—Threaded Shackle Bushing | 22—Shock Absorber Assembly |

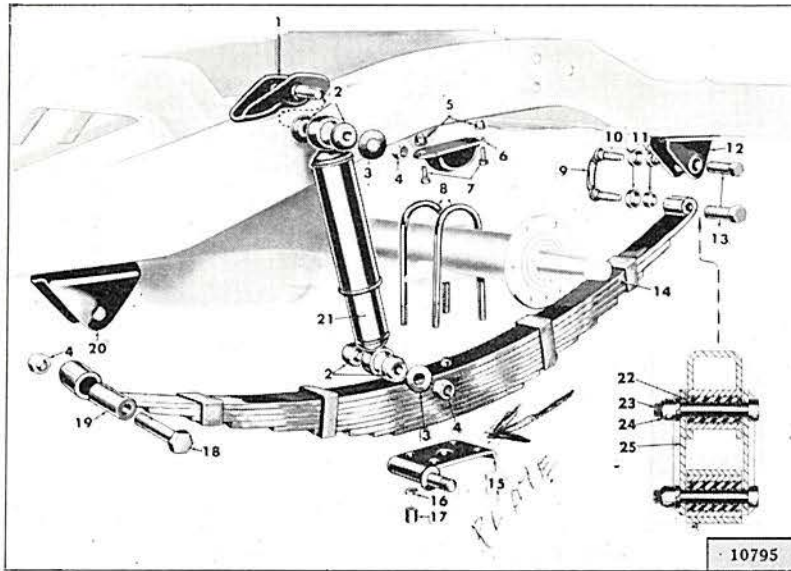


FIG. 306—REAR SPRING AND SHOCK ABSORBER—CJ-3B, CJ-5, CJ-6

- 1—Bracket
- 2—Bushing
- 3—Washer
- 4—Lock Nut
- 5—Nut and Lockwasher
- 6—Axle Bumper
- 7—Bolt
- 8—Spring Clip
- 9—U-Bolt
- 10—Grease Retainer
- 11—Grease Seal
- 12—Bracket
- 13—Bushing
- 14—Spring
- 15—Plate and Shaft
- 16—Lockwasher
- 17—Nut
- 18—Bolt
- 19—Bearing
- 20—Bracket
- 21—Shock Absorber
- 22—Silent Block Bearing
- 23—Bolt
- 24—Nut
- 25—Side Plate

early 1957 production, 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.

On Models CJ-2A, CJ-3A, and early production of Models CJ-3A, CJ-3B, CJ-5, and CJ-6, six bushings are used with right-hand threads and two with left-hand threads. The right-hand threaded bushings have plain hexagon heads. The left-hand bushings have a groove around the heads.

The two left-hand threaded U-shackles are identified by a small forged boss on the lower shank of the shackle. They are used at the left front spring and the right rear spring with the left-hand threaded end DOWN at the spring eye. The left-hand threaded parts have been cancelled in the production of Models DJ-3A, CJ-3B, CJ-5 and CJ-6. All later production vehicles, up to early 1957, use all right-hand threaded parts.

When replacing shackles and bushings on these vehicles, examine the parts carefully for parts of the same type removed must be reinstalled. A right-hand threaded bushing cannot be installed satisfactorily after one having left-hand threads has once been installed.

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, taking care that when it enters the thread in the frame it does not cross-thread. Screw the bushing on the shackle about half way. Start the lower bushing, holding the shackle tightly against the spring eye, and thread the bushing in approximately half way. 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 $\frac{1}{32}$ " [0,794 mm.] away from the spring as 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 may cause spring breakage and it will be necessary to rethread the bushings on the shackle.

S-7. Shock Absorbers

The hydraulic, direct-action shock absorbers used on these vehicles are designed to absorb both upward and downward motion. The upper ends of the shock absorbers are secured to the vehicle frame

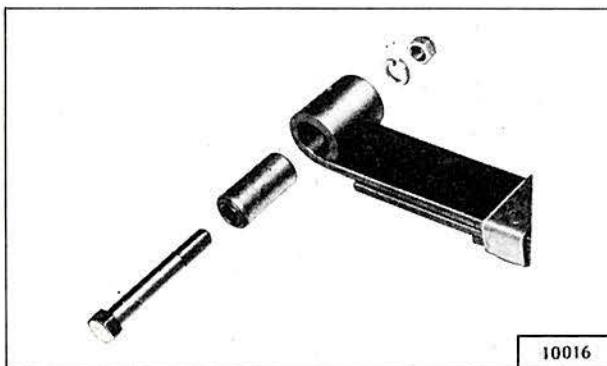


FIG. 307—SPRING PIVOT BOLT

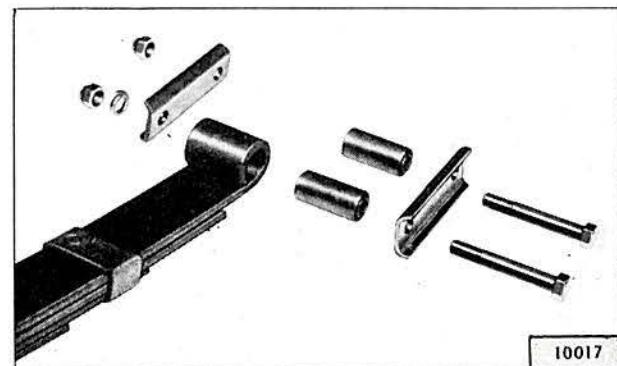


FIG. 308—FRONT SPRING SHACKLE

side rails with mounting brackets and pins. The lower ends are secured to the springs with pins which are an integral part of the spring plates.

Rubber bushings are installed between the mounting pins and shock absorber eyes. Movement at the bushings is taken by flexing of the rubber.

The rubber bushings and shock absorber eyes are held in place on the mounting pins either by a flat washer and a cotter pin on Models DJ-3A, CJ-2A, CJ-3A, and CJ-3B, or by a flat washer and a locknut on Models CJ-5 and CJ-6.

To remove a shock absorber, first remove the cotter pins (or locknuts) and washers. Then pull the shock absorber eyes and rubber bushings from the mounting pins.

To install a shock absorber, first install the rubber bushings and shock absorber eyes on the mounting shafts. Then install the cotter pins or lock nuts. Tighten the lock nuts securely.

Squeaking usually occurs when movement takes place between the rubber bushings and the metal

parts. The squeaking may be eliminated by placing the bushings under greater pressure. This is accomplished either by adding additional washers where cotter pins are used or by tightening the locknuts. Do not use mineral lubricant to remove squeak as it will deteriorate the rubber.

The shock absorbers are not refillable and not adjustable. If trouble develops the shock absorber must be discarded and replaced with a new one. 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, hold it in an upright position and work the plunger up and down the full travel four or five times to determine whether 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 piston. Do not roughen the stem with pliers or similar tool during removal or installation as this will destroy the effectiveness of the seal.

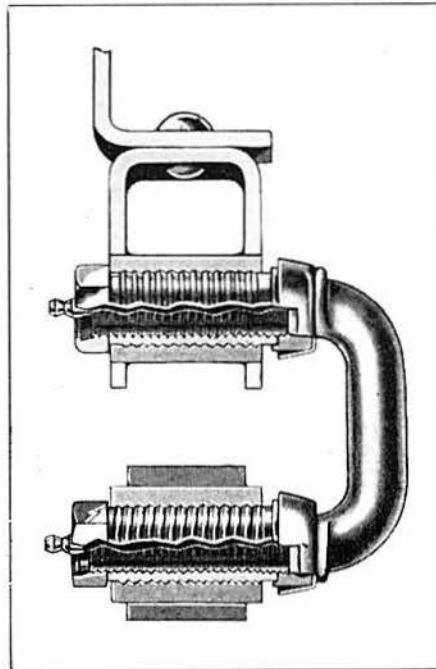


FIG. 309—FRONT SPRING SHACKLE
(Up to early 1957)

S-8. SPRING SPECIFICATIONS

TYPE	Longitudinal Leaf		
DRIVE THROUGH	Springs		
SPRING TYPE	Semielliptical		
MODEL:	CJ-2A, CJ-3A, CJ-3B	CJ-5	CJ-6
FRONT SPRINGS:			
Number of Leaves	10	7	7
Length	36 $\frac{1}{4}$ " [92,08 cm.]	39 $\frac{5}{8}$ " [100,6 cm.]	39 $\frac{5}{8}$ " [100,6 cm.]
Width	1 $\frac{3}{4}$ " [4,44 cm.]	1 $\frac{3}{4}$ " [4,44 cm.]	1 $\frac{3}{4}$ " [4,44 cm.]
Load to Attain			
Design Camber	640 lb. [290,2 kg.]	550 lb. [249,4 kg.]	550 lb. [249,4 kg.]
Stack Height	2.090" [5,308 cm.]	1.684" [4,277 cm.]	1.684" [4,277 cm.]
Design Camber	$\frac{3}{8}$ " [0,95 cm.]	1 $\frac{1}{2}$ " [3,81 cm.]	1 $\frac{1}{2}$ " [3,81 cm.]
REAR SPRINGS:			
Number of Leaves	9	9	9
Length	42" [106,68 cm.]	46 $\frac{1}{8}$ " [117,15 cm.]	46 $\frac{1}{8}$ " [117,15 cm.]
Width	1 $\frac{3}{4}$ " [4,44 cm.]	1 $\frac{3}{4}$ " [4,44 cm.]	1 $\frac{3}{4}$ " [4,44 cm.]
Load to Attain			
Design Camber	800 lb. [362,8 kg.]	940 lb. [426,3 kg.]	845 lb. [383,2 kg.]
Stack Height	1.832" [4,653 cm.]	2.925" [7,432 cm.]	2.461" [6,250 cm.]
Design Camber	$\frac{1}{4}$ " [0,63 cm.]	- $\frac{3}{8}$ " [-0,95 cm.]	$\frac{5}{8}$ " [1,58 cm.]
MODEL:	DJ-3A Open Body	DJ-3A W/Tail Gate	DJ-3A Hard Top
FRONT SPRINGS:			
Number of Leaves	3	7	10L 7R
Length	36 $\frac{1}{4}$ " [92 cm.]	36 $\frac{1}{4}$ " [92 cm.]	36 $\frac{1}{4}$ " [92 cm.]
Width	1 $\frac{3}{4}$ " [4,44 cm.]	1 $\frac{3}{4}$ " [4,44 cm.]	1 $\frac{3}{4}$ " [4,44 cm.]
Load to Attain			
Design Camber	450 lb. [204,1 kg.]	735 lb. [333,3 kg.]	640 lb. L [290,2 kg.] 735 lb. R [333,3 kg.]
Stack Height	.648" [1,645 cm.]	1.481" [3,761 cm.]	2.090" L [5,308 cm.] 1.481" R [3,761 cm.]
Design Camber	$\frac{3}{4}$ " R [1,905 cm.] 0" L [0,000 cm.]	- $\frac{5}{8}$ " [-1,587 cm.]	$\frac{3}{8}$ " L [0,95 cm.] - $\frac{5}{8}$ " R [-1,587 cm.]
REAR SPRINGS:			
Number of Leaves	3	7	9 L 7 R
Length	42" [106,68 cm.]	42" [106,68 cm.]	42" [106,68 cm.]
Width	1 $\frac{3}{4}$ " [4,44 cm.]	1 $\frac{3}{4}$ " [4,44 cm.]	1 $\frac{3}{4}$ " [4,44 cm.]
Load to Attain			
Design Camber	450 lb. [204,1 kg.]	800 lb. [362,8 kg.]	800 lb. [362,8 kg.]
Stack Height	.711" [1,805 cm.]	1.636" [4,155 cm.]	1.832" L [4,653 cm.] 1.636" R [4,155 cm.]
Design Camber	$\frac{1}{2}$ " [1,27 cm.]	$\frac{1}{4}$ " [0,635 cm.]	$\frac{1}{4}$ " [0,635 cm.]

S-9. SHOCK ABSORBER SPECIFICATIONS

TYPE	Hydraulic		
ACTION	Double		
MODEL:	CJ-2A, CJ-3A, CJ-3B	CJ-5, CJ-6	DJ-3A
FRONT SHOCK ABSORBERS:			
Length:			
Compressed	10 $\frac{3}{4}$ " [26,31 cm.]	11 $\frac{7}{16}$ " [29,05 cm.]	11 $\frac{7}{16}$ " [29,05 cm.]
Extended	17 $\frac{1}{2}$ " [44,4 cm.]	18 $\frac{1}{16}$ " [46,83 cm.]	18 $\frac{1}{16}$ " [46,83 cm.]
Piston Diameter	1" [2,54 cm.]	1" [2,54 cm.]	1" [2,54 cm.]
REAR SHOCK ABSORBERS:			
Length:			
Compressed	10 $\frac{3}{4}$ " [26,31 cm.]	11 $\frac{5}{16}$ " [30,32 cm.]	12 $\frac{5}{16}$ " [32,85 cm.]
Extended	17 $\frac{1}{2}$ " [44,4 cm.]	19 $\frac{1}{16}$ " [48,37 cm.]	21 $\frac{1}{16}$ " [54,43 cm.]
Piston Diameter	1" [2,54 cm.]	1" [2,54 cm.]	1" [2,54 cm.]

BODY

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Canvas Tops.....	T-8	Windshield.....	T-2, T-3, T-4
Care of Fabric Tops.....	T-10	Windshield Glass.....	T-6, T-7
Trouble Shooting.....	T-13	Windshield Weatherstrip.....	T-5

T-1. GENERAL

The body is of all steel construction with mountings that provide a secure attachment to the frame. All major panels are of No. 18 gauge steel. All open edges of the panels are turned under, reinforced and flanged to provide strength. These panels are reinforced with "U" sections and welded. All component panels are seamed and welded together. The body is insulated from the frame with insulator shims placed between the body and frame and held in position by the body bolts.

A covered tool compartment is mounted in the vehicle floor at the right of the driver's seat on all models with the exception of DJ-3A.

The instruments and controls, mounted on the instrument panel are within clear view and easy to reach.

Note: A new floor pan cover plate has been released on late CJ-5 and CJ-6 models, that is identified by a stamped oval-shaped bubble or

relief, located to the right of the accelerator treadle. Floor pan noise on early CJ-5 and CJ-6 models may be corrected by installing the new floor pans.

T-2. Windshield

- Model CJ-2A, CJ-3A, CJ-3B

The entire windshield and frame assembly may be lowered down on top of the hood. This is accomplished by unlatching the retaining catches mounted on the cowl above the instrument panel. When lowered do not fail to strap it down with the strap provided which is mounted at the top of the radiator guard.

On Model CJ-3A, when the windshield is in an upright position, ventilation is provided by a hinged ventilator mounted at the center of the panel directly under the windshield.

T-3. Windshield

- Model DJ-3A

Three different windshields, dependent on the type

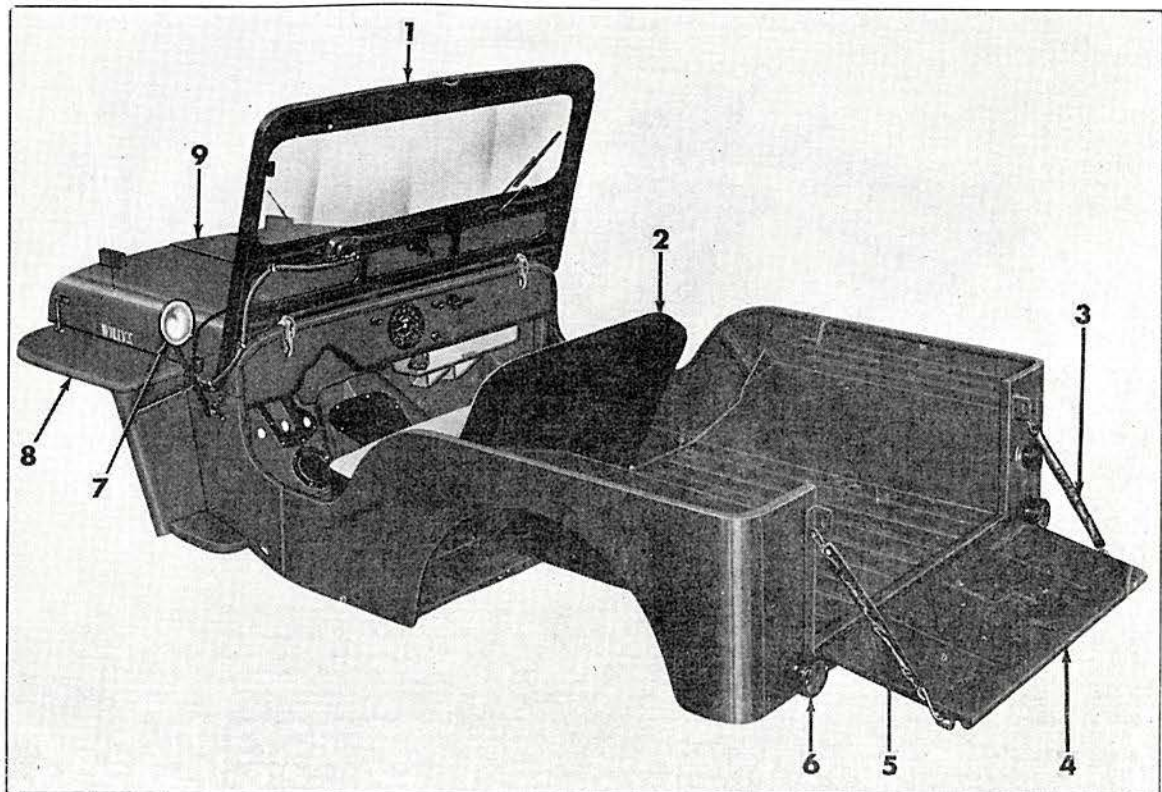


FIG. 310—MODEL DJ-3A BODY

- 1—Windshield Assembly
- 2—Drivers Seat
- 3—Tail Gate Support Chain

- 4—Tail Gate Assembly
- 5—Tail Gate Support Chain
- 6—Tail and Stop Light

- 7—Rear View Mirror
- 8—Left Front Fender
- 9—Hood Assembly

top installed, are used on Model DJ-3A.

A stationary type windshield is used on all vehicles equipped with soft or canvas tops. A hinged ventilator mounted in the center of the panel directly under the glass is provided for ventilation. The glass is installed in the same manner as on Models CJ-3B, CJ-5, and CJ-6.

Vehicles equipped with metal enclosure employ a stationary windshield which is the same as that used with the canvas top except that it has a higher silhouette and is wider. Glass installation is the same as CJ-3B, CJ-5, and CJ-6.

Open body vehicles are equipped with a low silhouette windshield. The frame is stationary, however, the glass tilts forward and up for ventilation. Glass installation is the same as Models CJ-2A, and CJ-3A.

T-4. Windshield

- Model CJ-5, CJ-6

The windshield and frame may be lowered to the hood by unlatching the two clamps at each side of the windshield. When in the lowered position,

always secure the windshield by passing the strap at the top of the windshield through the loop on the hood and drawing the strap up firmly.

To remove the windshield from the Jeep body, first, pull the windshield wiper vacuum hose from the windshield wiper vacuum fitting. Unlatch the two windshield clamps on each side of the windshield. Fold the windshield forward until the slot in the windshield hinges aligns with the flat side of the pin in the body hinges. Slip windshield off the pins and remove from body.

T-5. Windshield Weatherstrip

- Models CJ-2A, CJ-3A

The Models CJ-2A and CJ-3A windshield weatherstrip may be readily replaced as follows:

Open the windshield, swinging it up until it is parallel to the hood and tighten the screws holding it in this position. Remove the old weatherstrip and clean out the channel or groove thoroughly. Loading slots are provided in the vertical sides of the windshield frame at each corner to feed the new weatherstrip into the channel. First lubricate the

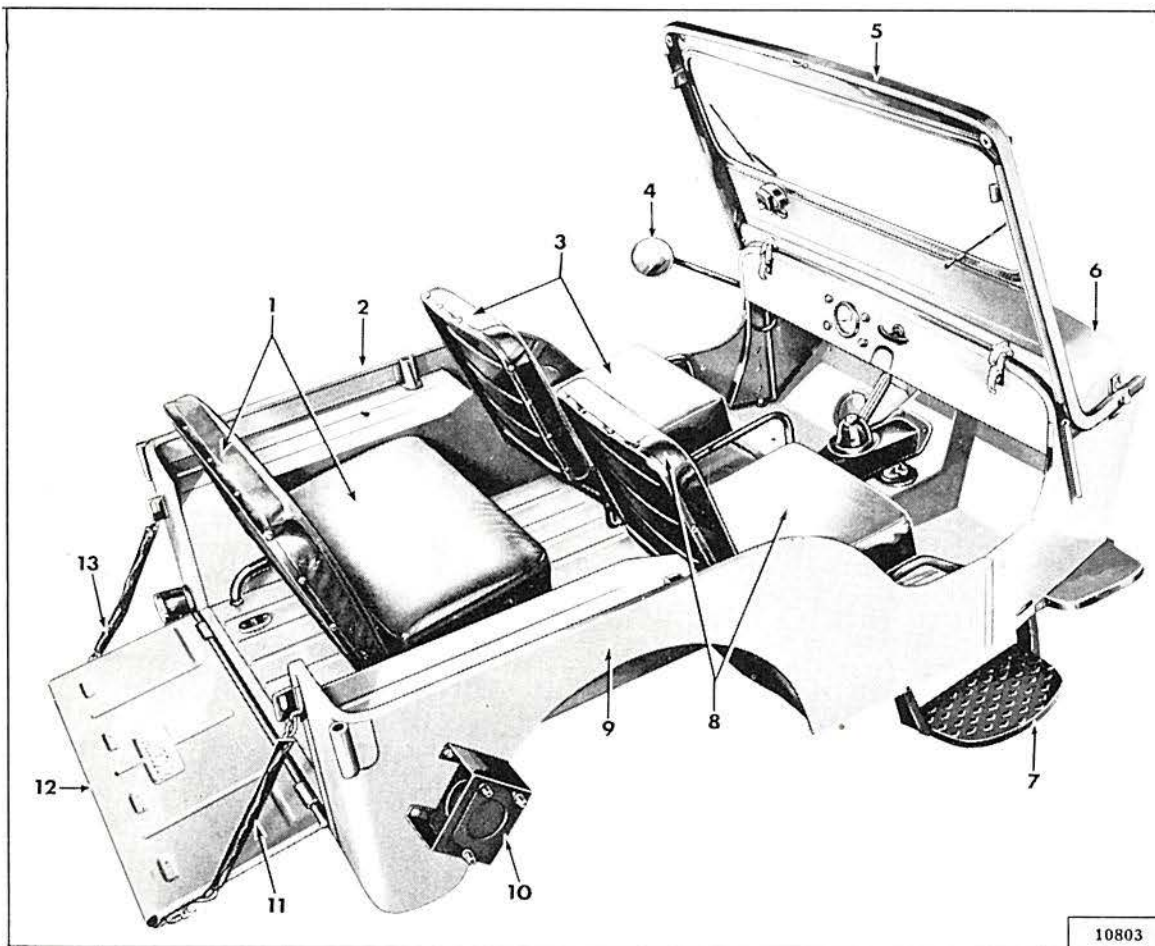


FIG. 311—MODEL CJ-3B BODY

- | | |
|-----------------------|--------------------------|
| 1—Rear Passenger Seat | 8—Front Passenger Seat |
| 2—Left Side Panel | 9—Right Side Panel |
| 3—Driver's Seat | 10—Spare Wheel Bracket |
| 4—Rear View Mirror | 11—Right Tail Gate Chain |
| 5—Windshield | 12—Tail Gate |
| 6—Cowl | 13—Left Tail Gate Chain |
| 7—Step | |

channel with either powdered graphite or brake fluid. Guard against over lubrication as the weather seal will become coated making it hard to handle. Feed the left lower end of the seal into lower right end of the channel working it across the width of the windshield frame. Feed the two vertical ends into the vertical channels in the same manner and use a blunt tool to roll the corners of the seals into the corners of the channel. The flange of the seal is reduced in width at the corners to facilitate the installation.

T-6. Windshield Glass Replacement

• Model CJ-2A, CJ-3A

To replace the Models CJ-2A and CJ-3A windshield glass, follow the procedure outlined below:

- a. Remove screws in each side of windshield adjusting bracket at top.
- b. Bend down lip on left hand outer end of hinge at top.
- c. Open windshield sufficiently to clear the frame and slide assembly out of hinge to left.
- d. Remove the nuts and bolts which hold the upper glass channel to frame.

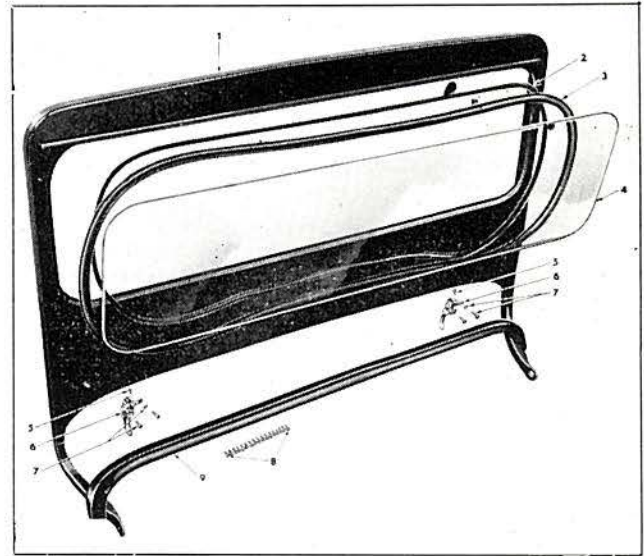


FIG. 312—WINDSHIELD

- | | |
|-----------------------|------------------------|
| 1—Windshield Assembly | 6—Clamp |
| 2—Filler Strip | 7—Screw and Lockwasher |
| 3—Weatherstrip | 8—Screw |
| 4—Windshield Glass | 9—Weatherstrip |
| 5—Screw | |

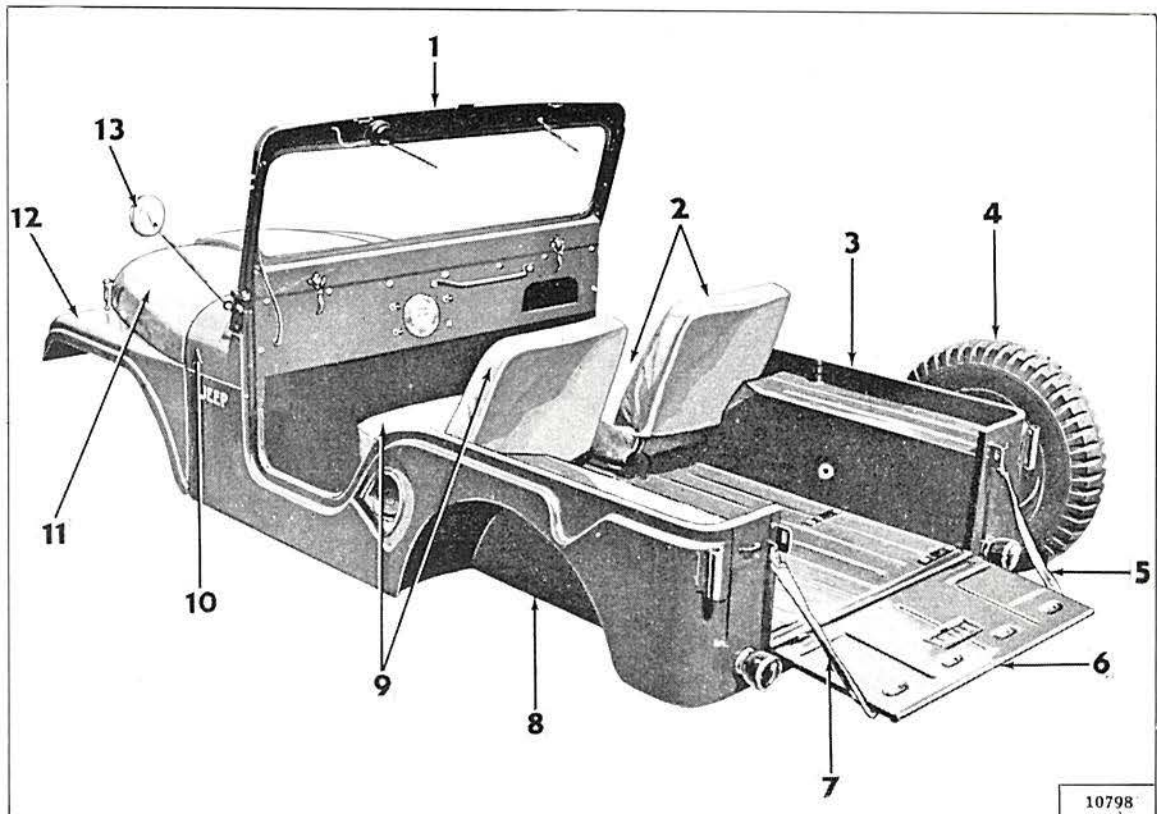


FIG. 313—MODEL CJ-5 BODY

- | | |
|-------------------------|------------------------|
| 1—Windshield | 7—Left Tail Gate Chain |
| 2—Front Passenger Seat | 8—Left Side Panel |
| 3—Right Side Panel | 9—Driver Seat |
| 4—Spare Wheel and Tire | 10—Cowl |
| 5—Right Tail Gate Chain | 11—Hood |
| 6—Tail Gate | 12—Left Front Fender |
| | 13—Rear View Mirror |

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- e. Remove upper glass channel.
 f. Withdraw glass from frame.
 The installation of the glass is the reverse of the above operations. Use new tape around the glass.

T-7. Windshield Glass

- Model CJ-3B, CJ-5, CJ-6

The windshield glass is mounted in a rubber weatherstrip which in turn mounts in the frame. A rubber locking strip, which holds the glass firmly in the frame, is inserted in a moulded groove around the rear face of the weatherstrip as shown in Fig. 312. To remove the glass it is necessary to first remove the locking strip which may be pried out with a screw driver or similar tool. Installation is obvious.

T-8. Canvas Tops

- Model CJ-5, CJ-6

Canvas tops are available in Half Tops and Full Tops on Models CJ-5 and CJ-6. For progressive, easy installation of the half and full top, we suggest use of the following procedure.

T-9. Half Top

- a. Place the top cross bow in the sockets provided on the body sides just to the rear of the front seats.
 b. Connect the stabilizer board between the top cross bow and the bracket on the windshield, using the provided carriage bolts and wing nuts.
 c. Install the left and right top rails in the brackets on the top cross bow and windshield and secure with the locking pins.

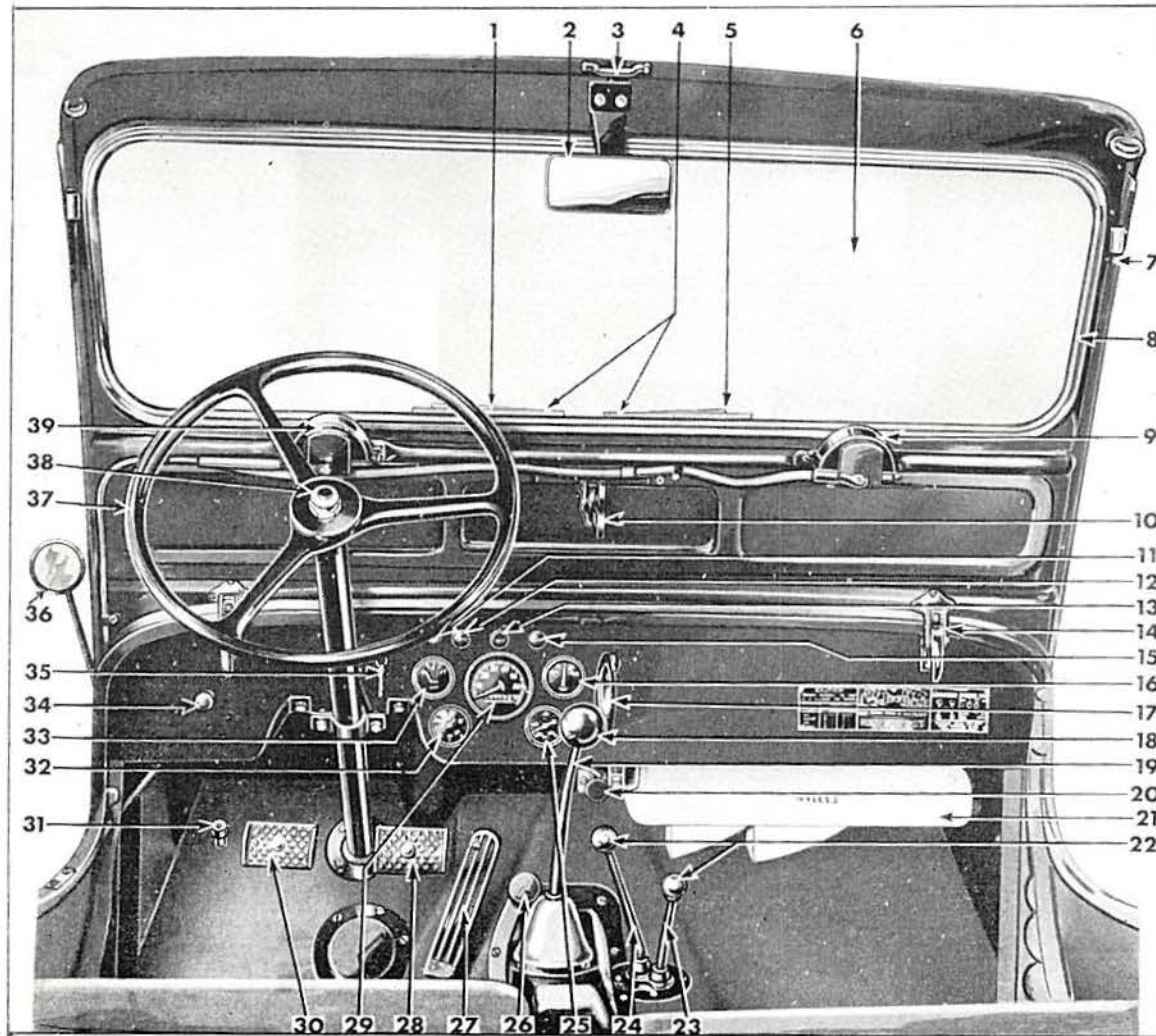


FIG. 314—FRONT COMPARTMENT—MODEL CJ-3A

1—Windshield Wiper Arm
 2—Rear View Mirror
 3—Top Bow Loop
 4—Windshield Wiper Blade
 5—Windshield Wiper Arm
 6—Windshield Glass
 7—Weatherstrip
 8—Weatherstrip
 9—Windshield Wiper Motor
 10—Ventilator Handle
 11—Tall-Tale Lens
 12—Throttle Control
 13—Instrument Panel Light

14—Windshield Clamp
 15—Choke Control
 16—Ammeter
 17—Hand Brake Handle
 18—Gearshift Lever Ball
 19—Gearshift Lever
 20—Starter Rod
 21—Heater
 22—Control Lever Ball
 23—Underdrive Lever
 24—Front Drive Shift Lever
 25—Heat Indicator Gauge
 26—Accelerator Foot Rest

27—Accelerator Treadle
 28—Brake Pedal
 29—Speedometer
 30—Clutch Pedal
 31—Dimmer Switch
 32—Oil Gauge
 33—Fuel Gauge
 34—Lighting Switch
 35—Ignition Switch
 36—Rear View Mirror
 37—Steering Wheel
 38—Horn Button
 39—Windshield Wiper Motor

d. Install the upper header stowage straps between the footman loops attached to the top cross bow and upper windshield frame. These straps are used for stowing the doors, when not installed in the vehicle.

e. With the top placed upside down on the hood of the vehicle and the rear opening to the front, slide the welt edge in the top retaining channel located on the upper face of the windshield frame. Then, fold the top back over the intermediate cross bow and work into place. Slip the door latch rod into the provided hem in the forward edge of the side of the canvas. Insert the upper end of the door latch rod in the holes provided in the brackets on the top side rails, then insert the lower end in the

sockets provided in the top edge of the body.
 f. Work the canvas down smoothly all around and attach the four straps to the footman loops provided; two on the vehicle sides and two on the wheel housing. Attach the four fasteners on each side, securing the top to the side rails. To install the doors, slide the forward welt edge into the retaining channels on the windshield pillars from the bottom to the top.

Note: This can be most easily accomplished if the vehicle is on a hoist and raised sufficiently to allow clearance for the door length.

Insert the upper end of the hinge rod in the bracket on the windshield pillar. Install the lower end of the

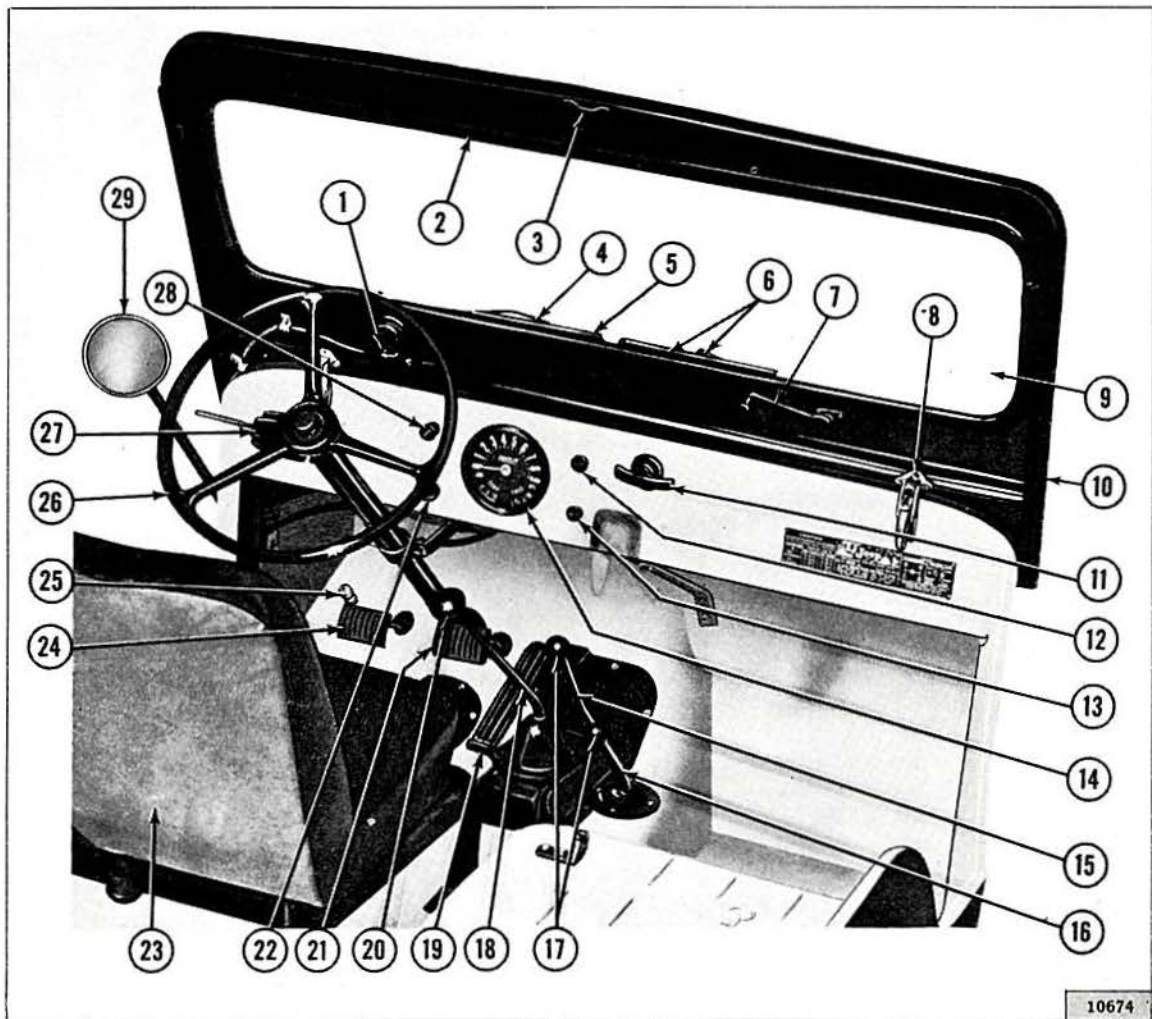


FIG. 315—FRONT COMPARTMENT—MODEL CJ-3B

- 1—Windshield Wiper Motor
- 2—Windshield Glass Weatherstrip
- 3—Top Bow Loop
- 4—Windshield Wiper Arm
- 5—Windshield Wiper Blade
- 6—Arm and Blade
- 7—Wiper Handle
- 8—Windshield Clamp
- 9—Windshield Glass
- 10—Windshield

- 11—Hand Brake Handle
- 12—Choke
- 13—Throttle
- 14—Instrument Cluster
- 15—Front Wheel Drive Shift Lever
- 16—Underdrive Shift Lever
- 17—Knob
- 18—Gearshift Lever
- 19—Accelerator Treadle
- 20—Knob

- 21—Brake Pedal
- 22—Ignition and Starter Switch
- 23—Driver's Seat
- 24—Clutch Pedal
- 25—Foot Dimmer Switch
- 26—Steering Wheel
- 27—Directional Signal Switch
- 28—Light Switch
- 29—Rear View Mirror

hinge rod in the well socket provided in the body top edge and work the entire assembly into its proper position.

g. Fasten the rear top panel with the eleven fasteners and strap down to the two footman loops installed on the floor.

T-10. Care of Fabric Tops

Remove fabric tops from their protective covering immediately after they are received. Store in a dry, clean, airy place. If the material is damp, the top should be installed on the vehicle immediately and washed with a mild soap; then give the top a quick and thorough rinsing.

T-11. Full Top

Installation of the full top is very similar to the above procedure, with the exception that both intermediate and rear top cross bows are installed prior to assembly of the canvas on the vehicle. Two additional top side rails are installed between the holes provided in the rear face of the inter-

mediate top cross bow and the forward face of the rear top cross bow.

The full top is installed in the same manner as the half top, with the exception that the rear quarter and ends are secured to the rear of the body and tail gate. After securing of the straps of the footman loops, then the top should be worked into position with the hands, resulting in a smooth installation. Install the side curtains with fasteners provided in the top canvas and slide the door latching rod in the hem of the forward edge. These latching rods then are positioned in place as described for the half top. The side curtains are then secured to the body by hooking the ends of the rods in the lower hem of the curtain into the clips on the body sides. The back panel is installed as described for the half top. Doors also are installed as described above.

After the half top, or full top, has been installed and securely fastened, it is suggested that the various points be worked with the hands to make the installation as smooth as possible.

After this has been accomplished, then a thorough wetting with water will remove the remaining wrinkles and result in a neat appearing top.

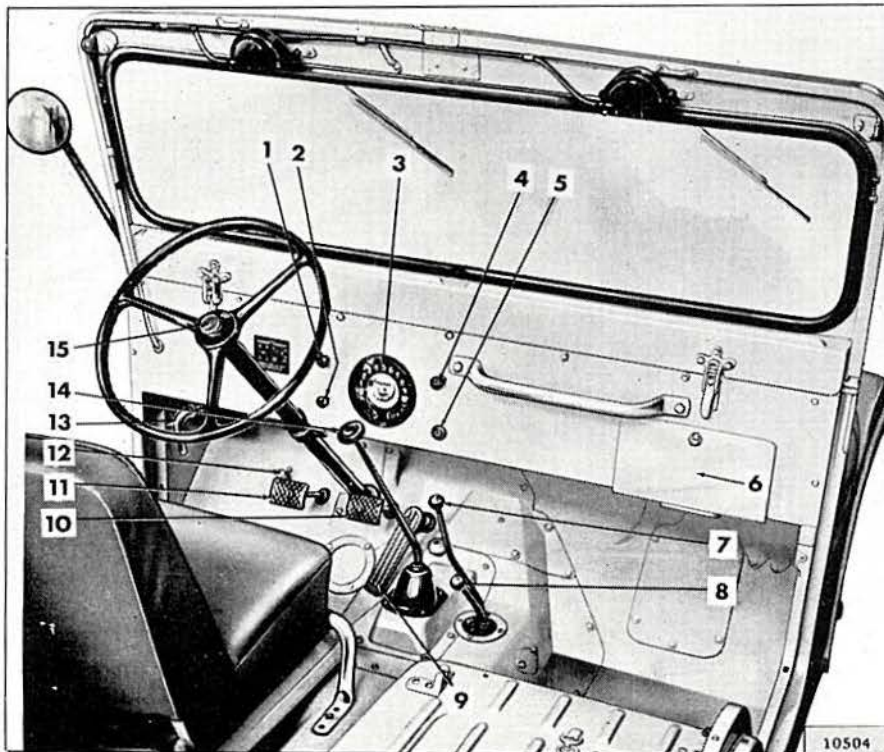


FIG. 316--FRONT COMPARTMENT--MODEL CJ-5, CJ-6

- | | |
|--------------------------------|-----------------------------|
| 1—Hand Throttle | 9—Accelerator Pedal |
| 2—Choke Control | 10—Brake Pedal |
| 3—Instrument Cluster | 11—Clutch Pedal |
| 4—Light Switch | 12—Headlight Dimmer Switch |
| 5—Ignition Switch | 13—Hand Brake Handle |
| 6—Starter Switch | 14—Transmission Shift Lever |
| 7—Front Axle Drive Shift Lever | 15—Horn Button |
| 8—Underdrive Shift Lever | |

T-12. Brake and Clutch Pedal Pads

A clutch and brake pedal pad cover has been released which has a .44" groove molded into the



FIG. 317—CLUTCH AND BRAKE PEDAL PAD

back side of the pad cover. When installing,

the grooved opening is located down and to the bottom of the pedal. See Fig. 317. The purpose of the groove concerns models not listed in this manual. The pedal pad cover formerly used is solid in construction without groove. Either grooved and solid pad covers can be installed on CJ-3B, CJ-5, CJ-6, and DJ-3A models.

T-13. TROUBLE SHOOTING

T-14. Vehicle Vibrations
Model DJ-3A

See also Service Diagnosis in the Clutch Section and Rear Axle Section for other possible causes. With some DJ-3A vehicles, a drumming sound emitting from the rear of the vehicle will become audible at speeds ranging from 35 to 55 mph. [56 a 88 kph.]. This condition can sometimes be eliminated by padding the two wood insulating strips which rest between the top of the fuel tank and the body floor pan. Lowering the fuel tank will be necessary to gain working space.

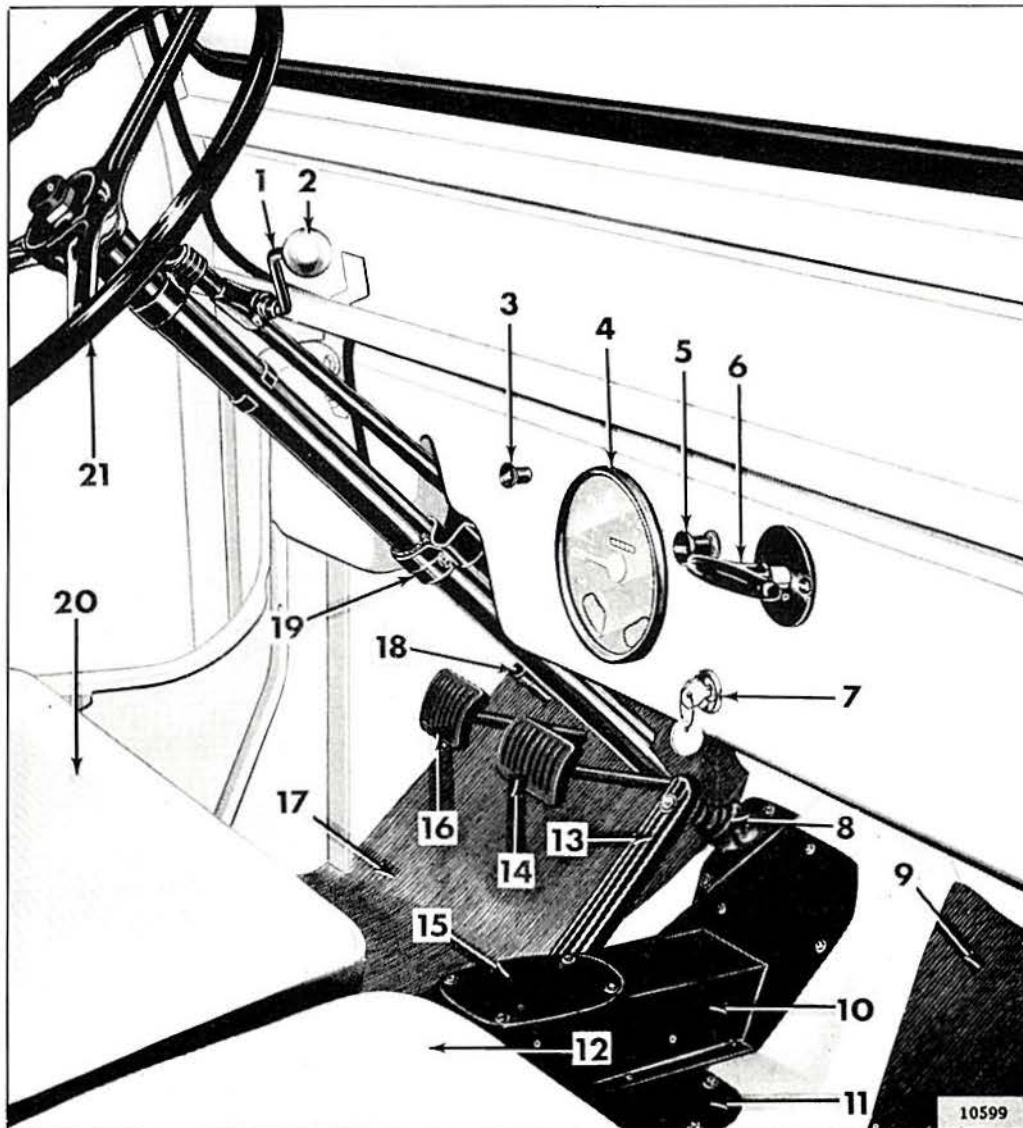


FIG. 318—FRONT COMPARTMENT—MODEL DJ-3A

- 1—Shift Lever
- 2—Shift Lever Ball
- 3—Choke Control
- 4—Instruments
- 5—Lighting Switch
- 6—Hand Brake Handle
- 7—Ignition Switch
- 8—Treadle Rod Seal
- 9—Floor Mat (Right Front)
- 10—Transmission Floor Plate
- 11—Transfer Cover Plate
- 12—Seat (Passenger)
- 13—Accelerator Treadle
- 14—Brake Pedal
- 15—Gearshift Cover Plate
- 16—Clutch Pedal
- 17—Floor Mat (Left Front)
- 18—Foot Dimmer Switch
- 19—Steering Column Support Clamp
- 20—Seat (Driver's)
- 21—Steering Wheel

MISCELLANEOUS

Contents

SUBJECT	PAR.	SUBJECT	PAR.
Abbreviations	U-57	Power Take-Off	U-3
Extra Equipment	U-2	PTO Propeller Shaft	U-6
Front Bumper Weight	U-15	PTO Pulley Drive	U-8
Governor	U-9	PTO Shaft Drive	U-7
Miscellaneous Data	U-56	PTO Shift Assembly	U-5
Monroe Hydraulic Lift	U-16	Special Tools	U-54
Pintle Hook	U-13	Torque Specifications	U-55

U-1. GENERAL

Miscellaneous information included in this section includes coverage of extra equipment, special tools, torque specifications, and charts and tables.

U-2. EXTRA EQUIPMENT

Much of the utility of the Jeep 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.

U-3. Power Take-Off

Several methods of utilizing engine power, both with the vehicle standing or in motion, have been developed.

The rear power take-off is covered in detail in the following paragraphs.

U-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, propeller shaft and universal joints, shaft drive assembly, and 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.

U-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 Fig. 319. The sliding gear is

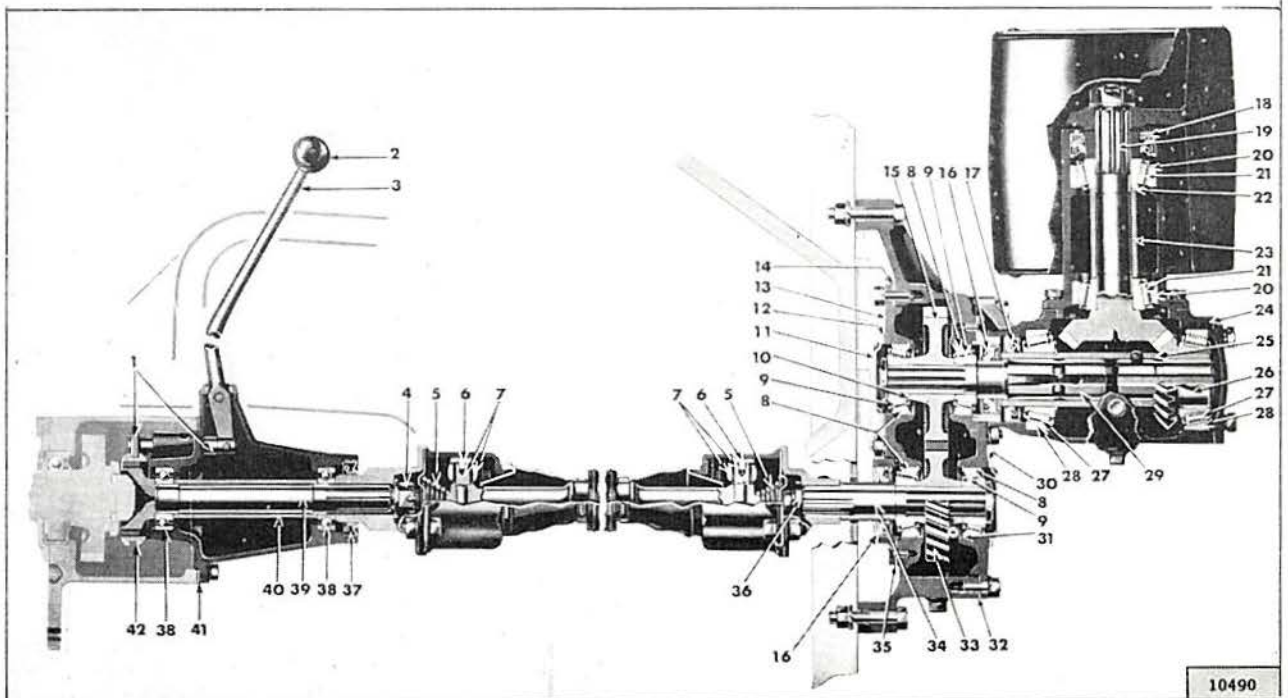


FIG. 319—POWER TAKE-OFF

- | | | | | | |
|---------------------|--------------|--------------------|--------------------|-----------|-------------------|
| 1—Fork and Rod | 8—Cup | 15—Gear | 22—Shims | 29—Shaft | 36—Washer |
| 2—Ball | 9—Bearing | 16—Oil Seal | 23—Spacer | 30—Gasket | 37—Oil Seal |
| 3—Lever | 10—Snap Ring | 17—Oil Seal | 24—Shims | 31—Shims | 38—Ball Bearing |
| 4—Nut | 11—Plate | 18—Oil Seal | 25—Shims | 32—Gasket | 39—Gear and Shaft |
| 5—Button and Spring | 12—Gasket | 19—Gear and Shaft | 26—Pinion | 33—Gear | 40—Spacer |
| 6—Spring | 13—Retainer | 20—Cup | 27—Cone and Roller | 34—Shaft | 41—Gasket |
| 7—Trunnion and Ball | 14—Gasket | 21—Cone and Roller | 28—Cup | 35—Gasket | 42—Sleeve |

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 forward to clear the poppet ball and spring, using care not to lose the ball and spring, and remove the shifting sleeve.

Remove nut and the companion flange, after which the shaft may be driven forward out of the housing. Be careful not to damage oil seal as the shaft is removed. Remove the spacer after which bearing can be removed. Remove bearing 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.

U-6. Propeller Shaft and Universal Joint Assembly

The propeller shaft is tubular and has two universal joints, Fig. 319. 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 [1,600 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 using Tool W-220 and repack them with lubricant once each year.

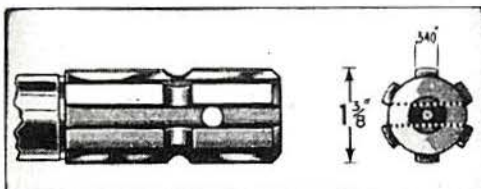


FIG. 320—POWER TAKE-OFF SPLINED SHAFT

Note: When replacing the power take-off shaft on Models CJ-2A, CJ-3A, and early production CJ-3B, the replacement shaft must be of the same diameter as the old shaft. If a 2½" diameter [6,3 cm.] shaft would be used to replace a 2" [5 cm.] shaft, interference with the frame cross members would result.

U-7. Shaft Drive Assembly

The standard six splined, 1⅜" [34.92 mm.] diameter output shaft Fig. 319, 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 rpm. At this speed the splined output shaft turns 536 rpm., 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.

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 Fig. 319, and gasket. Bend the locking tangs away from the nut and remove the nut and locking washer on the input shaft. Remove the five screws attaching the bearing retainer and remove the bearing and retainer assembly with the gasket. Use care not to lose the shims installed between the gear and 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. The gear 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.

U-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. 319, 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 through the housing, removing the inner bearing cone, spacer and shim pack, Nos. 22 and 23.

Remove the oil seal, after which the outer bearing cone may be lifted from the housing. If necessary, pull the bearing cups from the housing.

To dismantle the gear housing assembly, first remove bearing retainer cover and shim pack, No. 24. The bearing assembly and gear 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 and, if necessary, bearing cup.

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 mm.] 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 filling the housing to filler plug level with hypoid gear oil. See Lubrication Chart.

U-9. Governor Assembly

The Novi governor is supplied for these models. This is a centrifugal type governor and is illustrated in Fig. 322. Complete installation instructions are supplied with each assembly. Adjustment and operating procedures are given below.

U-10. Governor Adjustment

- a. Adjust the carburetor to obtain smooth engine idle at 600 rpm., then stop the engine.
- b. Check throttle linkage to ensure maximum throttle opening. Be certain that throttle and governor linkage is free.
- c. Place the carburetor throttle in wide-open position and pull the governor control handle out to the last notch. Adjust the governor to bellcrank rod 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 at adjusting yoke 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.

If the engine runs faster than this speed, loosen the lock nut which locks the governor hand control handle on the dash to the rod and back off the handle until the carburetor idle speed adjusting screw bears on the stop. Tighten the lock nut.

In the absence of electrical tachometer equipment, 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 from 13½ to 15 mph. [21.6 to 24.0 kph.] at an engine speed of from 900 to 1000 rpm.

U-11. 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 rpm. and each successive notch increases the speed 200 rpm. until 2600 rpm. 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.

U-12. Governor Maintenance

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 $\frac{1}{2}$ " [12,7 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 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.

Caution: Do not fill the governor housing above the level plug. Overfilling will prevent governor control and possibly cause damage to governor internal parts. The capacity of these governors is two fluid ounces [59,15 cm³]. The filler plug is also a vent which should be cleaned thoroughly at each oil change to be sure that the vent operates.

U-13. Pintle Hook

The standard type pintle hook, Fig. 321, affords a safe, easy hitch for towing a trailer or other vehicle. Designed primarily for use on the road, a safety latch locks the hook in the closed position and two eye bolts are provided for attachment of safety chains which should be crossed when installed, to prevent the hooks from jumping out of the eyes. Keep the attaching bolts tight at all times. When

lubricating the vehicle, place a few drops of oil on the hook and safety latch pivot pins.

U-14. Pintle Hook Installation

Six holes are provided in the frame rear cross members of 'Jeep' Universals for the installation of pintle hooks and safety chain eye bolts. On most vehicles, the pintle hook is attached using the top four holes and the eye bolts are attached using the lower two holes. On 'Jeep' Universals equipped with tail gates, the position of the hook and the eye must be changed to provide proper clearance.

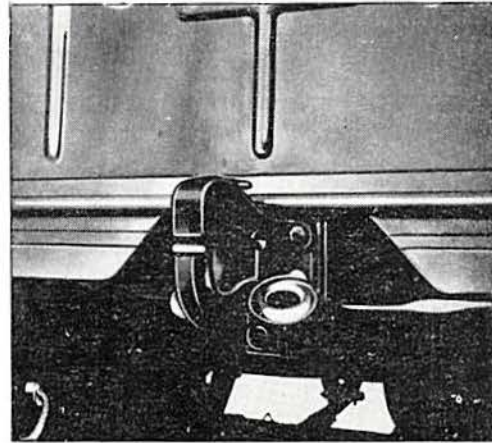


FIG. 321—PINTLE HOOK

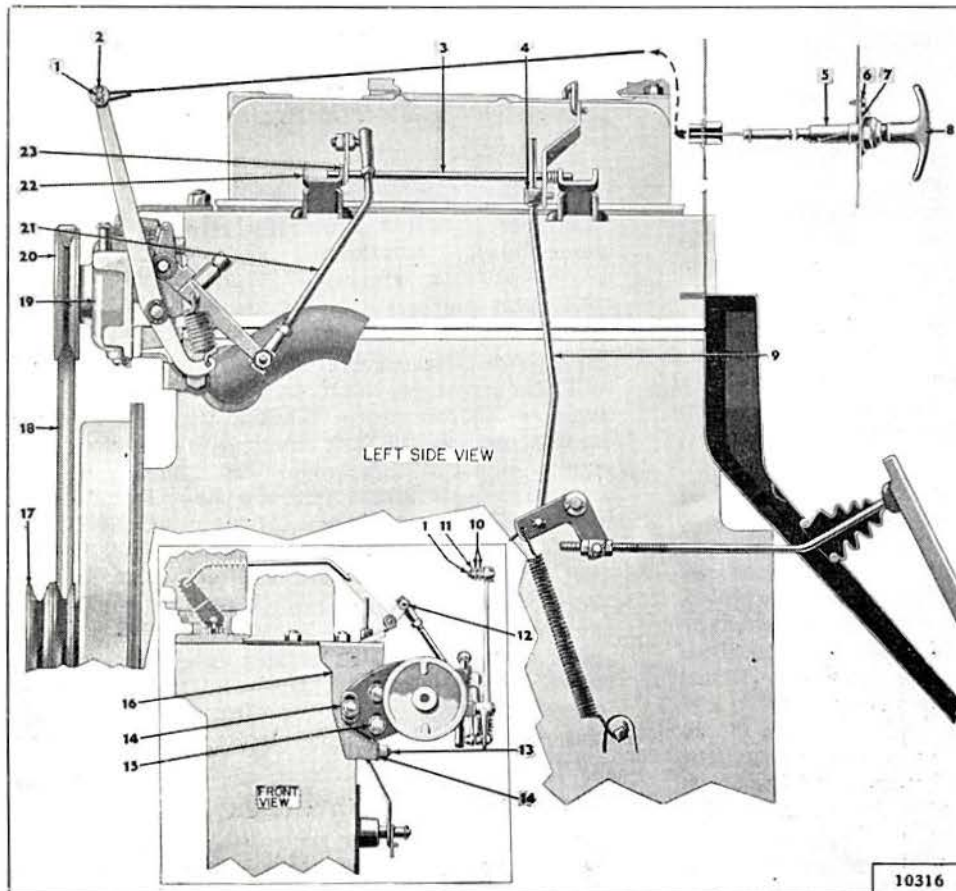


FIG. 322—NOVI GOVERNOR

- 1—Pivot Bolt
- 2—Cotter Pin
- 3—Governor Bellcrank
- 4—Adjusting Block
- 5—Governor Control
- 6—Screw
- 7—Control Bezel
- 8—Handle
- 9—Vertical Rod
- 10—Washer
- 11—Nut
- 12—Nut and Lockwasher
- 13—Stud
- 14—Washer
- 15—Screw
- 16—Support Bracket
- 17—Fan Drive Pulley
- 18—Governor Drive Belt
- 19—Governor (Novi)
- 20—Governor Drive Pulley
- 21—Horizontal Rod
- 22—Bellcrank Bracket
- 23—Washer

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On these vehicles, use the lower four holes for attaching the pintle hook and the upper two holes for attaching the safety chain eye bolts.

U-15. Front Bumper Weight

The best performance of a four-wheel drive vehicle is obtained when the load is equally distributed for traction on the front and rear wheels. This weight distribution is disturbed when the vehicle is used for drawbar work as the load on the rear wheels is increased and that on the front wheels decreased. The addition of a 265 pound front bumper weight equalizes the load.

When the load is equalized the front and rear axles do approximately the same work which results in prolonged life of these parts and considerably more satisfactory performance.

The bumper weight, Fig. 323, is held in place by four bolts and is provided with hand holes for lifting. Do not add sand bags or other weights in the vehicle. When driving over rough terrain, with the weight in place, the driver should exercise due care.

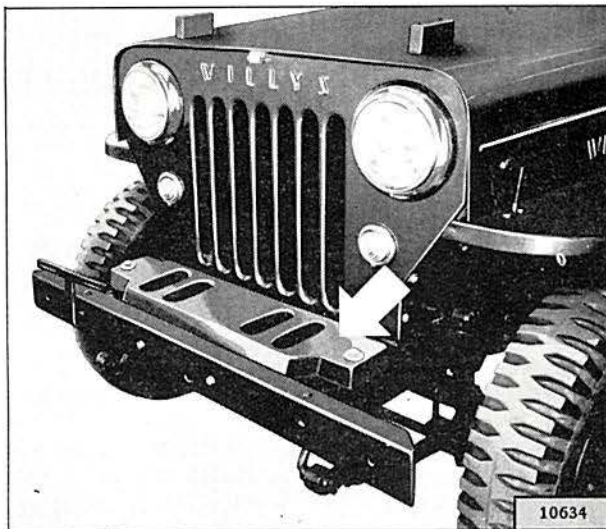


FIG. 323—FRONT BUMPER WEIGHT

U-16. MONROE HYDRAULIC LIFT

Production of the Monroe Hydraulic Lift has been discontinued. However, information about the lift is retained in this manual for those units previously produced. Information following covers: installation of the lift, overhaul of components, servicing procedure, and operation.

U-17. Installation of Lift

Installation of the Monroe Hydraulic Lift is covered in Par. U-18 through U-28.

The front bumper block spacers shown in Fig. 324 are furnished with all kits for field installation, but are to be installed only on Model CJ-2A before serial number 178936. Model CJ-2A serial numbers 178936 to 215648 have these spacers installed in production. Model CJ-2A after serial number, 215648 and all other models have a change in frame where these spacers are not required.

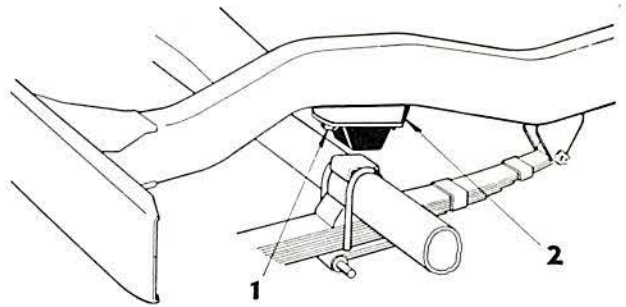


FIG. 324—FRONT BUMPER BLOCK SPACERS

- 1—Bolt $\frac{3}{8}$ "-24 x 11 $\frac{3}{4}$ "
- 2—Axle Bumper Spacer

The installation of these spacer blocks on the early vehicles is important for without them the hydraulic pump, mounted at the front of the engine may be damaged on a jounce, due to hitting the axle

U-18. Installation of Fan and Governor Drive Pulley

This new pulley may be identified by three lugs that fit into the rubber flexible drive. The new nut does not have a cross pin for the starting crank. Install the new pulley and nut as shown in Fig. 325. The installation of this pulley may be made without removing the radiator.

Note: Jeeps after Model CJ-2A, Serial No. 178-936, are equipped with this new drive pulley and crankshaft nut at the factory.

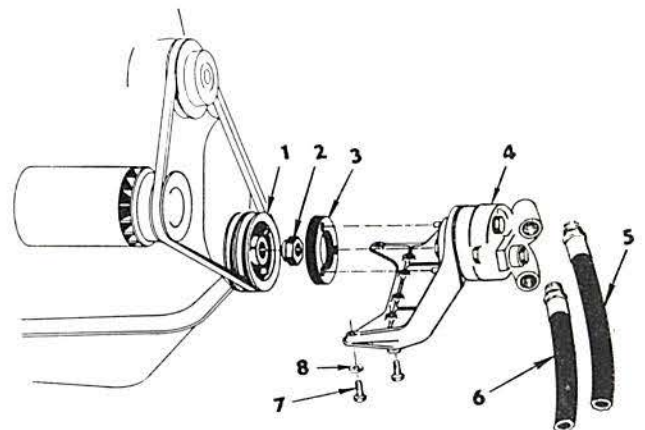


FIG. 325—PUMP AND SUPPORT

- 1—Fan and Governor Drive Pulley
- 2—Crankshaft Nut
- 3—Flexible Drive, Rubber
- 4—Pump and Support Bracket Assembly
- 5—Hose, Suction
- 6—Hose, Pressure
- 7—Bolt, $\frac{3}{8}$ "-18 x 1 $\frac{1}{4}$ "
- 8—Lockwasher, $\frac{3}{16}$ "

U-19. Installation of Pump and Pump Support Bracket

Remove the front six bolts that hold the oil pan to the crankcase and discard. Save the lockwashers. Remove the fan pulley shield and discard.

Remove the spacing washers that were used between the fan pulley shield and oil pan and discard. Thoroughly clean the flange of the oil pan around the six bolt holes.

Place the flexible drive (rubber) Fig. 325, No. 3 in position on the fan and governor drive pulley

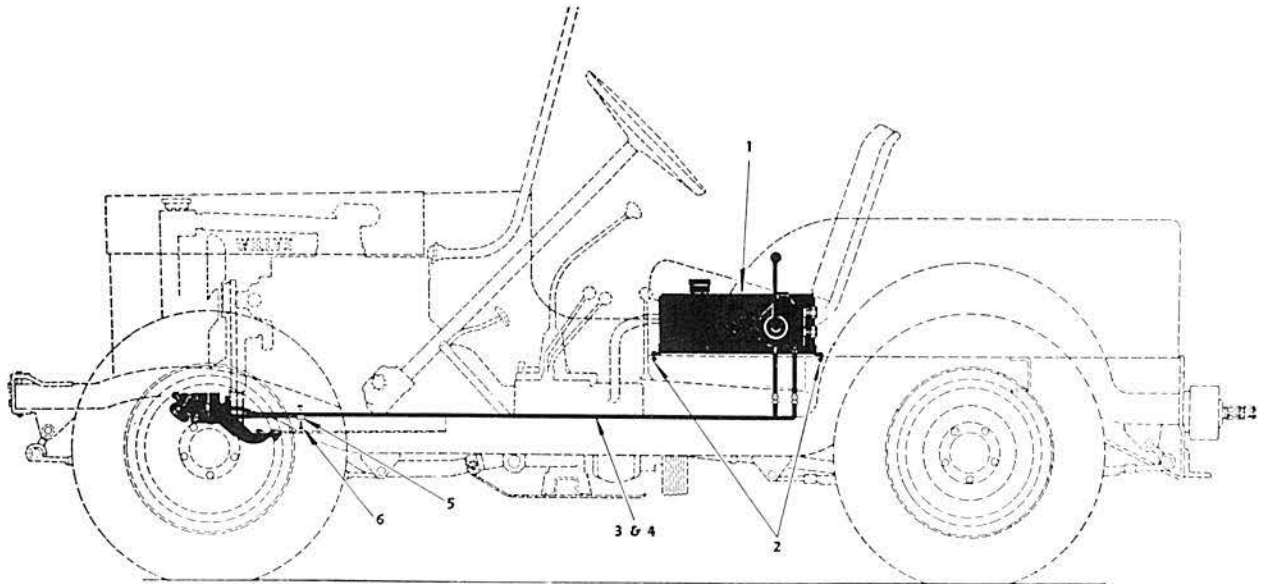


FIG. 328—INSTALLATION OF HYDRAULIC LINES

- | | |
|---|---|
| <p>1—Tank and Control Valve Assembly
 2—Bolt, $\frac{1}{4}$"-28 x $\frac{3}{4}$"
 Lockwasher, $\frac{1}{4}$"
 Nut, $\frac{1}{4}$"-28
 3—Pressure Tube, $\frac{1}{2}$" Diameter</p> | <p>4—Suction Tube, $\frac{3}{4}$" Diameter
 5—Clip
 6—Screw, #10-24 x $1\frac{1}{2}$"
 Lockwasher, #10
 Nut, #10-24</p> |
|---|---|

Attach the flexible hoses from the pump. The hose fittings are of different sizes to prevent incorrect assembly. Use thread sealing compound. Connect the tubes to the pipes extending through the floor from the valve, connecting the pressure tube FIRST which is smaller ($\frac{1}{2}$ " diameter). Use thread sealing compound. Drill a $\frac{3}{32}$ " hole through the air cleaner shield or splash pan between the two hydraulic lines and attach the hold down clip using the screw, lockwasher and nut.

Note: To operate any implement which is equipped with a one-way action cylinder, connect the cylinder to the lower high pressure valve outlet only.

U-22. Installation of Main Housing and Cylinder Assembly

A new type drawbar should be installed before installing the Monroe lift. The new type drawbar is identified by the drawbar support straps being welded on the bottom side of the drawbar and by an additional angle iron reinforcement being welded to the drawbar center upright supports.

Note: On Model CJ-3A prior to Serial No. 33961, four reinforcement plates were included in each drawbar kit. After Serial No. 33961 these plates were installed on vehicles equipped with a drawbar at the factory.

Two of these plates should be discarded and are replaced by the mounting angle support. To install the two remaining plates, first disconnect the drawbar support straps from the intermediate cross

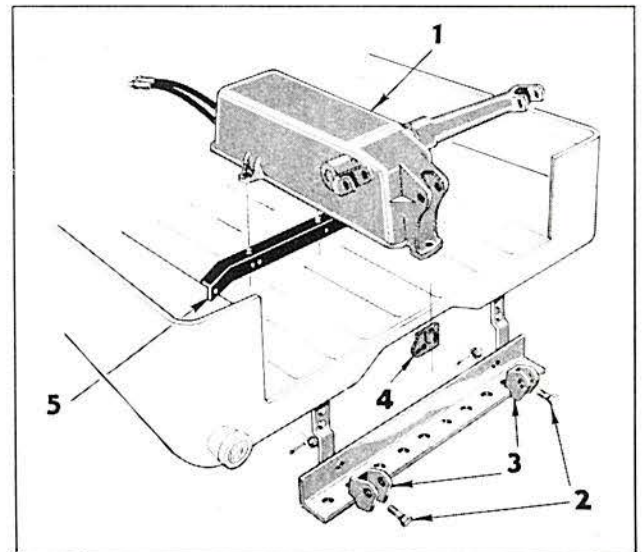


FIG. 329—MAIN HOUSING AND CYLINDER MOUNTING

- | |
|--|
| <p>1—Main Housing and Cylinder Assembly
 2—Bolt, $\frac{3}{16}$"-20 x $1\frac{1}{2}$"
 3—Clevis
 4—Main Housing Back Support
 5—Angle Support Assembly</p> |
|--|

member. Enlarge the holes in the cross member, the support straps and the two reinforcing plates from $\frac{13}{32}$ " to $\frac{19}{32}$ ". Install $\frac{9}{16}$ " bolts, with the reinforcing plate next to bolt head and the mounting angle support next to the nut.

U-23. Install Mounting Angle

To install the mounting angle assembly in the channel of the frame cross member underneath the floor proceed as follows:

- a. Remove the two bolts that hold the muffler mounting bracket to the cross member. Discard the bolts but save the nuts and lockwashers.
- b. Position the mounting angle so that the $\frac{5}{16}$ " diameter holes align with the holes from which the $\frac{5}{16}$ " bolts were removed in the proceeding operation and in the center of the cross member. Install the new bolts using the original lockwashers and nuts. Install hug lock nuts without lockwashers on the bolts and tighten securely.

U-24. Install Support

Install main housing back support No. 4, Fig. 329. This bracket attaches through the drawbar center support bolt holes and the method of assembly is obvious. Use two $\frac{7}{16}$ "-20 thd. x $1\frac{1}{2}$ " long bolts, one $\frac{7}{16}$ "-20 thd. x 1" long bolt, three $\frac{7}{16}$ "-std. lockwashers and two $\frac{7}{16}$ "-20 thd. nuts.

U-25. Install Housing and Cylinder Assy.

To install the main housing and cylinder assembly, use the $\frac{1}{2}$ "-13 thread x $1\frac{3}{4}$ " long bolt and lockwasher to attach the rear of the housing to the housing back support. Do not tighten. Align the housing in the straight ahead position and center punch through holes in the main housing brackets

to align with the holes in the angle support. Drill two $\frac{9}{16}$ " holes in the floor. Bolt the housing to the angle support with the two $\frac{1}{2}$ " x $1\frac{1}{2}$ " SAE thread

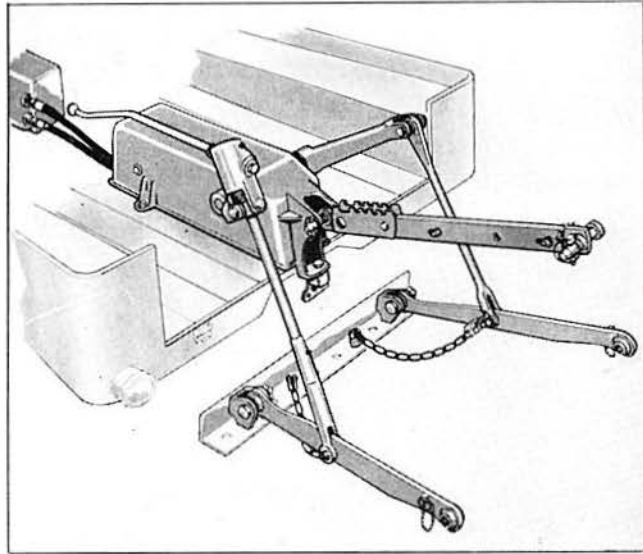


FIG. 330—INSTALLATION OF LIFT AND LINKAGE

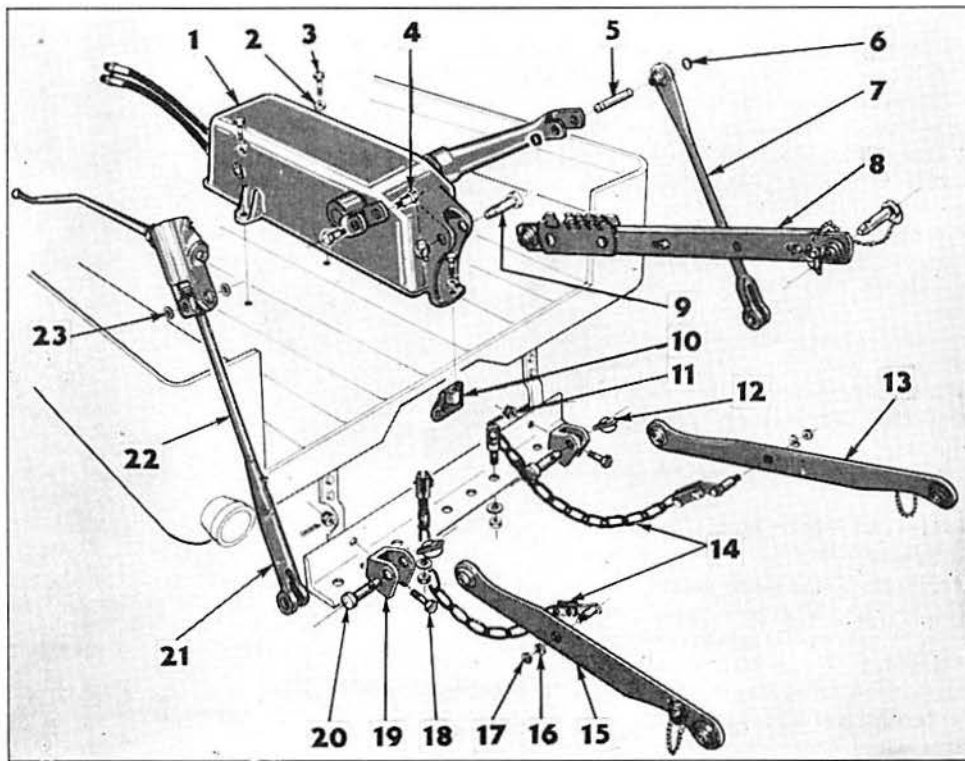


FIG. 331—MAIN HOUSING AND LIFT LINKAGE

- | | |
|---|---|
| <ul style="list-style-type: none"> 1—Housing and Cylinder Assembly 2—Lockwasher, $\frac{1}{2}$" 3—Bolt, $\frac{1}{2}$"-13 x $1\frac{3}{4}$" 4—Shoulder Bolt 5—Pin 6—Lock Ring 7—Rod Assembly 8—Upper Link Assembly 9—Upper Link Pin 10—Main Housing Back Support 11—Nut, $\frac{3}{8}$"-18 Slotted Hex Head 12—Cotter Pin $\frac{3}{16}$" x $1\frac{3}{8}$" | <ul style="list-style-type: none"> 12—Linch Pin and Ring Assembly 13—R. H. Lower Link 14—Limit Chain Assembly 15—L. H. Lower Link 16—Lockwasher, $\frac{7}{16}$" 17—Nut, $\frac{7}{16}$"-20 18—Special Bolt 19—Clevis 20—Lower Link Pin 21—Fork 22—Leveling Link Assembly 23—Internal Type Lockwasher |
|---|---|

bolts, using lockwashers and nuts and tighten all bolts securely.

U-26. Installation of Hydraulic Lines

To install the hydraulic hoses, remove the (4) shipping plugs from the (2) adapter unions on the valve and from the (2) hydraulic hoses and SAVE. It is necessary to reuse these plugs whenever the lift is removed. Attach the hydraulic hoses to the unions on the valve. Use thread sealing compound. Always be sure that the smaller hose is installed in the lower union of the valve.

If quick disconnect fittings are used, install them between the hydraulic hoses and adapter unions on the valve.

Do not remove the unions from the valve.

If it is ever necessary to remove or replace the unions in the valve, note that the swivel ends of the unions are of a different size to prevent incorrect assembly of the hydraulic hoses. Always make sure that the union with the $\frac{3}{8}$ " connection is installed in the upper hole and the union with the $\frac{1}{4}$ " connection is installed in the lower hole of the valve.

U-27. Installation of Drawbar Clevises

Bolt the clevises No. 19, to the upright face of the drawbar as shown in Fig. 330, using the $\frac{5}{8}$ "-18 x $1\frac{1}{2}$ " long bolts, the $\frac{5}{8}$ "-18 slotted head nuts and the cotter pins.

Important: The head of the bolt should be in the clevis, with nut and cotter pin forward of the drawbar. Do not use lockwashers.

U-28. Installation of the Lift Linkage

Note: Some operators prefer to have the leveling link assembly on the right hand side. This may be accomplished by using leveling link assembly R.H. Part No. 802004 and lifting rod L.H. Part No. 802006. Be sure the lubrication fitting on the lower casting on the leveling link is to the rear. Make installation as follows but on the opposite side.

To install the lift linkage attach the upper end of the leveling link No. 22, Fig. 331, to the left hand lifting arm of the main housing. Use the (2) special internal type lockwashers No. 23 and the (2) special shoulder bolts No. 4.

Caution: The special lockwashers must be used or the shoulder bolts will draw up too tight and prevent the universal action of this joint.

Before installing the two shoulder bolts in the lifting arms, first remove any paint and burrs from the holes in the lifting arms; also remove any paint from the shoulders of the bolts and coat the shoulders with a film of light oil. Start the shoulder bolts with the fingers and do not force or pound them into the lifting arms.

Attach the upper end of the R. H. lifting rod No. 7 to the R. H. lifting arm. Use pin No. 5 and (2) locking rings No. 6.

Attach the lower links No. 13 and No. 15 to the clevis brackets on the vehicle drawbar. Use pin No. 20 and lynch pin No. 12.

Attach the leveling link fork No. 21 and the R.H. lifting rod No. 7 to the lower links No. 13 and No. 15. Use the longer shoulder bolts on the ends of the limit chains No. 14 to attach.

Caution: The lubrication fitting on the lower casting of the leveling link assembly must be to the rear so that the slot in this casting will clear the lower arm when the arm is in the DOWN position.

Attach the (2) limit chains to the drawbar. Be sure to use the 2nd hole in from each clevis shown in Fig. 331. In this position the limit chains will prevent any swaying of implements while they are being transported.

Be sure that the flat washers provided are installed on the underside of the drawbar. The nuts are self locking and lockwashers are not necessary.

Note: Remove all paint with a paint remover from all the ball sockets at the ends of the attaching links. When paint is removed do not oil as oil will collect grit which will have an abrasive action on the sockets. If the balls remain tight after removing the paint, expand the socket by tapping it with a hammer.

U-29. Filling Hydraulic System

Add oil. Use 6 qts. motor oil of the same grade and weight as is used in engine to completely fill the system.

Always keep the oil level in the tank at the bottom mark of the "Safe Range" indicated on the dip stick. Never mix brands of oil in the hydraulic system.

U-30. Functional Test

a. Remove the down pressure screw, poppet and spring. To remove poppet and spring use a magnetized screw driver. Discard the poppet and spring and replace down pressure screw and tighten.

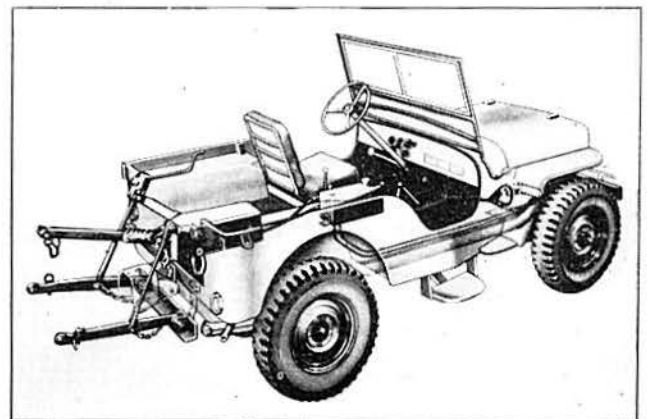


FIG. 332—COMPLETED INSTALLATION OF LIFT

b. Move the control handle on the valve to the completely forward position.

c. The lower lift links No. 13 and 15, Fig. 331, can now be raised up and down by hand, to see that the linkage is properly assembled and that there is no interference at any of the joints.

Caution: Do not operate the lift until you have read about care and operation.

Keep all attaching nuts and bolts tight when using the lift.

d. Start engine and run at idle speed to operate the hydraulic system.

U-31. HYDRAULIC LIFT OPERATION

U-32. To Attach Implement

Back the vehicle up to the implement so that the lower links of the lift are close to the attaching pins on the implement. Move the control valve handle to the forward position.

Attach the three lift links as follows: (1) The right-hand lower link, (2) the left-hand lower link (use the leveler to help align), (3) the upper link. It may be necessary to move the Jeep slightly to get proper alignment of the upper link if the implement is too heavy to be moved into position. Attach and check all linch pins to make sure they are in the locked position.

U-33. To Adjust Upper Link

The grooves in the two parts of the upper link Fig. 333, should be in line for most implements in normal usage. However, the length can be adjusted by removing notched plate and by loosening the bolts so as to change the angle at which the implement is held in relation to the ground. Also, for implements requiring a longer upper link, the bolts can be removed and the holes in the two parts reset at the required length.



FIG. 333—UPPER LINK

U-34. Depth Control

To regulate depth on implements that require depth control, a depth wheel must be used to give the implement floating action over the contour of the land and to hold it to the depth required.

U-35. To Raise and Lower Implements

Move the control handle (on the control valve at the side of the tank) toward the rear of the Jeep to raise the implement. Move to the vertical position (neutral) when desired height is reached, implement is now locked in this position. Move handle forward to lower implement.

Caution: Do not leave the control handle in the lift position after the lift is raised or when traveling on the highway. This causes unnecessary wear on the hydraulic pump seals and overheating of the oil.

U-36. To Level and Tilt

The handle on the leveler or tilt regulator is conveniently located at the rear of the operator's seat. Rotate the crank counterclockwise to raise the left hand plow arm or clockwise to lower it. Adjust to the required amount to compensate for the right hand wheels (which run in the furrow) when plowing, or adjust to the necessary setting for any other condition such as hillside operation, etc. Fig. 330.

U-37. How to Remove Main Housing and Lift Linkage

a. Remove the three hold down bolts attaching the main housing to the vehicle.

b. Disconnect the two lower links from the clevises on the vehicle drawbar. (Note: The clevis pins and the linch pins are best kept and ready for use if they are always replaced in the clevises when the lower links are detached.) Also disconnect limit chains at drawbar.

c. Disconnect the hydraulic lines at the valve.

Important: Never remove the adapter unions from the valve. They have different size threads on the swivel and so that the hydraulic hoses cannot be incorrectly attached

The smaller ($\frac{1}{4}$ " thread) should always be in the lower port. The shipping plugs furnished with the Monroe Hydraulic Lift must always be screwed into the swivel end of the unions of the valve, and on the open ends of the hydraulic hoses whenever the implement lift is removed from the vehicle.

To attach, reverse the above procedure.

Keep all attaching nuts and bolts tight when using the lift.

U-38. PROPER CARE

Caution: Always keep oil in the hydraulic system whether or not the lift is used. This is necessary to lubricate the hydraulic pump.

U-39. To Add Oil

Add oil whenever necessary as indicated by the markings on the dip stick attached to the filler cap on the top of the tank. When oil is added it is recommended that the same grade and brand of oil is used as is in the system. If two or more brands of oil are used in the system a sludge formation may result.

U-40. To Change Oil

It is recommended that the oil in the system be changed every 250 hours (or approx. 1000 miles) of work operation. If the lift is not being used regularly a change every 2000 miles should prove satisfactory. If the oil for any reason becomes dirty or contains sludge, it should be changed.

U-41. To Remove Oil from the System

a. Empty oil in tank by removing with a suction gun or similar device.

b. Disconnect both lines at the valve and place lines in a container. Move the lift arms up and down to pump out the oil from the cylinder.

c. Run the engine slowly for not more than a few seconds to empty lines and pump.

To prevent permanent damage to the pump, do not run the Jeep engine while the oil is out of the lift hydraulic system.

U-42. To Lubricate Lift Mechanism

Lubricate the two bearings on the main housing every eight or ten hours of lift operation. Lubricate the two points on the leveler assembly once a month or oftener when the lift is in regular operation. Use pressure gun grease at all four points. Do not grease or lubricate the ball joints on the lower links, as this will cause dirt and sand to collect on them and work into the bearings. Keep them dry and reasonably clean at all times. Lubricate all implements at the required points regularly when they are being used.

PROPER SERVICE

- a.** Grease main housing bearings regularly.
- b.** Change oil at proper time.
- c.** Clean oil filter at each change.
- d.** Always add same brands of oil as used in system when filled.
- e.** If different brand of oil is to be used, drain system completely and clean out tank.
- f.** If it is necessary to add oil often, locate and correct any leaks.
- g.** Always make sure that all linch-pins are securely locked before operating implements.
- h.** Keep mounting bolts, housing and brackets tight at all times.
- i.** Use a depth wheel when necessary.
- j.** Do not mix brands when adding oil to the supply tank.
- k.** Do not operate when the oil is low in the tank.
- l.** Do not run engine when pump is disconnected from system. If it is necessary to operate when the pump is not connected to the tank, remove the pump or the pump flexible drive rubber so that the pump will not operate.
- m.** Do not continue to operate if excessive foaming of the oil occurs, stop and correct the trouble.
- n.** Do not operate lift when attaching bolts are loose. Keep them tight.
- o.** Do not lubricate or grease any of the joints on the tow links. Grease or oil will collect dirt and grit which will act as an abrasive and cause needless wearing of parts.
- p.** Do not operate at unnecessary speeds when transporting an implement on the lift. Using a little judgement will keep down service expense.

U-43. Service Checks

If a hydraulic lift will not hold an implement in the "UP" position check as follows:

a. Start engine and run at idle speed.

b. Move valve control handle backward to the lift position.

c. Disconnect the top hydraulic line at the back of the control valve.

d. With the implement in fully raised position and with the control in "lift" position, check for leakage at the end of the hose and at the valve port. If oil continues to run steadily out of the end of the hose, it indicates leakage past the piston and the cylinder should be taken apart for servicing. If oil runs steadily out of the valve port, it indicates leakage inside the valve. A few drops of leakage should not be considered serious, but a small stream of oil indicates that the control valve requires adjustment.

If oil leakage appears from under the main housing, it indicates loose hose connections on the cylinder or a worn oil seal "O" ring in the piston guide which must be replaced.

If a hydraulic lift will not pick up an implement, check the control valve and cylinder as described above. If the lift will still not operate, pump trouble is indicated. It will be necessary to remove the pump and repair or replace it with a new unit. Before removing pump however, check to see if the tapered pins holding the center arm to main shaft in the housing have been sheared off.

If the lift seems to be sluggish or is not operating properly, check for oil foaming by removing the cap on the supply tank. If the oil appears to be unusually foamy or boils out of the tank, trouble is indicated. (Air in hydraulic system.)

Generally, the correction is to tighten all joints in the suction lines and if this does not correct the trouble, unhook each joint, put thread sealer on the threads generously and retighten securely. If foaming continues after this is done, it indicates trouble in the pump itself and it should be removed and repaired or replaced.

When excessive foaming occurs, stop operation and correct the trouble because air in the fluid will soon cause pump failure.

U-44. OVERHAUL PROCEDURE

U-45. Hydraulic Pump—Removal

- a.** Remove the oil from the supply tank.
- b.** Jack up front of Jeep sufficient for working clearance.
- c.** Remove the six oil pan bolts attaching the pump bracket to oil pan.
- d.** Drop pump and bracket down turning it sufficiently so that the manifold can be removed, leaving oil lines attached to manifold. The pump and bracket can now be removed from under the vehicle.
- e.** Remove the pump driver by removing the retaining nut, and pulling the driver off the pump shaft. Remove the pump assembly from the bracket by unscrewing two mounting bolts. Remove the Woodruff key from the pump shaft to complete the dismantling.

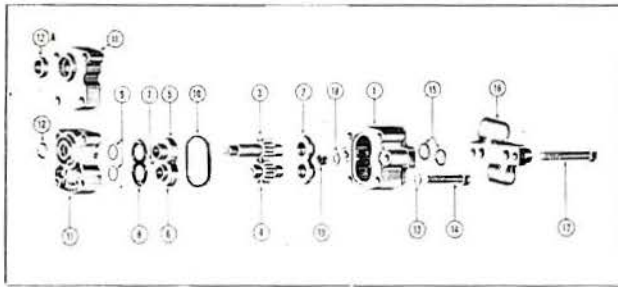


FIG. 334—HYDRAULIC PUMP

- | | |
|--------------------------|---|
| 1—Pump Gear Body | 12—Shaft Seal "O" Ring |
| 2—Pump Body Bearing | 12A. Shaft Oil Seal (Used on Model 051012-123-01) |
| 3—Pump Drive Gear | 13—Lockwasher |
| 4—Pump Driven Gear | 14—Cap Screw |
| 5—Cover Bearing | 15—Manifold Seal Rings |
| 6—Pump Cover Bearing | 16—Manifold |
| 7—Rubber Pin | 17—Manifold Attaching Bolts |
| 8—Cover Bearing Spring | 18—Lockwasher |
| 9—Bearing Seal "O" Rings | 19—Nut |
| 10—Pump Gear Body Seal | |
| 11—Pump Cover | |

U-46. Overhaul of Pump

Models:

- | | |
|---------------|---------------|
| 051012-023-01 | 051012-023-04 |
| 051012-023-02 | 051012-023-05 |
| 051012-023-03 | 051012-023-06 |

The 051012-023 pumps covered herein differ as to type of seal, and construction of the manifold attached. Pump model 051012-023-01 employs a commercial type seal for sealing off drive shaft leakage,

whereas models 051012-023-02/03/04/05 and 06 have a standard "O" ring operating in a groove cut in the pump cover for this purpose. The procedures outlined below apply to all models.

U-47. Disassembly

a. Remove the manifold seal rings (15) from the recesses around the ports in the pump body.

b. Remove the two cap screws (14) and lock washers (13) securing the cover (11) to the pump body. Then slide the cover carefully off the drive shaft extension holding the drive gear in place by pressing on the drive extension while the cover is being removed. If this procedure is carefully followed, the gears and bearings will remain assembled in the body and need not be disturbed.

c. Model 051012-023-01 only — Press the seal assembly (12A) from the pump cover using a short piece of $\frac{13}{16}$ " brass rod in an arbor press.

d. Models 051012-023-02/03/04/05 and 06 — Remove the drive shaft seal ring (12) from the recess in the pump cover.

e. Remove the split line seal ring (10) from the recess in the pump body and cover bearing seal rings (9) from around the cover bearings (5 and 6). Note size of bearing seal rings (9) so that seal rings of corresponding size are used at reassembly.

f. Lift the spring (8) off the cover bearings to ex-

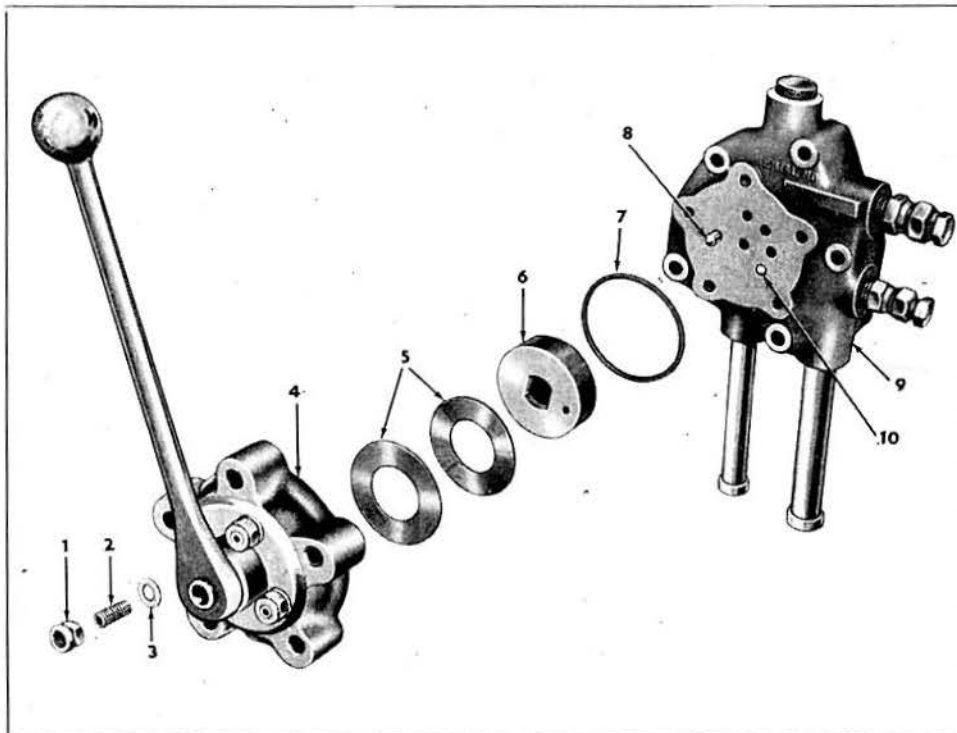


FIG. 335—HYDRAULIC CONTROL VALVE—FRONT VIEW

- | | |
|-------------------------------|-------------------------|
| 1—Valve Adjusting Locking Nut | 6—Rotor |
| 2—Valve Adjusting Allen Screw | 7—Rotor Housing Seal |
| 3—Flat Washer | 8—Rotor Positioning Pin |
| 4—Rotor Housing | 9—Valve Body |
| 5—Bearing Washers | 10—Hydraulic Lock Valve |

pose the rubber pin (7) in the drilled hole at the inlet side of the bearings.

g. Pry the rubber pin (7) out of the drilled hole using a sharp pointed instrument.

h. Discard the seal, seal rings, and rubber pin.

i. Before reassembly, carefully inspect cover (11). If there are cavities or casting defects present in the seal ring groove or if the cover seems to be porous (casting porosity), replace it with a new cover. Wash all metal parts thoroughly. Coat all new rubber seals with oil before installing. Use extreme care to keep any grit or dirt off pump parts when reassembling.

U-48. Reassembly

a. Install a new rubber pin (7) in the drilled hole at the inlet side of the cover bearings (5 and 6). Press firmly into position.

b. Install the spring (8) over the cover bearings with the spring nibs against the bearings.

c. First, place new bearing seal rings (9) over the bearing journals against the spring, and then place the new fibre washers (20) over the bearing journals against the rubber seal rings.

Important: Both light and heavy "O" rings and fibre washers are furnished. Replace with parts of corresponding size to the parts removed. Use fibre washers even if pump being repaired did not originally have them.

d. Place a new split line seal ring (10) in the recess in the pump body (1).

e. Model 051012-023-01 only — Press a new seal (12A) into position in the cover using an arbor press. Press squarely on the seal, taking care not to damage or distort it. Use Permatex between seal and cover.

f. Models 051012-023-02/03/04/05/ and 06 — Install a new shaft seal ring (12) in the recess in the pump cover.

The shaft seal and drive shaft should be well lubricated before installation of the cover, and care should be taken so as not to damage the seal.

g. Install the cover over the drive gear extension, and secure in place with two cap screws (14) and lockwashers (13).

Important: These two cap screws are of different lengths and must be installed into the same holes from which they were removed.

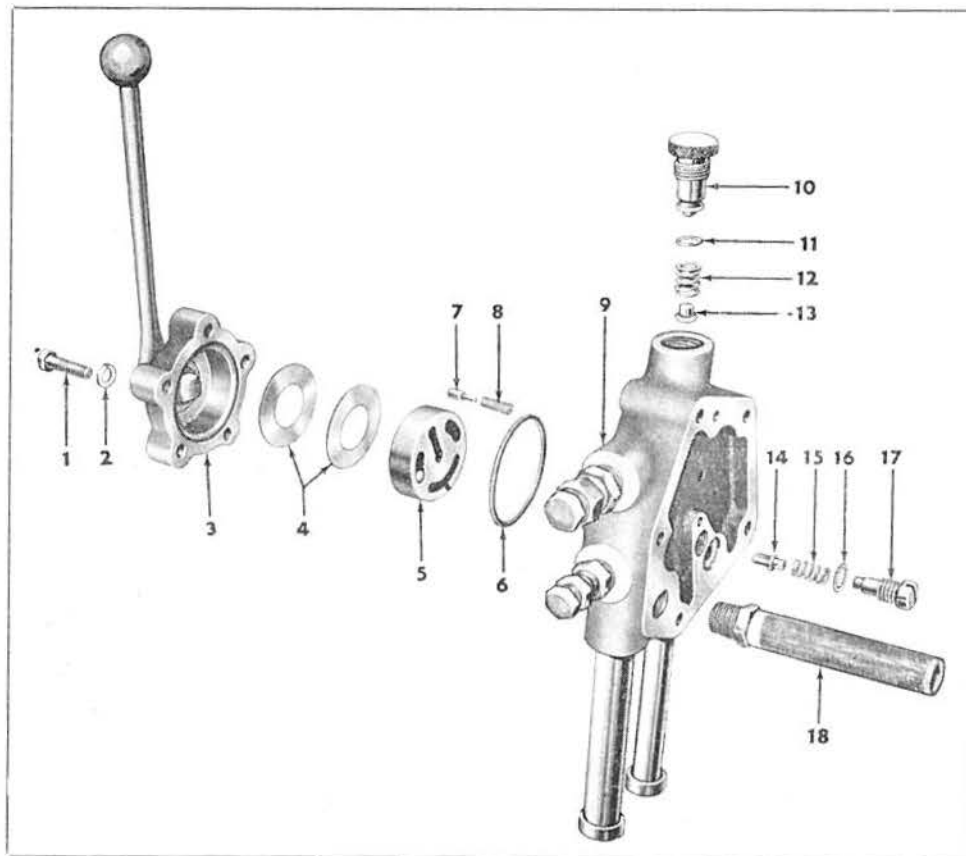


FIG. 336—HYDRAULIC CONTROL VALVE—REAR VIEW

- | | | |
|--------------------------------|--------------------------------|----------------------------|
| 1—Rotor Housing Attaching Bolt | 7—Rotor Positioning Pin | 13—Down Pressure Valve |
| 2—Lockwasher | 8—Rotor Positioning Pin Spring | 14—Hydraulic Locking Valve |
| 3—Rotor Housing | 9—Control Valve Body | 15—Locking Valve Spring |
| 4—Bearing Washers | 10—Down Pressure Control Knob | 16—Metal Seal Washer |
| 5—Valve Rotor | 11—"O" Ring Seal | 17—Locking Valve Cover |
| 6—Rotor Housing Seal | 12—Spring | 18—Filter |

h. Before installing the manifold check pump for leakage around shaft, put a small amount of light motor oil in one of the ports and then with one port held closed apply air pressure into pump through other port. (Any pressure from 5 to 25 psi. [5 a 25 kg-cm²] will show up defective seal in shaft.)

i. Install new manifold seal rings (15) in the recesses around the ports in the pump body (1), and install the manifold (16) in its previously identified position. Secure in place with two bolts (17), lock-washers (18) and nuts (19), and tighten the nuts securely. Note that the cap screws holding the manifold may be of different lengths depending on the model involved and must be properly installed in their original positions.

j. When pump is re-installed on vehicle, make sure that good alignment is obtained on the pump drive and that all hydraulic connections are securely tightened and are leakproof. The use of Permatex or any other good thread sealer is recommended.

k. Inspect the tank before adding fluid, to make sure that the tank is clean. Foreign matter in the form of dirt or scale in the tank will clog the filter back of the valve and starve the system causing continuous pump trouble unless corrected. If dirt or scale is present, the tank should be removed and thoroughly cleaned before adding fluid.

To remove the tank for cleaning, remove the five outer bolts that hold the valve to the tank. Remove the four bolts attaching the tank to the Jeep floor. Remove the screen filter from in back of the valve and clean thoroughly.

U-49. Overhaul of Control Valve

When oil leakage or loss of pressure is indicated in the control valve, first adjust the rotor to the valve face as follows: See Fig. 336.

Loosen the lock nuts on the three adjusting screws using a $\frac{1}{16}$ " open end wrench. Using a $\frac{1}{64}$ " Allen screw wrench, tighten each adjusting screw finger tight. Move the control valve handle to make sure that it can be moved from one position to the other without excessive effort. If it moves with a great deal of effort the adjusting screws have been tightened too much. Back off on all three screws and retighten using slightly less effort than previously, but make sure that each screw is tightened an equal amount. Recheck the effort to move the control valve handle. It should move with a slight amount of resistance but should not require effort. When the proper adjustment is obtained, retighten the lock nuts.

If the above adjustment does not correct the oil leakage or loss of pressure, remove the five screws attaching the rotor housing to the valve body and remove the housing, rotor and two metal washers. Inspect the face of the rotor carefully for any roughness. If any roughness is present on the face, lap the face of the rotor carefully on a flat surface such as glass or a surface plate using a valve grinding compound or any fine wet emery paper.

Valves bearing Serial Nos. 6000 and up are equipped with a poppet and spring which protrudes .035" outward from the face of the valve. This poppet is a locking device which shuts off the oil

in the lower high pressure port of the valve and prevents settling of an implement from the raised position when the control handle is in the neutral position. Fig. 335, No. 10.

With the control handle in the down position, if the implement is slow in lowering, it indicates that the poppet is not being forced away from the valve seat enough to fully open the valve. To correct this, the tank must be removed from the valve and the poppet removed from the back of the valve. To removed the tank, see Step No. 11 in "Overhaul of Hydraulic Pump".

If a new poppet is available, it should be installed; otherwise the old poppet must be lengthened by welding on a very small amount of metal to the protruding end and grinding the weld smooth and to the correct length so that it protrudes .035" from the valve face.

When reinstalling the valve to the tank, always use a new gasket.

U-50. Relief Valve Adjustment

A system operating pressure of 1350 psi. should be maintained by setting the relief valve to by-pass pressures in excess of 1350 psi.

Pressure relief adjustment is made by first removing the valve from the tank. A $\frac{1}{4}$ " Allen screw, located to the lower right of No. 17, Fig. 336 when No. 17 is installed, adjusts the pressure relief setting. Turn the Allen screw clockwise (to increase pressure) until tight. One internal thread of the housing should show above the screw. This setting should attain the correct pressure of 1350 psi.

The symptoms which indicate low operating pressure are:

- Linkage arms with no load raise at normal speed but hesitate with a load.
- A chattering squeal is heard from the valve when the lift lever is in "raise" position but the lift arms will not respond.

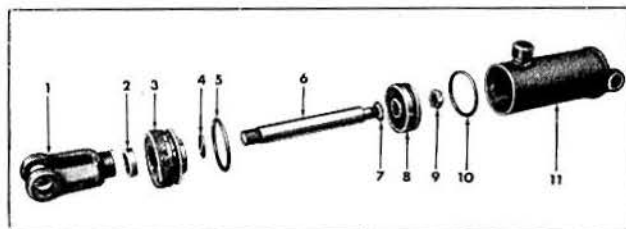


FIG. 337—PISTON AND "O" TYPE SEAL

- | | |
|---------------------------------|---------------------------|
| 1—Piston Clevis | 7—Fiber Seal Washer |
| 2—Rawhide Dust Seal | 8—Piston |
| 3—Piston Rod Guide | 9—Piston Rod Locking Nut |
| 4—"O" Ring Piston Rod Seal | 10—"O" Ring Piston Seal |
| 5—"O" Ring Cylinder Barrel Seal | 11—Cylinder Body Assembly |
| 6—Piston Rod | |

U-51. Overhaul of Hydraulic Cylinder

If, after checking the hydraulic cylinder as outlined in "Service Checks", it is found that the cylinder must be overhauled, proceed as follows:

- Make sure all hoses are tightly connected.
- Place control handle in the forward or down position.
- Raise and lower the attaching links by hand

in a pumping action to force the oil out of the cylinder.

d. Remove the two shoulder bolts that hold the leveling link to the clevis arm and remove leveling link.

e. Disconnect the lifting rod assembly at the lower link.

f. Remove the three hold down bolts which attach the main housing.

g. Turn the housing upside down in the Jeep body.

h. Remove the snap ring that holds the pin in the clevis end of the cylinder rod. Remove pin.

i. Raise clevis end of cylinder out of the housing and support it in this position with a suitable brace across the housing.

j. Remove the rod guide assembly with a suitable spanner type wrench. Tap lightly with a hammer around cylinder end to loosen the guide assembly. Remove guide and piston.

k. Inspect the inside surface of cylinder for scoring or roughness. Minor roughness can be removed with emery paper. Any deep scoring will necessitate installing a new cylinder.

l. Install new rubber seals in piston guide and piston. Two types of seals can be used on the piston. To install the round "O" ring type seal, place it in the groove on the piston head and oil the seal and groove thoroughly with clean oil. Fig. 337.

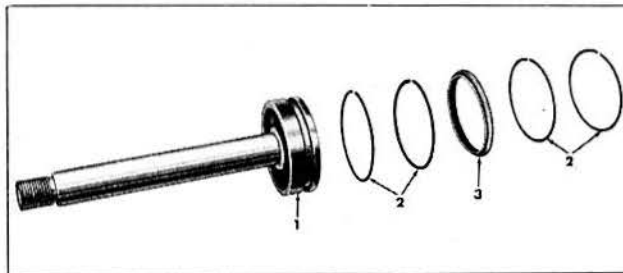


FIG. 338—PISTON AND "T" TYPE SEAL

- 1—Piston and Rod Assembly
- 2—Plastic Backing Rings
- 3—Neoprene "T" Ring Seal

To install the "T" type seal, first install the "T" seal in the piston head groove. Next, install two of the split fibre washers in front of the "T" seal and two in back of the "T" seal. Rotate the fibre washers so that their split ends are staggered around the piston. Oil the washers and "T" seal thoroughly with clean oil. Fig. 338.

Replace the large and small round "O" ring seals as well as the wiper seal in the cylinder guide if any of them show signs of wear or leakage. Fig. 337. Before installing the piston in the cylinder, coat the cylinder walls thoroughly with clean oil.

m. Assemble the hydraulic cylinder and the cylinder in the housing in the reverse order of disassembly.

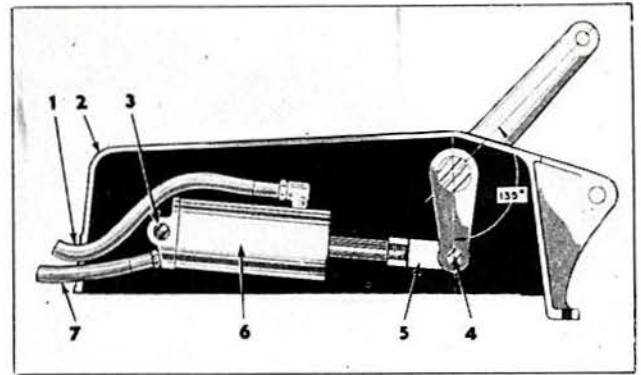


FIG. 339—MAIN HOUSING AND HYDRAULIC CYLINDER

- 1—Hose, $\frac{3}{8}$ " I.D. $\frac{1}{4}$ " thd. Valve End
- 2—Main Housing
- 3—Shaft, Cylinder End
- 4—Shaft, Clevis End
- 5—Clevis
- 6—Cylinder Assembly
- 7—Hose, $\frac{1}{2}$ " I.D. $\frac{3}{8}$ " thd. Valve End

U-52. How to Replace Arms on Main Shaft

Drive the two tapered pins Fig. 340, No. 3 out of the hub of the short arm inside the main housing. Remove the tapered pin from the hub on one arm and remove that arm from the shaft.

Note: The outer arms fit tightly on the shaft and must be driven or pulled off.

If difficulty is encountered, the hub on the arm can be heated or a wheel puller or similar tool, may be used for removal. Next, drive the main shaft out of the housing and remove the other arm if necessary. The reverse procedure is followed in reassembling. If a new arm or main shaft is to be in-

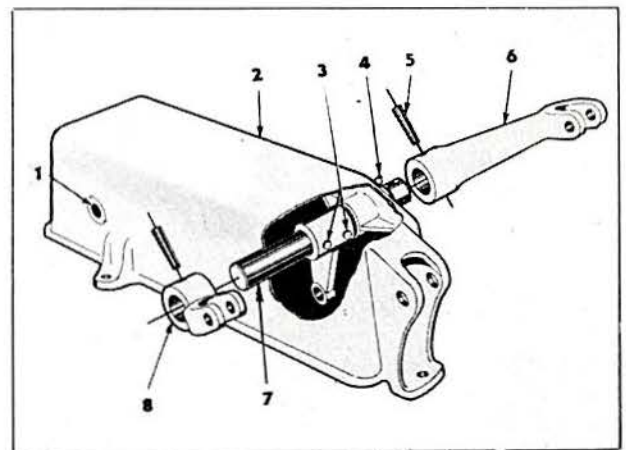
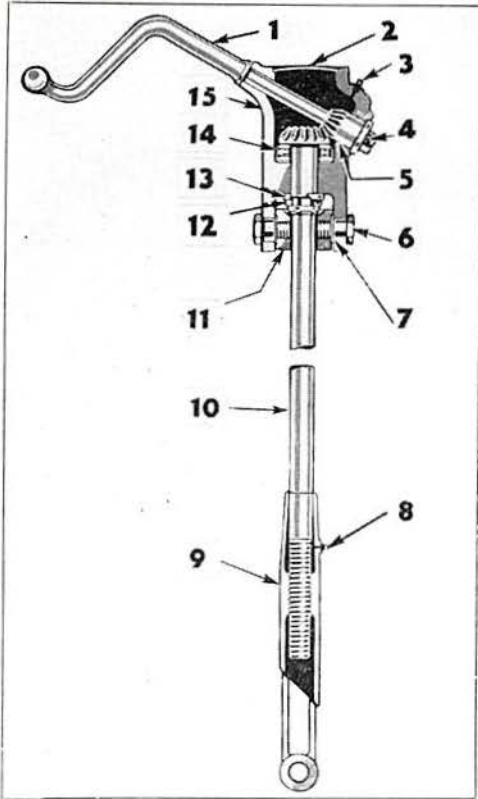


FIG. 340—MAIN HOUSING AND LIFT ARMS

- 1—Snap Ring
- 2—Main Housing
- 3—Tapered Pins
- 4—Grease Fitting
- 5—Tapered Pin
- 6—Clevis Arm
- 7—Main Shaft and Center Arm
- 8—Clevis Arm

stalled, it is necessary to drill and taper ream the arm and shaft at assembly, or the arm may be welded to the shaft. Make sure that the outer arms



are assembled at 135° to the center arm as shown in Fig. 339.

U-53. Disassembling Leveling Link and Fork Assembly

To replace parts in the leveling link assembly, first remove the lower fork assembly No. 9, Fig. 341, after disconnecting the link from the lift. File

FIG. 341—LEVELING LINK ASSEMBLY

- 1—Handle
- 2—Welch Plug
- 3—Grease Fitting
- 4—Pinion Gear Pin
- 5—Pinion Gear
- 6—Shoulder Bolt
- 7—Special Lockwasher
- 8—Grease Fitting
- 9—Leveling Link Fork
- 10—Leveling Link Fork
- 11—Pivot Block
- 12—Snap Ring
- 13—Washer
- 14—Bearing
- 15—Housing

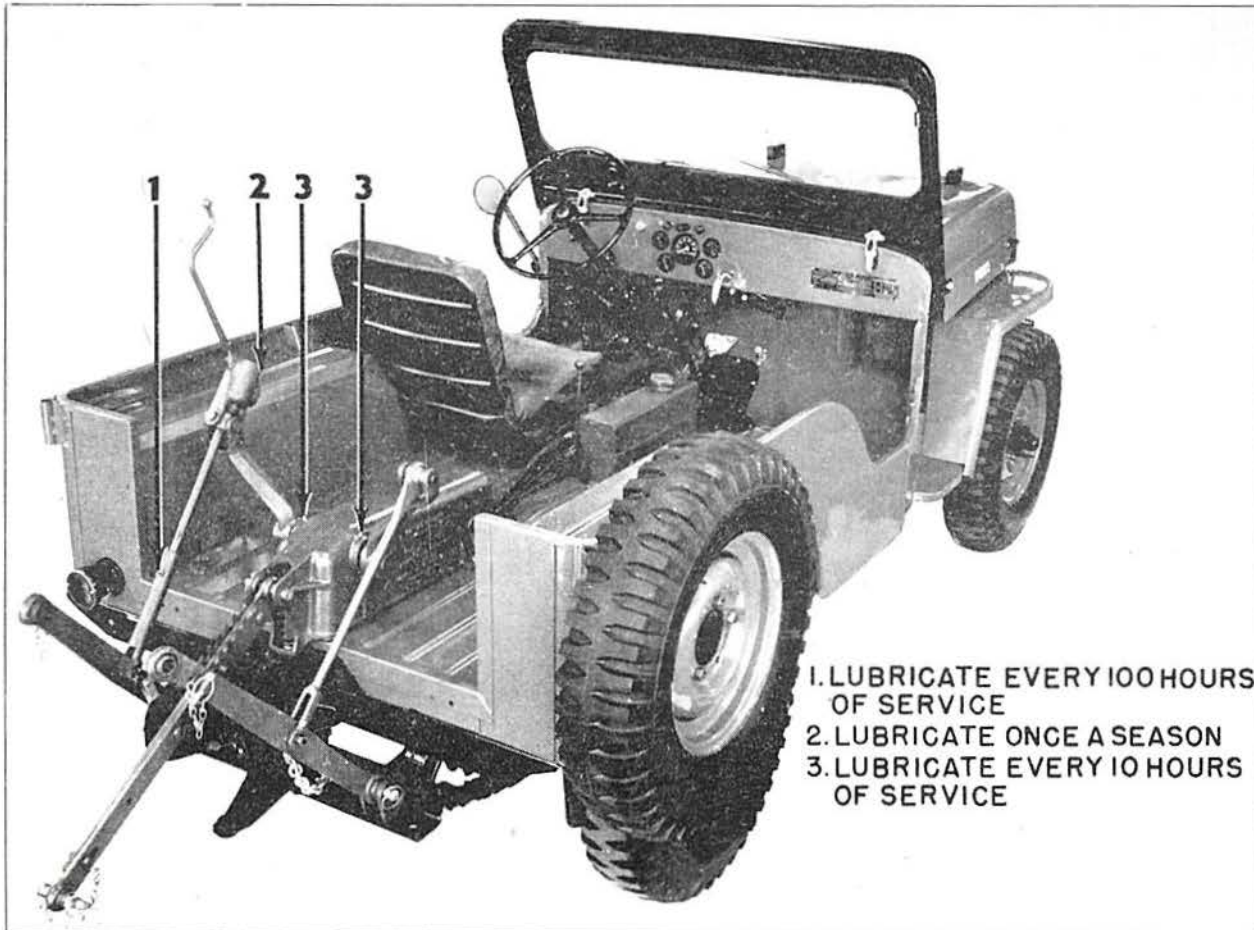


FIG. 342—HYDRAULIC LIFT LUBRICATION

off the end of the pin No. 4 holding the pinion No. 5 on the handle No. 1 and drive the pin out. Remove the pinion gear and handle. Remove the pivot block No. 11 by unscrewing the two shoulder bolts No. 6. Spread the lock ring No. 12 with a ring spreader or a similar tool, and strike the end of the gear post No. 10 to force it through the lock ring. Remove the Welch plug No. 2 by either pushing it out with the gear post or by striking it in the center with a ball

peen hammer. Remove the gear post and bearing No. 14. The reverse procedure is followed in re-assembly. It is recommended that a new Welch plug be used when assembling. Lubricate all parts as they are assembled.

Use care when lubricating the gear box at the upper lubrication fitting to prevent blowing out the soft plug.

U-54. 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.

TOOL	DESCRIPTION
Engine Group	
C-38	Reamer — Valve Guide
W-172	Puller, Timing Gear, U-Joint Flange, Vibration Damper
W-231	Kit, Flywheel Dowel Installing
W-238	Driver, Intake and Exhaust Valve Guide
C-482	Compressor, Valve Spring
C-3422	Compressor, Valve Spring
Transmission Group	
W-166	Arbor & Sleeve, Countershaft Needle Bearing Assy.
W-193	Arbor, Countershaft Needle Bearing Assembly
W-194	Plate, Transmission Main Shaft Retaining
Transfer Case Group	
W-130	Thimble & Driver, Shifter Rod Oil Seal
W-131	Thimble & Driver, Pinion Shaft Rear Bearing Cone
W-133	Driver, Speedometer Drive Pinion Bushing
W-139	Driver, Output Shaft Front Bearing Cone Removing
W-141	Ring, Output Shaft Front Bearing Cone Removing
W-143	Driver, Output Shaft Front & Rear Oil Seal Installer
W-176	Puller, Shift Rod Oil Seal
W-192	Pilot Pin, Transfer Case Intermediate Gear Thrust Washer
W-251	Puller, Pinion Shaft Oil Seal, Transfer Case Front and Rear Oil Seal Removing
Universal Joint Group	
W-162	Tool, U-Joint Flange Installer
W-220	Jig & Bushing, Power-Take-Off U-Joint Pin Remover & Installer
C-452	Puller, U-Joint Flange
C-3281	Wrench, U-Joint Holding
Rear Axle Group	
W-99B	Set, Pinion & Ring Gear Gauge Setting
W-104B	Puller, Axle Shaft, Pinion Shaft, Differential Case Bearing Cone
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 Model 23 & 25 Axle
W-147	Driver, Pinion Shaft Oil Seal
W-186	Driver, Rear Axle Shaft Oil Seal
W-188	Driver, Differential Case Bearing Cone Model 44 Axle
W-262	Installing Sleeve, Pinion Bearing, Model 27 Axle
C-319	Puller, Rear Wheel Hub
C-637	Puller, Axle Shaft & Oil Seal
C-3095	Installing Sleeve, Pinion Bearing, Model 44 Axle
C-3716	Driver, Differential Bearing Cone, Model 27 Axle
Front Suspension Group	
W-138	Driver & Adapter, King Pin Bearing
W-144	Wrench, Wheel Bearing Adjusting
W-163	Puller, Front Axle Drive Flange
C-690	Scale, King Pin Bearing Preload
Steering Group	
C-3646	Puller, Steering Shaft Arm
Brake Group	
W-213	Wrench, Brake Adjusting

U-55. TORQUE SPECIFICATIONS

ENGINE:	Pounds-Feet	kg-m.
Camshaft Gear to Camshaft.....	30-40	[4,1 a 5,5]
Camshaft Thrust Plate Bolt.....	20-26	[2,8 a 3,6]
Clutch Control Ball Stud — $\frac{5}{16}$ " [0,8 mm.].....	35-45	[4,8 a 6,2]
Clutch Control Ball Stud — $\frac{9}{16}$ " [1,4 mm.].....	70-85	[9,7 a 11,8]
Connecting Rod Cap Bolt Nut — $\frac{3}{8}$ " [1 mm.].....	35-45	[4,8 a 6,2]
Crankshaft Counterweight Bolt.....	60-70	[8,3 a 9,7]
Cylinder Head to Block Bolts.....	60-70	[8,3 a 9,7]
Engine Mounting (Center Bolt).....	45-55	[6,2 a 7,6]
Exhaust Manifold to Cylinder Block.....	29-35	[4,0 a 4,8]
Flywheel to Crankshaft Bolt.....	35-41	[4,8 a 5,7]
Generator Bracket to Cylinder Block.....	25-35	[3,4 a 4,8]
Intake Manifold to Cylinder Block.....	29-35	[3,4 a 4,8]
Main Bearing Caps.....	65-75	[9,0 a 10,4]
Oil Pan Screws to Cylinder Block.....	9-14	[1,2 a 1,9]
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.....	25-33	[3,4 a 4,6]
Starting Motor Mounting Bolt.....	20-25	[2,8 a 3,4]
Valve Chamber Cover Nuts.....	7-10	[1,0 a 1,4]
Water Outlet Elbow to Cylinder Head.....	20-25	[2,8 a 3,4]
Water Pump to Cylinder Block.....	12-17	[1,7 a 2,3]

Note: Turn the connecting rod cap nut locks (inverted type, pressed steel) finger tight and then tighten $\frac{1}{8}$ 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 — $\frac{7}{16}$ " [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 — $\frac{1}{2}$ " [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.....	95-115	[13,1 a 15,9]
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 — $\frac{3}{8}$ " [1,0 mm.].....	30-40	[4,1 a 5,5]
Steering Mounting to Frame — $\frac{7}{16}$ " [1,1 mm.].....	45-55	[6,2 a 7,6]
Steering Tie Rod Clamp Bolts — $\frac{5}{16}$ " [0,8 mm.].....	10-15	[1,4 a 2,1]
Steering Tie Rod Clamp Bolts — $\frac{7}{16}$ " [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]

U-56. MISCELLANEOUS DATA

DRAW BAR PULL

The power plant of the 'Jeep' Universal is particularly well adapted to the great variety of applications. For higher speed highway use, and draw bar pull requirements for towing loads, the full engine power is available; for power take-off shaft and pulley drive, the full engine torque (turning effort) is available.

Draw bar pull is the force exerted by a vehicle to tow a trailed load and is expressed in pounds.

For continuous agricultural work, the maximum draw bar pull should be limited to 1200 pounds [544 kg.]. The 'Jeep' Universal is capable of much higher draw bar pulls than the 1200 pounds approved for continuous service, which may be used for starting loads or towing loads for short periods on good ground in which case a draw bar pull as high as 1800 pounds [817 kg.] may be safely used.

Maximum continuous draw bar pulls are most often encountered in plowing, disking and harrowing and it is in these applications that the owner should guard against continuously exceeding the recommended limit.

The approved limit of 1200 pounds [544 kg.] may be judged by the following operations which nearly approach this limit:

Operating two 12 inch [30,5 cm.] plows at a depth of 6½ inches [16,5 cm.] in dry clay loam.

Operating a 7 foot [2,13 meter] tandem disk at a depth of 4½ inches [11,4 cm.] in hard winter packed soil.

Operating a 3-section spring tooth harrow at a depth of 5 inches [12,7 cm.] in soil which has been previously disked.

It is expected that, either on account of soil conditions or implement adjustments, these draw bar pulls will be exceeded. In these instances, tire slippage provides an inherent safeguard against overloading. Do not add weight, other than the standard bumper weight, to increase draw bar pull.

**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	358	2.22	644	4.01	1000	6.22	1000
	High	358	5.40	644	9.75	1000	15.13	
2	Low	428	2.67	773	4.81	1200	7.47	1200
	High	428	6.48	773	11.71	1200	18.15	
3	Low	500	3.11	902	5.62	1400	8.72	1400
	High	500	7.56	902	13.66	1400	21.17	
4	Low	571	3.56	1031	6.42	1600	9.96	1600
	High	571	8.65	1031	15.61	1600	24.20	
5	Low	643	4.00	116	7.22	1800	12.08	1800
	High	643	9.73	116	17.56	1800	27.22	
6	Low	714	4.44	1289	8.02	2000	12.45	2000
	High	714	10.81	1289	19.51	2000	30.25	
7	Low	786	4.89	1418	8.83	2200	13.70	2200
	High	786	11.89	1418	21.46	2200	33.27	
8	Low	857	5.34	1547	9.63	2400	14.94	2400
	High	857	12.97	1547	23.41	2400	36.31	
9	Low	929	5.78	1675	10.43	2600	16.19	2600
	High	929	14.05	1675	25.36	2600	39.33	

**POWER TAKE-OFF SHAFT AND VEHICLE GROUND SPEEDS
ALL GEAR SHIFT POSITIONS
KILOMETERS 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 K.P.M.	Take-Off Shaft R.P.M.	Vehicle Speed K.P.M.	Take-Off Shaft R.P.M.	Vehicle Speed K.P.M.	
1	Low	358	3.57	644	6.45	1000	10.00	1000
	High	358	8.68	644	15.68	1000	24.35	
2	Low	428	4.29	773	7.73	1200	12.02	1200
	High	428	10.43	773	18.84	1200	29.20	
3	Low	500	5.00	902	9.04	1400	14.02	1400
	High	500	12.16	902	21.98	1400	34.05	
4	Low	571	5.72	1031	10.33	1600	16.03	1600
	High	571	13.91	1031	25.12	1600	38.93	
5	Low	643	6.44	1160	11.61	1800	19.43	1800
	High	643	15.65	1160	28.25	1800	43.80	
6	Low	714	7.15	1289	12.90	2000	20.00	2000
	High	714	17.39	1289	31.40	2000	48.65	
7	Low	786	7.86	1418	14.20	2200	22.02	2200
	High	786	19.11	1418	34.53	2200	53.53	
8	Low	857	8.59	1547	15.48	2400	24.03	2400
	High	857	20.87	1547	37.66	2400	58.40	
9	Low	929	9.30	1675	16.78	2600	26.04	2600
	High	929	22.60	1675	40.80	2600	63.28	

PULLEY SPEEDS (R.P.M.) - 8" (20.3CM.) PULLEY

Governor Control Positions	1-1 RATIO			Engine Speeds
	TRANSMISSION			
	Low	Inter.	High	
1	306	552	857	1000
2	367	662	1028	1200
3	428	774	1200	1400
4	490	884	1372	1600
5	551	995	1542	1800
6	612	1105	1714	2000
7	673	1237	1885	2200
8	734	1326	2057	2400
9	796	1438	2228	2600

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	8.52	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	11.43	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.

U-57. LIST OF ABBREVIATIONS

o (metric conversions)	lb.	pounds
fter bottom center	lb-ft.	pounds-feet of torque
mpere	lg.	long
American Petroleum Institute	l.h.	left hand
pproximately	ltr.	liters
ssembly	m.	meters
fter top center	max.	maximum
efore bottom center	mfd.	microfarads
efore top center	min.	minimum
entigrade	mm.	millimeters
entimeter	mph.	miles per hour
quare centimeter	No.	number(s)
ubic centimeter	O.D.	outside diameter
andle power	O.S.	over size
ubic inches	oz.	ounces
iameter	P.T.O.	Power Take-Off
ahrenheit	Par.	paragraph
igure(s)	psi.	pounds per square inch
gallons	r.h.	right hand
grams	rpm.	revolutions per minute
gallons per minute	SAE	Society of Automotive Engineers
orsepower	S/N	serial number
inside diameter	sq. in.	square inches
ilograms	U.S.	under size
ilograms per square centimeter	v.	volts
ilograms per meter	x	times or by
ilometers	"	inches
ilometers per hour	:	to (ratio)
	°	degrees