BUSES
STUDEBAKER
TRUCKS

FOR PROMOTION OF UNIVERSALLY SATISFACTORY SERVICE

Shop Manual

1937 TRUCKS AND BUSES

THE STUDEBAKER CORPORATION
SOUTH BEND, INDIANA

Studebaker Truck Shop Manual

1937 Models

MODELS	STARTING SERIAL NUMBERS	RATING	
J15	J15-001	1-1/2	ton—Standard Series Truck
J15B	J15B-001	1-1/2	ton—Standard Series Bus
J15M	J15M-001	1-1/2	ton—Cab-Forward Series Truck
J20	J20-001	2	ton—Standard Series Truck
J20M	J20M-001	2	ton—Cab-Forward Series Truck
J20MB	J20MB-001	2	ton—Cab-Forward Series Bus
J25	J25-001	2-1/2	ton—Standard Series Truck
J25M	J25M-001	2-1/2	ton—Cab-Forward Series Truck
J25MB	J25MB-001	2-1/2	ton—Cab-Forward Series Bus
J30	J30-001	3	ton—Standard Series Truck
J30M	J30M-001	3	ton—Cab-Forward Series Truck

The Studebaker Corporation
South Bend, Indiana

FOREWORD

STUDEBAKER recognizes the fact that trucks and busses are purchased for the purpose of producing a profitable revenue for the purchaser, and every effort has been made to produce a vehicle which will perform its task efficiently and economically. The dealer also, has a very definite responsibility to the purchaser in that the factory necessarily depends upon him to make available to the purchaser an adequate parts and maintenance service. Even where the purchaser services his own equipment, the dealer should offer the purchaser his full cooperation.

In compiling this Shop Manual for the 1937 Studebaker trucks and busses, we have tried to cover each subject thoroughly and to provide information which will assist the dealer and his mechanical staff in rendering an effective service. Study the Manual carefully and make sure that it is used as a daily reference by your shop personnel. Be prepared to meet your service obligation to Studebaker truck and bus operators satisfactorily, promptly, and efficiently.

As a part of your service to the purchaser, convince him of the importance of avoiding over loading and excessive speeds, and of having his trucks and busses thoroughly inspected and lubricated at regular intervals. Failure to observe one or more of these requirements is the most common cause of rapid depreciation and road failures which involve costly delays and repairs.

Do not overlook the advantages to be derived from the Dealer Service Policy, one of which is supplied by the factory with each new truck or bus shipped. The Policy will insure practically a one hundred percent contact with truck and bus operators during the warranty period. The relationship established during this period should be such as to insure a continuance of this degree of contact after the warranty period, covered by the policy, has expired.

Cab Forward Models

Cab Forward Models J15M, J20M, J25M and J30M

The design of the Cab Forward models provides ready access to the engine and accessories. The accessories and other units used on these models as well as the J20MB, and J25MB bus models, are the same as used on the J15, J20, J25, and J30 conventional models which are described in detail in the following pages.

Adjustment of the carburetor, distributor, removal of the spark plugs, cylinder head, and so forth is accomplished by the removal of the rear section of the engine hood from inside the cab. Removal of the cab floor boards provides ample room for the removal or adjustment of the starter, generator, distributor, or fuel pump. The valve mechanism is readily accessible by the removal of the side louvers and the floor boards.

To Remove Engine Assembly—The engine as an assembly is removable through the front, in the following manner:

1. Remove the rear and front sections of the engine hood. The bolts holding the front section of the engine hood also hold the radiator grill in position.
2. Remove the cab floor boards.
3. Remove the front bumper.
4. Remove the radiator grill.
5. Remove the radiator core.
6. To prevent the possibility of damage, it is advisable to also remove the generator, starter, distributor, manifold assembly and carburetor, fuel pump and oil filler tube.
7. Remove the engine hold down bolts.
8. Disconnect the universal joint at the rear of the transmission.
9. Place a roller type jack under the engine oil pan, using a piece of board to protect the pan. Then raise the front end of the engine sufficiently to permit the entire assembly to be moved forward onto the frame front cross member, when in this position attach a chain fall and swing the assembly clear of chassis.

Bus Models J15B, J20MB, and J25MB.

The J15B model bus chassis is identical with the conventional J15 truck model, except that the bus chassis has a double drop framé, underslung rear springs, and a 30 gallon capacity gasoline tank.

The J20MB and J25MB model bus chassis is identical with J20M and J25M Cab-Forward truck models, except that the bus chassis is equipped with a double drop frame, underslung rear springs, and a 30 gallon capacity gasoline tank.

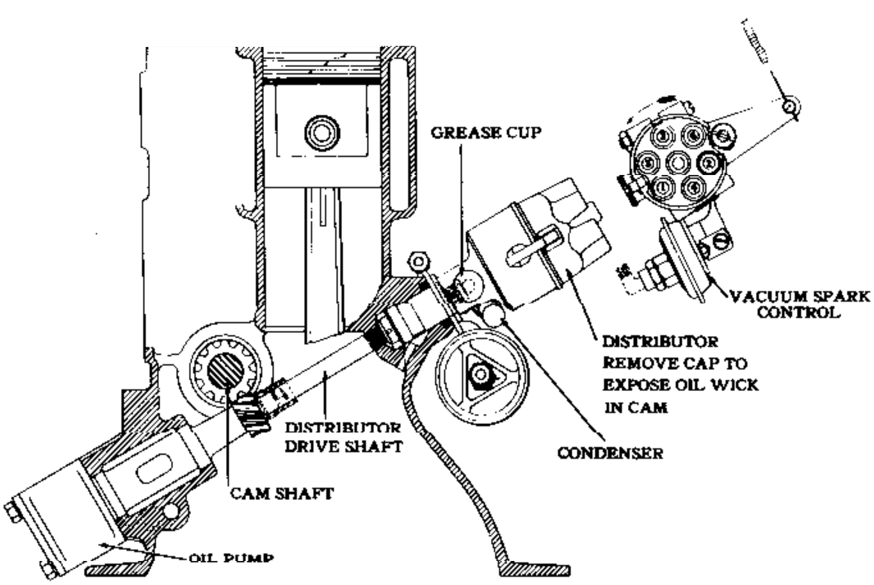


Illustration No. 1—Showing Assembly of Distributor and Oil Pump Drive Shaft—J-15 Models

Model J15 Engine

The six cylinder Studebaker truck engine used in the J15 models of both the cab forward and conventional design is of the L head type. Lubrication is supplied under pressure to all crankshaft, camshaft and connecting rod bearings as well as to the valve lifters. The cylinder walls, pistons and piston rings are lubricated by the oil discharged from the sides of the connecting rod bearings as well as the small escapement hole drilled in the web of each connecting rod at the lower end. The timing gears are lubricated by oil from the oil pressure relief valve.

Oil Pump—The oil pump is of the conventional gear design, with the drive shaft extending up to the camshaft on an angle of approximately 27°. The drive shaft gear meshes in the gear on the camshaft. Through a tongue and groove connection the oil pump shaft also drives the ignition distributor. The oil pump drive gear is attached to the drive shaft by a Woodruff key. The idler gear rotates on a stub shaft mounted in the oil pump body. Helical oil pump gears are used to insure quiet operation. The oil pump cover, oil pump body and gear assembly is attached to the crankcase by four cap screws. Gaskets are installed between the crankcase and body, and the body and pump cover. If the oil pump is removed, the oil pump and distributor drive gear will be drawn out of mesh with the gear on the camshaft. To insure correct spark timing, special attention must be paid to reassembling the oil pump as follows: With No. 1 piston on its compression stroke, turn the engine until the U.D.C. No. 1 and 6 mark on the crankshaft damper flywheel is directly under the timing pointer, on the timing gear cover. Assemble the oil pump to the crankcase, making sure that the tongue at the upper end of the drive gear shaft is in a horizontal position when the gears are engaged and also that the offset is toward the top. The position of the gear teeth may not permit an exact horizontal positioning of the tongue; however, make sure that the front gear is not meshing one tooth off. The distributor clamp should be loosened and the distributor removed when installing the pump to permit checking the position of the tongue.

Oil Distribution—Oil is drawn into the oil pump through a screen that floats just below the surface of the oil which permits only clean oil to enter the oiling system. The operation of this "Floto" type oil screen is automatic and requires no attention other than cleaning at least twice a year, preferably in the Spring and Fall.

From the oil pump the oil passes through a distributing line which is cast integral with the cylinder block. Crosswise intersecting passages cast integral with the crankcase lead the oil through the camshaft and crankcase bearings. From the crankshaft bearings, the oil is forced through passageways drilled in the crankshaft to the connecting rod bearings.

Six quarts is the recommended capacity of the engine lubrication system. It is of vital importance, that only a high quality mineral oil of the proper grade be used. The recommended engine oil specifications will be found in the general lubrication section.

Crankshaft Bearings—The crankshaft is supported by four steel back, babbitt lined bearings. These bearings are of the interchangeable type and no attempt should be made to line ream or hand scrape them, and stock must not be removed from the bearing cap to obtain an adjustment as this will render the caps useless when new bearing shells are installed. Main bearing journal sizes and recommended bearing clearances are listed in the general specification section.

The crankshaft end thrust is taken at the front bearing and is controlled by shims. The initial factory end play adjustment of the crankshaft is from .003" to .006".

Connecting Rod Assemblies—The connecting rods are clamped to the piston pins at the upper ends and are provided with integral, spun babbitt bearings at the lower ends.

If through wear or other causes, excessive clearance between the crankshaft journal and connecting rod bearing is encountered, it will be necessary to install new connecting rods. The new connecting rods should, of course, be obtained from our Parts and Accessories Division. They are supplied on a credit less cost of rebabbitting basis. Before fitting the new connecting rods, the crankshaft journals should be examined and, if necessary, turned down to obtain a smooth and round bearing surface. The connecting rods can then be reamed in the usual manner to obtain the proper bearing clearance of from .002" to .005". After the desired clearance is obtained, each connecting rod should be checked for alignment in an accredited aligning fixture.

Piston Assemblies—The pistons are of the electro-plated cast iron type and are fitted in the following manner. The electro plating of these pistons permits closer initial fit, reduces the possibility of piston seizure and increases the useful life of the piston. With a .002" thick feeler gauge 1/2" wide on the pressure side of the piston (camshaft side) insert the piston in an inverted position, midway in the length of the cylinder bore, with the piston pin parallel to the crankshaft. The specified clearance is obtained when a 15 to 20 pound pull, as measured by a spring scale attached to the feeler gauge, is required for the removal of the gauge while the piston is held stationary. If a greater pull is required to remove the feeler gauge a smaller piston should be tried; while a larger piston will be required if the pull is under 15 pounds.

In the event that new pistons are being installed, it is important that before they are fitted to the cylinder bores, the condition of the cylinder bores be determined with reference to taper and eccentricity. If either condition is found in excess of .002", the cylinders should be rebored, and finish honed to accommodate the smallest possible oversize piston assemblies which can be obtained from our Parts and Accessories Division in the following oversizes:

.002", .004", .010", .015", .020" and .030".

The pistons are equipped with three rings above the piston pin, the lowest of which is of the oil control type. The two compression rings are 1/8" wide, while the oil control ring is 3/16" wide. Fourteen 5/32" diameter holes are drilled in the bottom of the oil control ring groove in the pistons to drain the oil scraped off the cylinder walls. The size and number of holes is ample for this purpose and under no circumstances should the size or number of these holes be increased.

When replacing piston rings, each ring should be inserted in the particular cylinder in which it is to be used, squared up in the bore with the head of the piston, and the end gap checked with a feeler gauge. The recommended gap between the ends of the piston rings, when installed in the cylinder, is from .013" to .018" for both compression rings and oil control rings. If the gap is under the preceding recommendations, the ring ends should be filed. A ring with an end gap in excess of the preceding tolerances should not be used. A step is incorporated on one edge of the compression rings and they must be installed with this step downward. The piston pin is located in the upper end of the connecting rod, and is carried on two bronze bushings in the pistons. The recommended clearance between these bushings and the piston pin is .0004", and is established as a light push fit.

The pistons and connecting rods, as an assembly, are removed from the top which requires the removal of both the cylinder head and oil pan.

Camshaft—The camshaft is supported in four bushings which are of the split, steel back, babbitt lined type. The initial clearance between the camshaft and the front bushing is from .00075" to .00225" while the clearance of the other three bushings is from .002" to .00375". Rarely will it be necessary to replace the camshaft bushings; however, if this is done, care must be exercised in aligning the oil holes in the bushings with the oil supply holes in the cylinder block and the bearings must be reamed after assembly to the block.

The recommended camshaft end play is from .003" to .006" and is controlled by means of a steel thrust washer located at the front end of the camshaft back of the camshaft gear.

Camshaft Drive—The crankshaft to camshaft drive is through helical cut gears—the camshaft gear being of the composition steel hub type and the crankshaft gear of steel. A gear puller should be used for removing the gears and a gear pusher must be used for installing them. Under no condition should an attempt be made to force the gears on the shaft by hammer blows, as this will only result in serious damage.

Camshaft gears can be obtained from our Parts and Accessories Division in three sizes and are marked "S" for standard, "H" for high limit, and "L" for low limit. The crankshaft gear is available in the standard size only. Ordinarily, when new gears are installed the next size larger than the original gear should be used.

If for any reason the timing gears are removed, it is important when the reinstallation is made that the marked tooth on the crankshaft gear be meshed with the two marked teeth on the camshaft gear to obtain correct timing.

Camshaft Removal—If it is necessary to remove the camshaft, this operation is simplified by the use of special valve lifter support tools, No. HMJ-419 and HMJ-419A, which can be ordered from our General Service Department. These support tools make is possible to remove the camshaft without removing the cylinder head, valves, valve springs and oil pan. The support tools are forced under the heads of the tappet adjusting screws and raise the valve and tappet so that the camshaft can be withdrawn. The support tools can be obtained as outlined above or made in your shop.

Valves and Valve Lifters—The inlet valves are of chrome nickel steel. The valve head diameter being 1-15/32″ while the exhaust valves are of heat resisting silichrome steel, with a valve head diameter of 1-9/32″. The valve stem diameter of both the intake and exhaust is 11/32″. The valve lifter guides are an integral part of the cylinder block and therefore are not removable. Oil is supplied to the valve lifters under pressure as shown in the illustration. When re-

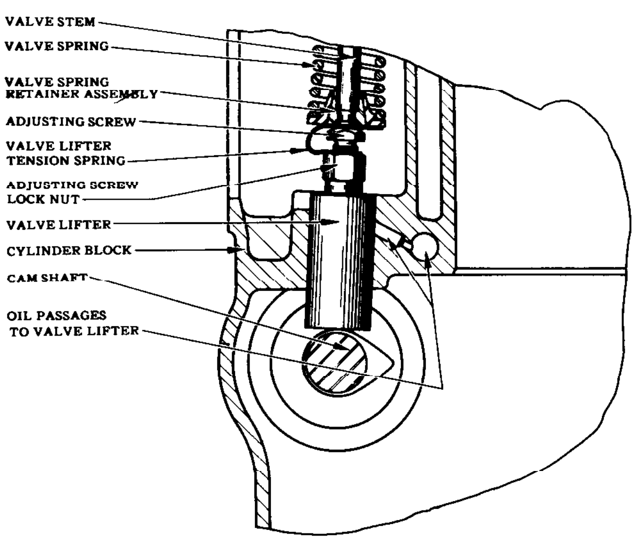


Illustration No. 2—Valve Push Rod Assembly—J-15 Models

moving the valve springs it is necessary to first remove the valve spring seat locks and the valves before the valve spring seats and springs can be removed. When installing the valve springs, place the valve spring seat on the bottom of the spring and spring seat up and over the valve lifter. The valve spring in its extended position, will not clear the valve lifter and the tappet adjusting screws so it is necessary to slightly compress the spring and push it over the lifter into a vertical position. Next, install the valves, compress the springs and again install the valve spring seat locks.

The valve lifter assemblies are of the same diameter over their entire length and can be removed from the top, after removing the valve and spring assemblies.

Valve Grinding—The usual cause of leaky valves is carbon deposits on the valve seats. These carbon deposits prevent the valves from closing properly and permit hot gases to burn over the polished faces of the valves, with consequent pitting. The importance of properly seating valves cannot be too highly stressed as there is probably no other item which affects the performance of an engine as much as the proper seating of the valves.

When the valves are removed, they should be inserted in a board provided with 12 holes. The holes should be numbered from 1 to 12 inclusive, so as to permit the reassembly of the valves in their original position. The valve seats should be reconditioned either with an accredited valve seating tool or with one of the recommended valve seat grinding tools as listed in the Studebaker Service Tool and Equipment Catalog. If valve seat cutters are used, a 45° roughing cutter should be used first while a 45° finishing cutter should be used as a final operation in finishing the seat. The recommended width of the valve seat is 3/32″. It is important that this seat width be maintained and that the seat registers in the center of the valve face. The valve seat width and location can be controlled by the use of narrowing cutters both at the top and at the bottom. A 15° narrowing cutter should be used at the top of the valve seat, and a 75° narrowing cutter should be used at the bottom. It is important, however, if a narrowing cutter is used, that it be used with caution and as little as possible, as excessive use of these cutters will materially shorten the life of the valve seats in the cylinder block. If a narrowing cutter is used, a very light final cut should be taken with a 45° finishing cutter or valve seat grinding tool.

In refacing the valves, an accredited valve refacing machine should be used and care exercised in taking only light cuts with the grinding wheel, also to have the carbon formation carefully cleaned off the valve stem where it is chucked into the valve refacing machine. If the valve seats and the valve faces are carefully reconditioned, very little grinding-in with an abrasive material will be required.

Before replacing the valve springs, the tension should be checked. The valve springs are designed to offer resistance of 123 pounds when compressed to a length of 1-3/4″. Springs which do not meet this specification within 10% should be replaced.

When assembling the valve springs, the closed coils must be placed at the top.

Valve Spring Damper—Over the upper end of the valve springs, a valve spring damper is used which provides an added factor of safety against breakage and valve spring surge, particularly at the higher engine speeds.

Valve Tappet Clearance—The recommended valve tappet clearance is .016″ cold, for both the intake and exhaust valves. Cold is considered as room temperature.

Valve Timing—A valve tappet clearance of .020″ should be provided when checking the valve timing. Valve timing marks will be found on the crankshaft vibration damper as shown in Illustration No. 3.

Crankshaft Vibration Damper — A vibration damper is mounted on the forward end of the crankshaft. The damper is of simple design and should require but little service attention.

The damper consists of the flywheel mounted in two rubber rings. Each ring is provided with six buttons which project into holes in the damper flywheel. The center of each button is provided with a hole through which the crankshaft fan pulley and vibration damper hub rivet passes. The rear surface of one of the rubber rings thrusts against the face of the vibration hub, while the forward ring is retained by the damper front plate. Two of the damper hub rivets extend through the damper hub plates and accommodate the vibration damper nut lock. A portion of the lock is bent over one of the flats of the vibration damper nut retaining the nut in position. The vibration damper nut retains the damper front plate. The damper flywheel does not rotate in relation to the crankshaft but merely oscillates on the shaft during periods of crankshaft torsional vibration.

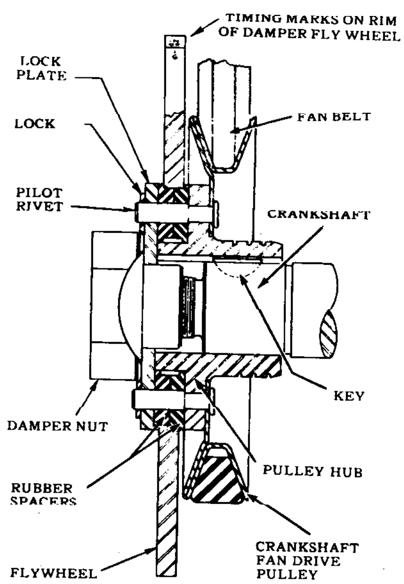


Illustration No. 3—Crankshaft Vibration Damper—Showing Timing Marks J-15 Models

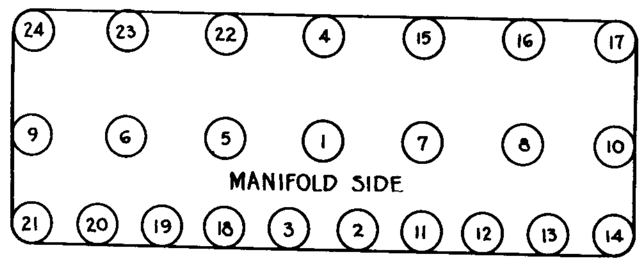


Illustration No. 4—Cylinder Head Tightening Order—J-15 Models

Cylinder Head—When installing a new cylinder head gasket, the cap screws should be tightened in the sequence shown in the illustration. This procedure will eliminate the possibility of strains in the head and insure an even compression of the cylinder head gasket.

Important—If the engine has been operated at sustained high speeds, it is important that it be permitted to idle for several minutes before turning off the ignition. This practice, which permits the valves to cool gradually, not only lengthens the life of the valves but also increases the time which may elapse between valve reconditioning operations.

Engine—Models J20, J25 and J30

The engines used in the J20 and J25 models are of the conventional L head design and, with the exception of the diameter of the cylinder bores, have the same general specifications. The engine used in the J30 model is also of similar design but is of heavier construction.

Cylinder Block—The cylinder block and crankcase are cast in one piece with the water jacket running the full length of the cylinder bore. This construction provides uniform cooling of the cylinder walls.

Lubrication System—The engine lubrication system is of full pressure type which distributes the oil under pressure to all the principal bearing surfaces. On Models J20 and J25, the oil passages are cast integral in the cylinder block. On Model

J30 oil is distributed to the main bearings by means of oil distributing pipes which are attached to the main bearing caps.

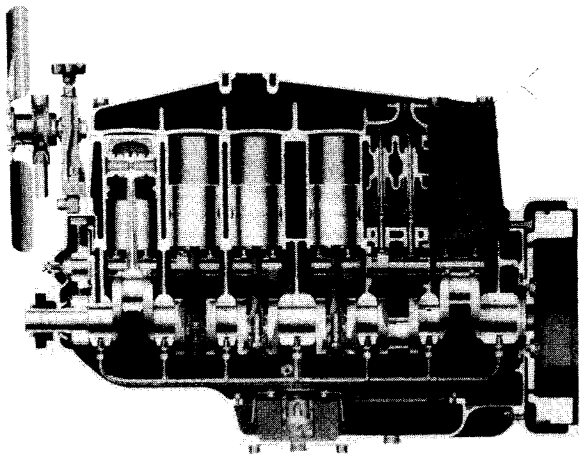


Illustration No. 5—Side Sectional View of J-30 Engine

The lubricating system is entirely automatic and keeps the oil circulating as long as the engine is in operation, with the provision, of course, that the oil supply in the oil pan is maintained and the oil pan screen is clean. The oil pan should be removed and thoroughly cleaned at least twice a year, preferably in the Spring and Fall.

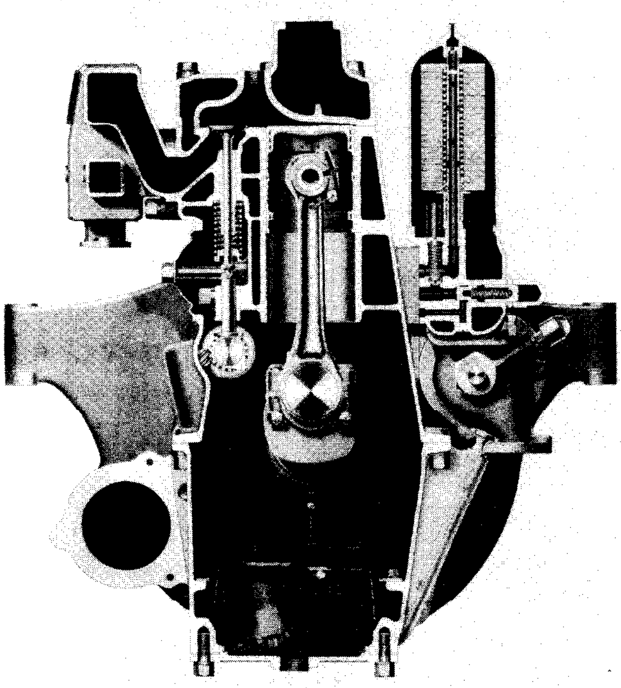


Illustration No. 6—End Sectional View of J-30 Engine

Oil Pump—The oil pump is of the conventional gear type and is bolted directly to the center main bearing web, the suction tube extends directly into a screened compartment in the oil pan. An adjustable oil pressure valve is incorporated in the oil pump on the J20 and J25 models. Should adjustment be necessary, the change is effected by increasing or decreasing the spring compression on the regulating plunger which is located in the cylindrical extension of the oil pump body. In order to change the compression of this spring, it is necessary to loosen the lock nut "A" and turn the cap screw "B" IN for increased pressure and OUT for decreased pressure. (See illustration.) After the adjustment is made the lock nut must be tightened. This adjustment can be made by means of special wrenches without removing the oil pan. The oil pressure relief valve on the J30 model is located on the left front side of the cylinder block and can be regulated as shown in the illustration. The normal oil pressure at maximum engine speed when oil is hot is 35 lbs.

Oil Pan—The oil pan is a sheet metal stamping, with a baffle plate covering the oil pump portion of the oil pan. The holes through the baffle plate which permit the entrance of the oil level gauge and oil pump suction tube, are flared upward in order to prevent dirty oil from the engine running into the strained oil compartment. The large flat

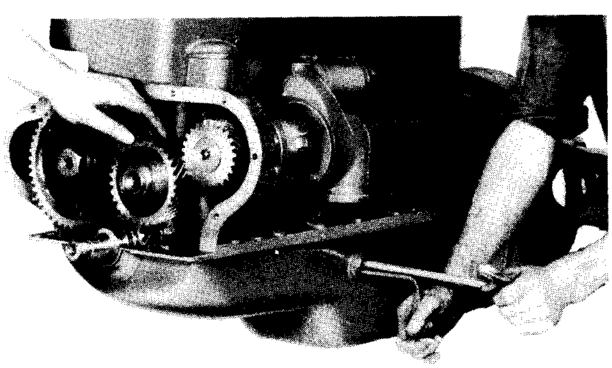


Illustration No. 7—Oil Pressure Adjustment (View A) J-20 & J-25 Models

surface of the baffle permits foreign particles settling out of the oil which flows down through the oil screen and in this manner the oil is strained before it reaches the oil pump. When removing the oil pan, move it forward approximately 1/16" in order to clear the front crankshaft throw.

Oil Filter—The Fram oil filter is used on the J15, J20, and J25 models. This oil filter is the latest development in an engine filtering device, and keeps the engine oil remarkably free from

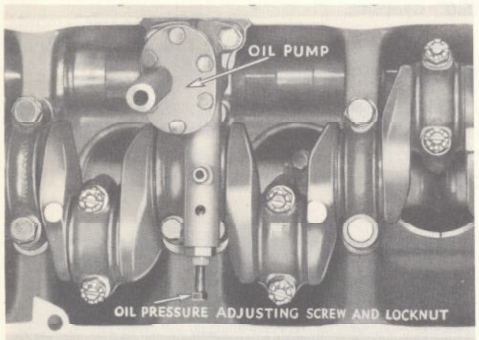


Illustration No. 8—Oil Pressure Adjustment (View B) J-20 & J-25 Models

dust and abrasive particles. The Fram oil filter cartridge is only changed when the oil starts to show discoloration.

The oil filter used on the J30 models is of the series type, through which the oil passes before entering the circulating system. The function of this filter is, to filter any foreign particles, such as metallic substances, carbon, etc., from the oil prior to its entrance into the bearings. It will require periodic inspection and cleaning if its efficiency is to be maintained at all times. It should be cleaned every 1,000 miles or every 50 hours of engine operation.

This oil filter may be cleaned by compressed air. To do this, remove the drain plug on the bottom

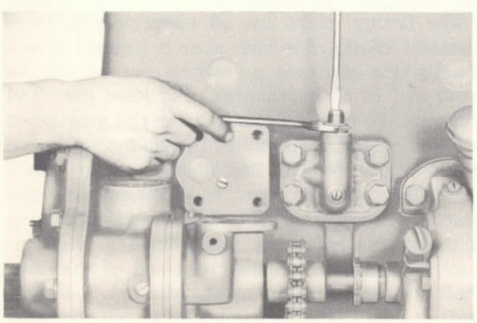


Illustration No. 9—Oil Pressure Adjustment—J-30 Models

of the filter and the small knurled nut on the top of the filter. Place a can or other suitable receptacle under the drain plug and force air through the top fitting of the filter. Air should be passed through the filter for a period of at least two minutes to force out all sediment and sludge that has accumulated on the outside of the filter element. After each cleaning, add two quarts of new oil to the crankcase, or as much more as required to bring it to the proper level.

Crankshaft and Main Bearings—The crankshaft is carried by seven main bearings, 2-1/2 inches in diameter in the J20 and J25 models and 2-5/8 inches in diameter in the J30 model.

All main bearings are of the replaceable type with shims under the caps for adjustment purposes. When installing new main bearing shells make certain that they are installed in such a manner that they do not restrict the oil passages. The number of the bearing caps is stamped opposite the camshaft side and the caps should be installed in this manner. The recommended radial clearance of the main bearings is .003″.

Main bearings can be obtained from our Parts and Accessories Division in the standard size and .020″ and .030″ undersize.

Connecting Rod Assemblies—The connecting rods are of I-Beam section and are forged of special alloy steel. The bearings are of the removable shell type with shims under the cap for adjustment purposes. Bearing shells are restrained from turning in either the connecting rod or the rod cap by small tongues which are extended from the shells. The tongues fit into a recess provided in the connecting rod and rod cap. When installing new connecting bearing shells, make sure that the oil holes in the connecting rod bearing shell line up with the oil escape hole in the connecting rod which provides lubrication to the cylinder walls and pistons. The connecting rod and rod cap bearing shells are identical, and can be obtained in standard size and .020″ and .030″ undersize.

At the time of manufacture, each connecting rod is subjected to a bending test by placing the rod between two supports and applying a heavy load at the center. An indicator is used to reveal the amount of the deflection and if the deflection is excessive, or if the rod does not spring back to its original position after the load is removed, it is rejected. This test detects invisible flaws instantly and thus no rod forging is used in production that is not thoroughly sound and up to physical strength requirements.

The recommended radial clearance of the connecting rod bearings is from .0015" to .0035" on models J20 and J25, on model J30 it is .002" to .004", the side play of the bearing on the connecting rod journal is .005" minimum.

Connecting rod alignment is of prime importance and in order to insure a connecting rod remaining in its aligned position, it is always well to tap it lightly with a hammer while it is being subjected to the bending stress during the alignment operation.

The piston pin is clamped rigidly in the upper end of the connecting rod by means of a clamp screw which passes through a notch in the pin. This method of clamping the pin eliminates the possibility of the cylinder becoming scored because of the piston pin floating against the side of the cylinder.

Piston Assemblies—The pistons are of aluminum alloy, heat treated and cam ground to a slight taper. They are initially fitted with a clearance of .003" to .0035", in the J20 and J25 models and .0035" to .004" in the J30 model. This clearance is determined by inserting the piston in the cylinder in an inverted position and placing a feeler gauge of the proper thickness, one-half inch wide, between the cylinder wall and the pressure side of the piston (side opposite skirt slot). The specified clearance is obtained when a pull of from 8 to 12 lbs., as measured by a spring scale attached to the feeler gauge, is required for the removal of the gauge while the piston is being held stationary. Pistons and pin assemblies can be obtained from our Parts and Accessories Division in standard size, also .005", .010", .020" and .030" oversize.

It is always well, before fitting a new piston, to determine the condition of the cylinder bore with reference to taper and eccentricity. If either condition is prevalent in excess of .002", the cylinders should be rebored and finish-honed to the smallest possible standard oversize and the corresponding oversize piston installed. It is not practical to enlarge the cylinder bore in excess of .050" over the standard size.

The piston pin is 1" in diameter in Models J20 and J25, and in Model J30 1-1/8" in diameter. The recommended piston pin clearance in the pistons is a hand push fit, with the parts at room temperature (70° Fahrenheit).

The pistons are equipped with three compression rings; also one oil ring. All compression rings are 1/8" wide and the oil ring is 3/16" wide. The joint clearance of these rings should range from .015" to .020", preferably .020" on the upper ring. The recommended vertical clearance of these rings in their respective grooves is .0015".

Both the compression and oil control rings can be obtained from our Parts and Accessories Division in the standard size; also .010", .020", and .030" oversize.

The piston and connecting rod as an assembly is removed from the top.

Timing Gears—The timing gears are of the helical-cut type driving the camshaft and water pump on the J20 and J25 models and also the generator on the J30 model. Ordinarily, these gears require no attention, since they are lubricated by the engine lubrication system.

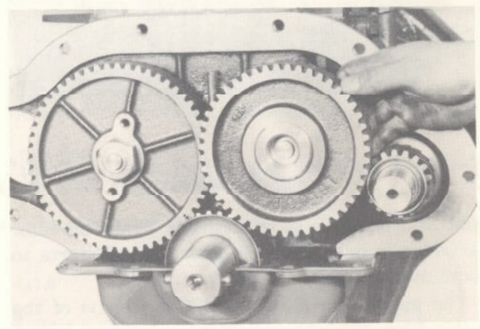


Illustration No. 10—Timing Gear Marking and Removal of Gears

If for any reason the timing gears are to be disturbed, the similar marked teeth on the several gears must be meshed with their mating gears, as indicated in the accompanying illustration.

The timing gears are available in several sizes.

The timing gears are all supported on large diameter shafts. The idler gear is pressed onto a shaft which rotates in a bushing pressed into the front end of the crankcase. The idler gear and shaft can be easily removed after the gear cover is taken off the front end of the engine, as shown in Illustration No. 10. The idler gear shaft has a small flange on the front end, consequently the gear must be pressed off and on over that portion of the shaft which runs in the bushing. The cam gear is pressed on to the front end of the camshaft and is retained by means of a nut. The camshaft and the cam gear can be drawn out the front end of the engine, care being taken to prevent the valve tappets from falling down and interfering with the removal of the shaft. The oil pump must be removed before this operation is attempted.

To Adjust End Play in Cam, Idler and Water Pump Shafts—Illustration Nos. 11 and 12 indicate the method of adjusting the end play in the cam, idler and water pump shafts. When excessive

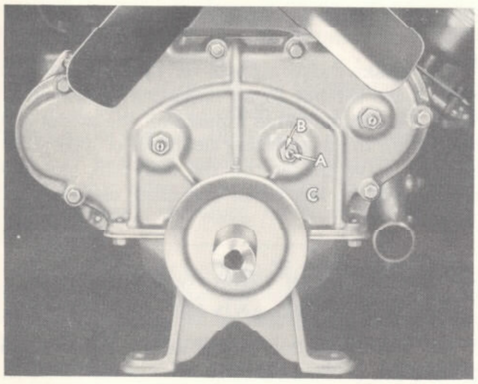


Illustration No. 11—Adjustment of Cam, Idler & Water Pump Shafts—J-20 and J-25 Models

end play is present, a very decided knock, which is more pronounced at idling speeds, will be heard. To eliminate this condition, adjustment is provided as shown. Lock nut "B" should be loosened and held from turning while the adjusting screw "A" is screwed up against the thrust button in the end of the shaft. Care must be taken not to tighten this screw too tight. The thread fit in the gear cover "C" permits the adjustment to be

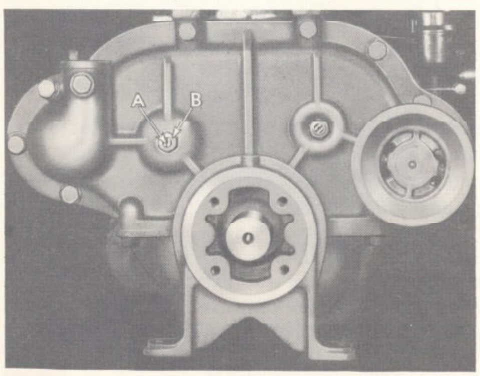


Illustration No. 12—Adjustment of Cam and Idler Gear Shafts J-30 Model

made by means of the fingers. Turn screw "A" up as far as it will go, then back off 1/8 of a turn and hold it from rotating while lock nut "B" is tightened.

If screw "A" cannot be tightened by means of the fingers, turn it up with a short wrench as far as it will go without any great amount of force being used and then back off slightly and tighten lock nut "B".

The adjusting screw is equipped with a hard fiber end which assists in preventing wear between the screw and the hardened plunger in the end of the gear shaft.

Construction at Front End of the Crankcase—The only shaft extending through the gear cover is the crankshaft to which is attached the fan pulley. This construction minimizes the possibility of oil leaks at the front end of the engine. An oil slinger is pressed on the crankshaft directly in front of the crankshaft gear. The oil pan and gear cover are recessed to accommodate the slinger. An oil retainer made of a cork composition is fitted in grooves machined in the oil pan and gear cover and assists in preventing oil leakage at this point.

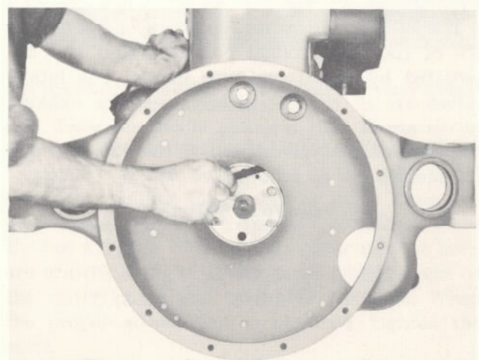


Illustration No. 13—Method of Obtaining Clearance Between Crankshaft Flange and Fly-Wheel Housing

Construction of Rear End of the Crankcase—The rear end of the crankshaft has been especially designed to prevent any excessive oil being thrown or blown out of the crankcase. There are no felt washers used. The centrifugal action of the oil when the engine is running tends to be thrown off the knife edge of the large diameter oil thrower, which is a part of the rear end of the crankshaft. Care must be exercised, however, to insure proper clearance between the crankshaft flange and the fly wheel housing.

Clearance Between Crankshaft Flange and Fly Wheel Housing—At all times it is desirable to maintain a clearance of approximately .015" between the fly wheel housing and the crankshaft flange. This clearance can be checked by means of a feeler gauge as shown in Illustration No. 13. If the flange should rub the fly wheel housing, it may be due to excessive end play in the crankshaft and should be remedied by installing a new rear crankshaft bearing, properly fitted for end clearance, of not over .006".

If for any reason it becomes necessary to remove the fly wheel housing, replace or adjust the main bearings, the clearance between the flywheel housing and the crankshaft flange should be checked. Any contact between the crankshaft and fly wheel housing will result in an oil leak.

After the original position of the crankshaft has been changed and an interference is found between the flange and the housing, the housing can be scraped out slightly or an extra gasket can be used between the housing and the crankcase.

VALVES AND VALVE LIFTERS—MODELS J20, J25 AND J30

The valves used in the J20, J25 and J30 models are of the conventional poppet design and are actuated by mushroom type lifters. The intake valves are of chrome nickel steel. The exhaust valves are of heat resisting silichrome steel. The diameter of the valves used in the J20, J25 and J30 models are as follows:

	Valve Head Diameter	
Model	Inlet	Exhaust
J20	1-3/4"	1-5/8"
J25	1-3/4"	1-5/8"
J30	1-3/4"	1-3/4"

Both the exhaust and intake valve seats are cut to a 45° angle and the seat width should range between 3/32" and 1/8". A 75° cutter should be used for reducing the seat width from the bottom and a 15° cutter for reducing it from the top.

The valve stem diameter is 3/8" and the recommended valve stem to guide clearance is .0025" to .003" for both the intake and the exhaust. The valve guides are of the removable type and the upper end is 15/16" from the top surface of the block.

The intake valve tappets on the J20 and J25 models are set hot to an operating clearance of .008". The intake valve tappets on the model J30 are set hot to an operating clearance of .006". The exhaust valve tappets on the J20, J25, and J30 models are set hot to an operating clearance of .010".

VALVE PUSH RODS—MODELS J20, J25 AND J30

The valve push rod guides in the J20 and J25 models are pressed directly into special webs in the cylinder block. This construction prevents misalignment between push rods and cam shaft, because of both parts being supported in the same casting. To replace the push rods it is necessary to remove the camshaft.

The valve push rods used in the J30 model are of the removable type and operate in demountable guides which are attached to machined surfaces on the cylinder block and are readily removable in banks of six. The valve push rods are lined up with the camshaft and valves by means of round collar dowels which fit into the guides around the cap screw holes.

Cooling System—All Models

Cooling System Thermostat—A thermostat is used in the cooling system of all models to limit the rate of water flow through the cylinder block during the warming up period or during winter operation. When the water in the cylinder block reaches the temperature of efficient engine operation, the thermostat valve opens slightly allowing partial water flow. As the water temperature in the cylinder increases, the thermostat valve opens a corresponding amount and allows additional flow. The thermostat is so designed that when the valve is in its wide open position there is no restriction to water flow. The thermostat action is automatic.

If it is thought that the thermostat is not functioning properly its operation can be checked by removing the thermostat assembly from the engine water outlet fixture. The thermostat valve is set to start to open at 145° to 150° F. This can be checked with an accurate thermometer and a pan of water warmed to the proper temperature. If the start to open temperature is more than two or three degrees above or below the established setting, the thermostat should be replaced.

No attempt should be made to change the setting of the thermostat in service. It is not necessary to check the temperature at which the valve is wide open as this will automatically be satisfactory, if the start to open setting is correct.

When installing a thermostat, the end carrying the thermostatic metal coil must be installed downward in engine water outlet. An error in this respect will render the thermostat inoperative.

When the cooling system has been drained, as for engine work or for the installation of anti-freeze, and the engine is cold, the thermostat valve is closed. Although the thermostat valve is provided with a hole which acts as a vent when refilling the system, the hole is necessarily very small to insure a minimum circulation through the radiator when the thermostat valve is closed. It is necessary, therefore, to fill the cooling system slowly.

If an attempt is made to fill the cooling system too rapidly, the upper radiator tank will fill and a gurgling sound will be heard as the air escapes through the thermostat vent hole. In this case it will be necessary to continue to add fluid until the gurgling noise stops—indicating that all air has escaped. The engine should then be started and operated until the thermostat is open. If necessary, add sufficient fluid to bring the level in the radiator between two and three inches from the top of the filler pipe.

COOLING SYSTEM—J15 MODEL

Water Manifold—The water manifold on the J15 model extends from the water pump through

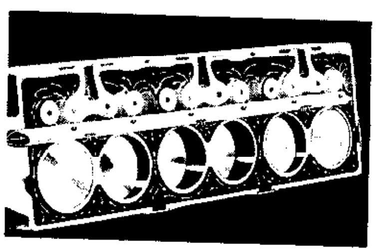


Illustration No. 14—Water Distributor J-15 Models

the engine block. Its purpose is to regulate the circulation of water around the valve seats and the cylinder walls. This water manifold requires no service attention and, ordinarily, there will be no occasion to remove it.

Fan Belt Adjustment—Duo V-type fan belts drive the generator, water pump and fan. To adjust the belts, loosen the bolts which pass through the slotted bracket at the front of the generator, also two bolts in the bottom of the generator

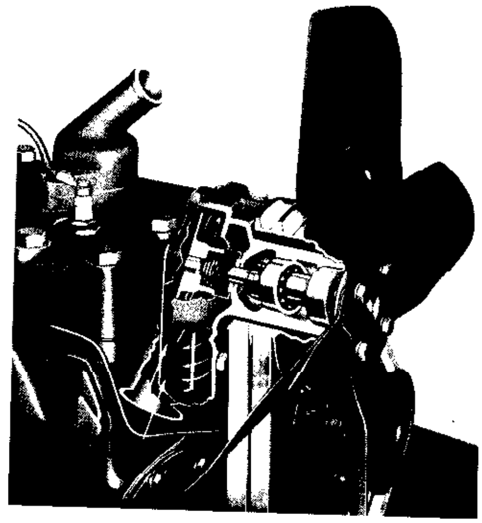


Illustration No. 15—Cut-A-Way View of Water Pump J-15 Models

which serve as hinges. After these bolts have been loosened, a proper adjustment of the belts is obtained by pulling the generator away from the engine to a point where it is just possible to move the fan with the belts held stationary. If the belts are drawn too tight, it will cause undue stress on the water pump and generator bearings. When the proper adjustment is obtained, tighten the bolts.

Fan belts should be installed in matched pairs only. If other than a matched pair of fan belts is installed, it is possible that after a short time one of the belts will be carrying all the load, because of the fact that the belts did not stretch an equal amount.

Water Pump—The water pump and cooling fan assembly as shown in Illustration No. 15 is of such design that the two annular ball bearings in the pump housing take both the fan and water pump thrust in addition to the fan belt radial load. The pump impeller is driven from the hub through the medium of a flange which is integral with the pump shaft. The fan pulley and fan blades are anchored to the flange by means of cap screws. The pump impeller is a tight press fit on the rear-end of the shaft.

The water pump is of the "glandless" type and requires no packing. The annular ball bearings re-

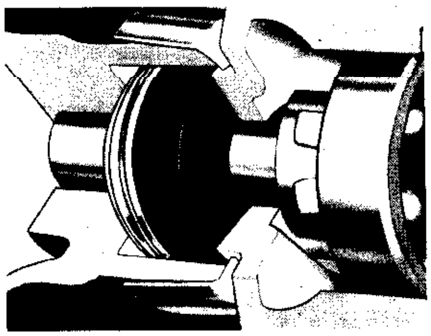


Illustration No. 16—Details of Water Pump Seal J-15 Models

quire no adjustment. The pump is prepacked with lubricant and under normal operating conditions should not require additional lubricant.

To disassemble the water pump and fan assembly, the unit should be removed from the engine. Remove the fan blade assembly attaching screws from the driving flange. Remove the water pump impeller using HM-925 puller (Described in our Service Tool and Equipment Catalog). Remove the seal retaining cup (See Illustration). Remove the carbon seal. Remove the seal clamp ring, flexible seal and spring. Remove the retaining snap wire. Pump shaft with bearings can now be readily removed from the front end of the water pump housing. Remove the bearing lock nut, first turning back the lock washer. Remove the rear bearing, bearing spacer and front bearing. To assemble, reverse the above procedure.

Draining the Cooling System—To drain the cooling system for the performance of any ordinary service operation, it is only necessary to open the drain valve located in the bottom of the radiator lower tank at the right side. If the cooling system is to be completely drained to prevent damage due to freezing temperatures, be sure to open the cylinder block drain cock located at the lower left rear side of the cylinder block. Failure to open the cylinder block drain cock may result in freezing and consequent breakage of the cylinder block.

COOLING SYSTEM—MODELS J20, J25 AND J30

The water pump on the J20 and J25 engine is mounted on the left front of the engine block and is driven by a direct connection with the timing gears.

The water pump and drive mechanism is readily removed from the engine without disturbing the cover, as shown in Illustration No. 17. It is only necessary to disconnect the water pump hose connections and remove the three cap screws holding the sleeve and water pump cover to the crankcase. The gear and shaft can be removed from this assembly after the water pump body and impeller have been removed from the shaft. Be sure and remove the water pump impeller key otherwise, the packing retainer and packing will be damaged when the shaft is pulled out through the front end of the housing. The water pump gear is removed and reassembled over the small end of the shaft.

The water pump shaft is supported on two bushings, a large diameter bushing just to the rear of the water pump gear and a small diameter bushing at the extreme rear of the pump body. The front bushing is lubricated by means of a grease cup on the water pump housing. Kassons water pump grease or any other good tallow base lubricant should be used. This grease cup should be turned in one-half turn each day.

Water Pump Packing Adjustment—Due to the length of packing used in the water pump but little pressure is required on the adjustment nut. This should never be tightened with any considerable force. If an ordinary adjustment does not correct the water leak, check the condition of the packing and shaft.

Water Pump J30 Model—To remove the water

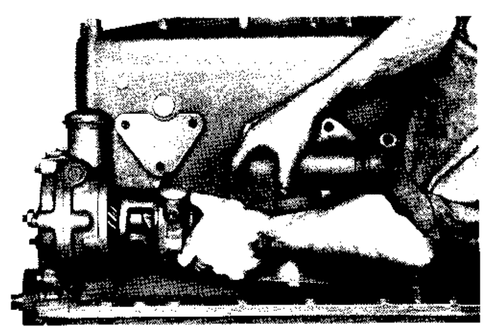


Illustration No. 17—Removing Water Pump Assembly J-20 and J-25 Models

pump on J30 models, remove the three water pump to cylinder block attaching screws and the water inlet hose elbow, then remove the master link from the water pump coupling sprocket chain. The water pump then can be lifted clear. The disassembly of this pump is the same as on Models J20 and J25.

Draining Cooling System—To drain the cooling system for the performance of any ordinary service operation, it is only necessary to open the drain cock located in the bottom of the water pump elbow. However, if the cooling system is to be com-

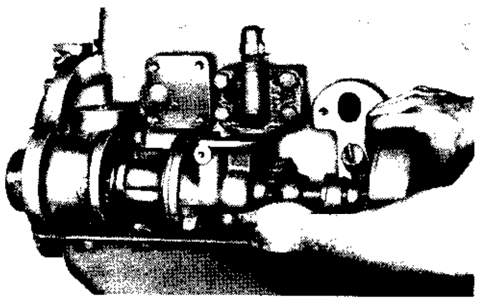


Illustration No. 18—Removing Water Pump Assembly J-30 Models

pletely drained on models J20 and J25 as a protection against freezing temperature or for storage, the drain cock located on the extreme left hand side of the engine cylinder block must be opened. The opening of the water pump drain cock alone will not completely drain the cylinder block and if it is to be protected against freezing temperatures, it must be completely drained. The cooling system on Model J30 is completely drained by opening the drain cock in the bottom of the water pump elbow.

ALL MODELS

In order to maintain the cooling system free from rust accumulation, it is recommended that a cooling system inhibitor be used at all times. Eveready Rustone is available at all Studebaker dealers for this purpose. It is a soluble oil which creates a film over all exposed surfaces of the cooling system and thus retards, to a very pronounced extent, the accumulation of rust. Further, this type of inhibitor also tends to neutralize acids that may be present in the cooling system and thus reduce their harmful effect. One quart of Everyready Rustone should be placed in the cooling system at the time of preparing the truck for delivery, and unless the system is drained and again refilled, it will not be necessary to add Rustone except at six month intervals. Every six months, however, the system should be thoroughly drained and flushed and new Rustone installed.

With the advent of freezing weather, the water in the cooling system should be replaced with an anti-freeze mixture, however, a solution containing corrosive chemicals must not be used, due to their detrimental effect upon the system. Eveready Prestone, G. P. A. glycerine, distilled glycerine or denatured alcohol, have been found to be satisfactory and are quite readily obtainable.

If alcohol or distilled glycerine are used, it will be advisable to use the Eveready Rustone mentioned above. An inhibitor is already incorporated in the Eveready Prestone and the G. P. A. glycerine. With the use of alcohol, it is also necessary that care should be taken to prevent spilling any of the solution on the lacquered surfaces as alcohol may cause flaking or spotting of the finish. With the Eveready Prestone or G. P. A. glycerine solutions there will be no loss due to evaporation, but it is especially important that all hose connections, cooling system gaskets, etc. be kept tight as these solutions may leak where water will not.

The following tables indicate the correct mixtures of the several anti-freeze solutions for J15, J20, J25 and J30 models for various temperatures:

MODEL J15

CAPACITY 16 U. S. QTS., 13.3 IMP. QTS., 15.14 LITERS

Quantity of Anti Freeze Required for Protection to:

Anti-Freeze	Fahrenheit / Centigrade	20 / −6,6	−10 / −12,2	0 / −17,8	−10 / −23,3	−20 / −28,8	−30 / −34,4	−40 / −40	−50 / −45,5
Eveready Prestone	U. S. Qts.	3	4.5	5.5	7	8	8.5	9.5	10.5
	Imp. Qts.	2.5	3.75	4.58	5.85	6.65	7.1	7.9	8.75
	Liters	3	4,5	5	6	7,5	8	9	10
G. P. A. Radiator Glycerine	U. S. Qts.	6	9	11	13	15			
	Imp. Qts.	5	7.5	9.15	10.8	12.5	14.11		
	Liters	5,5	8,5	10,5	12,5	14	16		
Denatured Alcohol	U. S. Qts.	3.5	5	6	7.5	8.5	9.5	10.5	11.5
	Imp. Qts.	2.81	4.14	5	6.25	7.1	7.9	8.75	9.6
	Liters	3,5	5	6	7	8	9	10	11
Distilled Glycerine	U. S. Qts.	4	5.5	7	8	9.5	10.5	12	13
	Imp. Qts.	3.38	4.58	5.85	6.65	7.9	8.75	10	10.8
	Liters	4	4,5	6,5	7,5	9	10	11,5	12,5

MODELS J20 AND J25

CAPACITY 21 U. S. QTS.. 17.4 IMP. QTS.. 20.1 LITERS

Quantity of Anti-Freeze Required for Protection to:

Anti-Freeze	Fahrenheit / Centigrade	−20 / −6,6	−10 / −12,2	0 / −17,8	−10 / −17,8	−20 / −28,8	−30 / −34,4	−40 / −40	−50 / −45,5
Eveready Prestone	U. S. Qts.	3.5	5	7	8	9	10	11	11.5
	Imp. Qts.	2.9	4.14	5.85	6.65	7.5	8.35	9.6	9.6
	Liters	3,5	5	6,5	7,5	8,5	9,5	11	11,5
G. P. A. Radiator Glycerine	U. S. Qts.	7	10	13	15.5	18	21		
	Imp. Qts.	5.85	8.35	10.8	12.36	14.9	17.5		
	Liters	6,5	9,5	12,5	14,8	17	20		
Denatured Alcohol	U. S. Qts.	4	6	7.5	9	10	11	12	13
	Imp. Qts.	3.38	5	6.25	7.5	8.35	9.6	10	10.8
	Liters	4	6	7	8,5	9,5	11	11,5	12,5
Distilled Glycerine	U. S. Qts.	4.5	6.5	8	9.5	11	12	13	14
	Imp. Qts.	3.75	5.4	6.65	7.9	9.6	10	10.8	11.65
	Liters	4,5	6	7,5	9	11	11,5	12,5	13,5

MODEL J30

CAPACITY 23 U. S. QTS., 19 IMP. QTS., 21,7 LITERS

Quantity of Anti-Freeze Required for Protection to:

Anti-Freeze	Fahrenheit / Centigrade	−20 / −6,6	−10 / −12,2	0 / −17,8	−10 / −23,3	−20 / −28,8	−30 / −34,4	−40 / −40	−50 / −45,5
Eveready Prestone	U. S. Qts.	4	5.5	8	9	10	11	12	12.5
	Imp. Qts.	3.38	4.58	6.65	7.5	8.35	9.15	10	10.4
	Liters	3,78	5,20	7,57	8,52	9,46	10,41	10,36	11,83
Denatured Alcohol	U. S. Qts.	5	7	8	10	11	12	13	14
	Imp. Qts.	4.14	5.85	6.65	8.35	9.15	10	10.8	11.65
	Liters	4,73	6,62	7,57	9,46	10,41	11,36	12,30	13,25
G. P. A. Radiator Glycerine	U. S. Qts.	8	11	14	17	19	22		
	Imp. Qts.	6.65	9.15	11.65	14.18	15.7	18.35		
	Liters	7,57	10,41	13,25	17	18	20,9		
Distilled Glycerine	U. S. Qts.	5.5	7.5	9	10.5	12	13	14	15
	Imp. Qts.	4.58	6.25	7.5	8.75	10	10.8	11.65	12.5
	Liters	5,20	7,09	8,52	9,93	11,36	12,30	13,25	14,20

Carburetors

Carburetor—J15, J20 and J25 Models — The Carter IN-1 carburetor furnished on the above models is of the down draft type, shown in Illustration Nos. 19 and 20. Except for the usual low

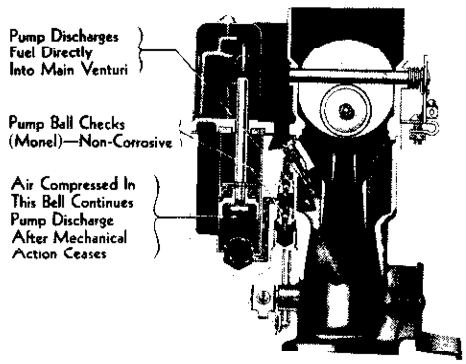


Illustration No. 19—Sectional View (A) of Carburetor J-15, J-20 and J-25 Models

speed or idling adjustment and the summer and winter acceleration pump setting, the carburetor is non-adjustable and service is ordinarily limited to regular lubrication. Details covering the operation and service requirements of the unit are included in the following paragraphs.

Lubrication—At intervals of not more than 2000 miles the retaining screw located in the top of the accelerating pump dust cover assembly (Illustration No. 19) should be removed and a few drops of light oil placed in the screw hole. This provides lubrication for the accelerating pump countershaft. Light engine oil should also be applied to the exposed ends of the throttle and choke shafts.

Float Level—In order to check the float setting, it is necessary to remove the float chamber cover assembly and, with the assembly held in an inverted position, remove the cork gasket and measure from the machined surface of the float cover casting to the lower surface of the free end of the float. This measurement should be 3/8 of an inch on Model J15, and 5/8 of an inch on Models J20 and J25, with the needle valve properly seated. (A 3/8" or 5/8" drill can be used for making this check.)

Any necessary correction can be made by removing the float lever pin and carefully bending the small tongue in the float lever arm which contacts the needle valve.

Accelerating Pump—The accelerating pump is of the plunger type, which discharges the additional supply of fuel necessary for quick acceleration, past a ball check, directly into the main venturi.

The pump is mechanically operated, through linkage, by the throttle and is adjustable for high or low temperatures.

Three positions are provided on the accelerating pump lever to give greater or lesser discharge of fuel depending on climatic conditions. The top hole in the pump arm for the pump link is the long stroke, the bottom hole is the medium stroke, and the hole nearest the pump arm shaft is the short stroke.

For winter or cold weather operation, the linkage should be adjusted to provide the longer stroke of the accelerating pump (the upper hole in the operating arm), for the J15 and the medium stroke for the J20 and J25 models. For summer or hot weather, the linkage should be adjusted to provide the medium stroke of the pump (the lower hole in the operating arm), for the J15 mod-

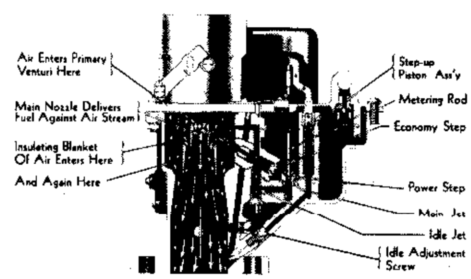


Illustration No. 20—Sectional View (B) of Carburetor J-15, J-20 and J-25 Models

el, and shortest stroke for the J20 and J25 models. If the operating efficiency and fuel economy is to be maintained, it is important that this adjustment be made to conform to prevailing temperature conditions.

If, as for cleaning, the accelerating pump plunger is removed from the cylinder a loading tool or sleeve should be used when reassembling it to avoid damage to the plunger leather.

Main Fuel Supply Jet—The metering orifice of this jet is calibrated at the factory to supply the proper amount of fuel at the intermediate and high speeds. The additional supply of fuel required for higher speeds is controlled by means of a metering rod. Rods on the J15, J20 and J25 only—main jets are specified for the J30 model.

Having two steps. The position of the metering rod in the jet is controlled by the manifold vacuum. Under part throttle the suction (or vacuum) on the manifold side of the throttle is higher than when the throttle is wide open. This suction holds down the vacuum economizer piston which holds the large part of the metering rod in the metering rod jet.

When the throttle is opened the suction decreases, permitting the vacuum economizer piston to be moved upward by its spring which raises the metering rod so that the smaller portion of the rod is in the jet permitting the maximum amount of fuel to pass through the jet for full power.

Optional Main Jet Metering Rods—To provide the proper amount of fuel for the various altitudes at which the truck may be operated, optional main jet metering rods are available and can be easily installed. The identifying number of each rod is stamped plainly on the rod as follows:

Part No.	Carter No.	FOR THE J15 MODEL:
643976	75-223	For altitudes from sea level to 4000 feet.
643977	75-234	For altitudes from 4000 feet to 8000 feet.
643978	75-235	For altitudes above 8000 feet.

Part No.	Carter No.	FOR THE J20 MODEL:
643980	75-218	For altitudes from sea level to 4000 feet.
643981	75-232	For altitudes from 4000 feet to 8000 feet.
643982	75-233	For altitudes above 8000 feet.

Part No.	Carter No.	FOR THE J25 MODEL:
643984	75-229	For altitudes from sea level to 4000 feet.
643985	75-230	For altitudes from 4000 feet to 8000 feet.
643986	75-231	For altitudes above 8000 feet.

Where economy is the most important consideration and a loss in performance is acceptable, the next higher altitude metering rod than specified can be installed.

Low Speed or Idling Adjustment—If it becomes necessary to adjust the engine idling speed, the engine should be slowed gradually until a minimum steady idle speed is attained. The idling adjustment (see Illustration No. 20), should then be turned to the right or left until the engine is operating smoothly at the fastest speed for that particular throttle opening. Turning the screw out provides a richer mixture and in, a leaner one. Ordinarily the proper adjustment will be obtained with the idling screw from one-half to one and one-quarter open (out). The engine idle should not be set at a slower speed than six miles per hour.

When Installing Gaskets—In order to avoid internal leakage of gasoline around the float needle seat gasket and the metering rod jet gasket, when servicing the carburetor, it is important that these gaskets be soaked in warm water for fifteen minutes before using.

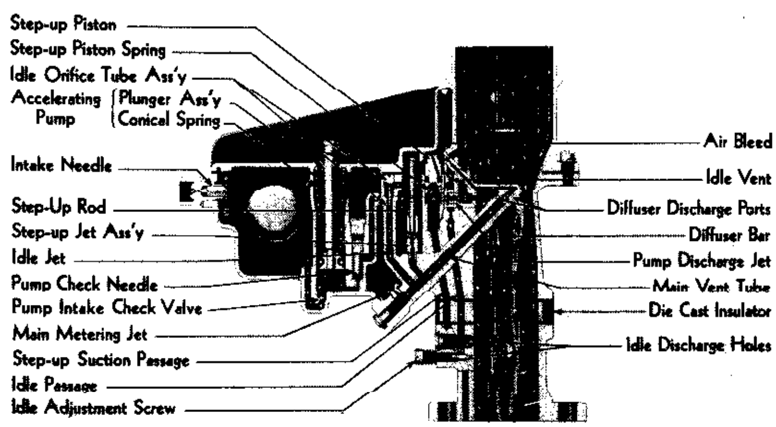


Illustration No. 21—Sectional View of Carburetor—J-30 Model

Carburetor—J30 Model—The Carter BBR2 carburetor furnished on the J30 truck engine is of the plain tube, down draft type with fixed jets which cover all speed ranges except the idle range, which is controlled by an adjusting needle. The carburetor is equipped with an accelerating pump which is adjustable for summer and winter conditions. Details covering the operation and service requirements of the unit are included in the following paragraphs.

Float Level—In order to check the float setting, it is necessary to remove the float chamber cover which includes the air horn and the cover gasket. Before adjusting float, be sure the float lever pin retainer is firmly seated. Adjust float level by bending lip of float away from needle to raise float, or bend lip toward needle to lower float level. Bend vertical lip of float only. The correct setting is when the top of the float is 5/64" down from the edge of the casting when the float lip is firmly against the needle.

Accelerator Pump—The accelerator pump is of the plunger type, which discharges the additional supply of fuel necessary for quick acceleration, past a needle check, directly into the main venturi. The pump is mechanically operated, through linkage, by the throttle and is adjustable for high or low temperatures.

Three positions are provided on the accelerator pump lever, in order to give greater or lesser discharge of fuel, depending upon climatic conditions. The hole farthest from the shaft is the long stroke, the intermediate hole is the medium stroke, and the hole nearest the shaft is the short stroke.

For winter or cold weather operation, the linkage should be adjusted to provide the long stroke. For summer or hot weather the linkage should be adjusted to provide the medium stroke.

Main Fuel Supply Jets—This carburetor has two jets, one of which meters the fuel for part throttle economy operation and one which meters the additional fuel necessary for full power. The power jet is opened and closed by a needle which is operated by a piston. The piston is controlled by the manifold vacuum and a spring.

Under part throttle the suction (or vacuum) on the manifold side of the throttle is higher than when the throttle is wide open. This suction holds down the step-up piston which holds down the step-up rod in the step-up jet shutting off the flow of fuel. When the throttle is opened the suction decreases, permitting the step-up piston to be moved upward by its spring, which raises the step-up rod and opens the step-up jet.

Optional Main Jets—To provide the proper amount of fuel for the various altitudes at which the truck may be operated, optional main jets are available and can be easily installed. The identifying number is stamped plainly on each jet, as follows:

Part No.	Carter No.	
644257	159-76S	For altitudes from sea level to 4000 feet.
644258	159-58S	For altitudes from 4000 feet to 8000 feet.
648259	159-66S	For altitudes above 8000 feet.

Where economy is most important and a loss in performance is acceptable, the next higher altitude main jet than specified can be installed.

Low Speed or Idling Adjustment—See J15, J20 and J25, using 1/4 to 1 turn open on screw.

FUEL PUMP

The fuel pump draws fuel from the gasoline tank and delivers it to the carburetor, as required, at a predetermined pressure under all operating conditions. In the event that the fuel supply in the gasoline tank is exhausted, the fuel pump will require no priming when the supply is replenished, as a few strokes of the pump at cranking speed will draw fuel from the tank to the carburetor.

Fuel Pumps—All Models—The following description, together with reference to Illustration No. 22 will provide a working knowledge of the construction and operation of the fuel pump.

The eccentric on the camshaft actuates the fuel pump rocker arm. The rocker arm pulls the link and the diaphragm assembly downward against the diaphragm spring pressure which in turn causes a vacuum in the pump chamber. On the suction stroke of the pump, fuel from the gasoline tank enters the sediment chamber and passes through the strainer and inlet valve and into the pump chamber. On the return stroke, the spring pressure pushes the diaphragm assembly upward and forces fuel from the fuel chamber through the outlet valve and into the carburetor. When the carburetor bowl is filled, the float in the carburetor will close the carburetor float valve, thus creating a pressure in the fuel pump chamber. This pressure holds the diaphragm assembly downward against the spring pressure where it will remain inoperative in a downward position until the carburetor requires additional fuel. The rocker arm return spring is merely for the purpose of keeping the rocker arm in constant contact with the camshaft eccentric.

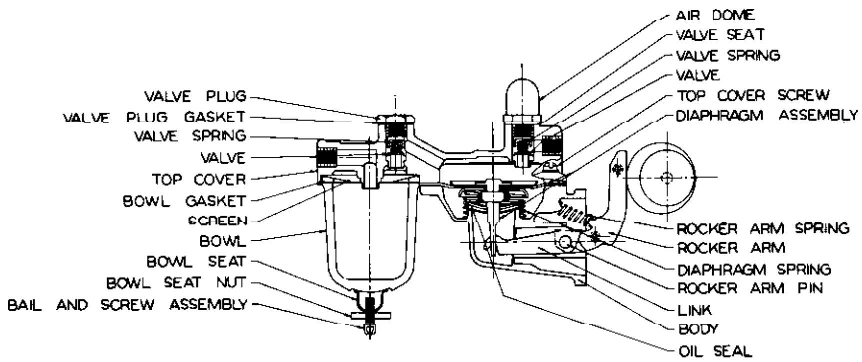


Illustration No. 22—Fuel Pump—All Models

Fuel Pump Troubles—Causes and Remedies— In many instances difficulty is attributed to the Fuel Pump which in reality is caused by other conditions. The most common of these, undoubtedly, is the carburetor and it is suggested in every case where there is evidence of a lack of fuel or an excessive amount of fuel in the carburetor, that the carburetor be checked carefully to see that the float and needle valve are functioning properly.

A simple test of fuel pump operation can be made by disconnecting the pipe connecting the fuel pump and carburetor, and by cranking the engine with the starter. Even at cranking speed, a considerable amount of fuel will be pumped out of the fuel pump outlet if the pump is operating. By holding the finger over the outlet, while the engine is cranking, a rough check also can be made of the condition of the valves and diaphragm by noting the amount of pressure built up in the pump.

Condition	Remedy
1. Glass bowl loose.	Tighten the retaining nut, making certain that the cork gasket lies flat on its seat and is not broken.
2. Dirty screen.	Remove the glass bowl and clean the screen, making certain that the cork gasket is cleaned and is in good condition and properly seated when reassembling the bowl in position.
3. Loose valve plug.	Tighten the valve plug securely, if necessary replacing the valve plug gasket.
4. Broken rocker arm.	Replace the rocker arm.
5. Broken rocker arm spring.	Replace the spring.
6. Broken rocker arm retaining spring.	Replace the spring.
7. Punctured or badly worn diaphragm.	Replace the complete diaphragm. Do not attempt to replace just one or two layers.
8. Sticking valves	Remove the valve plug and wash the valves in gasoline. Examine the valve and valve seat to make certain that there are no irregularities to prevent the valve from opening or closing properly. Replace the valves if worn or warped. Reassemble the valve, using a new gasket under the valve plug.
9. Loose valve seat.	Replace the top cover and valve seat assembly.
10. Fuel leakage around pull rod indicated by dripping through vent hole.	Replace the pull rod gasket, reassemble the diaphragm and washers and securely tighten the pull rod nut.
11. Leakage at diaphragm flange.	Tighten the cover screws alternately and securely. Also check the inlet and outlet pipe connections.

CARBURETOR AIR CLEANER

A wet type carburetor air cleaner is used on all models as standard equipment. This cleaner (Illustration No. 23) is of the one pint oil capacity type and will provide ample protection for average city and highway operating conditions. However, to provide suitable protection for trucks operating in dusty areas, and as optional equipment, a cleaner similar to the above, except that it has a one quart oil capacity, should be used.

Dust is highly abrasive and will cause rapid wear if permitted to enter the engine. Proper servicing of the air cleaner is very important and should be given regular and periodic inspection according to the type of operation in which the truck is being used.

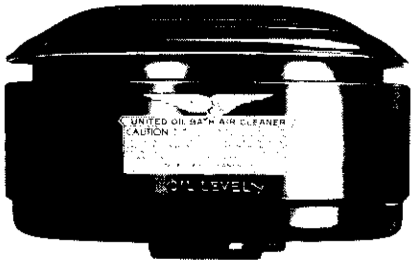


Illustration No. 23—Oil Bath Type Air Cleaner (Standard Equipment) J-15, J-20, J-25 and J-30 Models

Directions for servicing the wet type cleaner are stamped on the side of each cleaner. The oil reservoir should be cleaned and filled to the level indicated with S.A.E. 50 engine oil in summer and S.A.E. 30 in winter.

Heavy Duty Carburetor Air Cleaner—For J20, J25 and J30 Models—As shown in the accompanying Illustration No. 24, a special heavy duty air cleaner is available, as optional equipment, which should be installed on trucks subjected to unusual dust conditions.

In operation, the oil washes the dirt out of the air, this dirt is deposited in the cup. When an engine is operated steadily under very severe dust conditions, such as excavating or dusty roads, it may be necessary to clean the cup and refill with fresh oil twice a day. Under average conditions the cup will only need to be cleaned and refilled at 1,000 mile intervals. Directions for servicing are stamped on the cleaner.

We urge that dealers residing in the following states make every possible effort to induce operators and purchasers of new trucks to equip them with suitable carburetor air cleaners to take care of the dust conditions under which the trucks will operate. While we believe that either of the wet type cleaners previously mentioned are particularly important for states appearing in the bold face type, trucks operating in certain sections of states appearing in light face type should also be equipped with special cleaners. There may be certain sections of other states not listed where the dust conditions are severe and, if so, one of the special cleaners should be installed.

Alabama	**Louisiana**	**Oklahoma**
Arizona	Minnesota	Oregon
Arkansas	**Mississippi**	**South Dakota**
California	Missouri	**Texas**
Colorado	**Montana**	**Utah**
Georgia	**Nebraska**	Washington
Idaho	**Nevada**	Wisconsin
Iowa	**New Mexico**	**Wyoming**
Kansas	**North Dakota**	

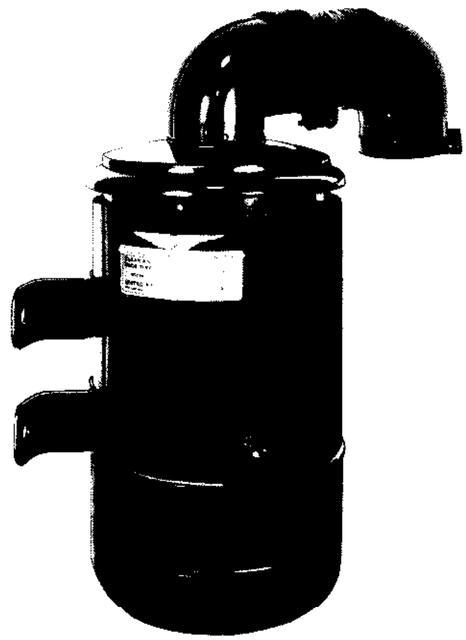


Illustration No. 24—Heavy Duty Oil Bath Air Cleaner (Optional Equipment)

Electrical System—All Models

Generator—The generators furnished as standard on all models are of the third brush regulated type. Moving the third brush in the direction of the armature rotation increases the charging rate, while moving it against armature rotation decreases the charging rate. The third brush is held in place by spring tension friction, and these adjustments are easily made.

The generator is designed for an approximate output of 20 amperes cold, on the J15 model and 22 amperes cold on the J20, J25 and J30 models. The third brush should never be set to produce a higher charging rate. The generator output will drop slightly as the unit warms from operation. An accurate ammeter and voltmeter should be used to check the generator performance whenever an adjustment in output is to be made. Due to the ammeter in the instrument panel being small and subjected to considerable vibration, it should not be used as a final check of generator output.

To assist in the protection of the generator against burning out, if operated with an open circuit or at too high a generator charging rate, a 7 1/2 ampere fuse is used in the generator field circuit. The circuit fuse on the J15 model is contained under a metal cover at the upper rearward end of the generator.

Relay Model J15—The function of the reverse current cut-out relay is to open and close the circuit between the generator and battery. As the generator terminal voltage increases and exceeds the battery terminal voltage, the relay points close. When the engine is stopped or running at idling speed, the relay points open.

Adjustment—The relay points close at 6.6-6.8 volts and open at 0-3 amperes reverse current. The air gap between the armature and core of the cut-out relay should be .010" to .030" when the contact points are closed. The contact point opening should be .015"-.045".

Voltage Regulator—The generators used on the Models J20, J25 and J30 are equipped with a voltage regulator.

The voltage control unit consists of a double core, each core wound with a large number of turns of wire, and both being connected in parallel between the battery connection of the control unit and ground. They are thus energized in proportion to the voltage applied to the battery.

When the generator first starts charging, the voltage control relay points are closed. When the battery becomes fully charged and the generator terminal voltage reaches a predetermined high value, the contact points open; thereby, automatically inserting into the field circuit a resistance which decreases the genertor charging rate. When the voltage has decreased to a predetermined low value, the contact points close and the generator will again supply more energy to the battery. This unit prevents the generator charging rate from becoming abnormally high after the battery has reached a fully charged condition.

Adjustment—Remove the generator control unit from the car and check it on a test bench. The following procedure may be used when adjusting the voltage control relay:

1. Hold the armature down against the lower armature stop and set the air gap at .038". The spring tension, measured at the contacts, should be approximately 3/4 ounce.
2. Release the armature and gauge the travel between the armature and the lower armature stop at .028". This travel is obtained by bending the upper armature stop backward or forward, as required.
3. With the armature in the extreme downward position, again the contact opening should be between .008" and .013".
4. Connect an accurate voltmeter to the terminal marked "BAT" and to the ground.
5. Run the generator until the regulator box has reached a very warm temperature. Control relay points should open at 8.3 volts. Increase or decrease the opening voltage by increasing or decreasing the armature spring tension.
6. Control relay points should close at 7.2 volts. The closing voltage is increased by increasing the armature air gap and decreased by decreasing the air gap. It is only necessary to bend the lower armature stop slightly to obtain this closing voltage adjustment.

NOTE: When checking the opening and closing voltages, cycle the regulator before arriving at the true reading. The cover must be in place when checking the readings. Do not overrun the voltages reached at each point. Insert a small resistance into the charging circuit if the voltages cannot be reached.

7. If the air gap is altered considerably to obtain the correct closing voltage, it will probably be necessary to bend the upper armature stop to allow for any large change. In the event this adjustment is changed, the contact point opening should again be checked within the limits specified.

Compensation—This control unit is over-compensated for temperature change; therefore, the hot opening and closing voltages will be lower than the cold opening and closing voltages.

Resistance in Charging Circuit—Even with a fully charged battery it may be difficult to obtain a voltage setting within the specified limits unless a small resistance is connected in the charging circuit. A variable resistance of sufficient current carrying capacity that will make it possible to obtain approximately .25 ohms resistance can be used to increase the voltage. The lowest possible resistance to obtain voltage should be used to prevent vibrating of contacts.

Cycling the Regulator—To cycle the regulator, increase the speed of the generator until the voltage is reached at which the points just open, then decrease the speed until the points just close. After making this cycle, obtain true readings at the very instant the points open and close. The fact must be kept in mind that the regulator unit will not permit the generator to charge at the high peak rate unless the battery is low.

Important—Charging circuit conditions, such as poor grounds, loose connections, corroded terminals, as well as the voltage of the battery affect the operation of the generator. It is recommended that the adjustment referred to should only be made by one having proper testing equipment and the necessary knowledge to test, check and adjust the conditions under which the generator is operating.

High Output Generators—Many tractor-trailer outfits are required to carry an exceptionally heavy electrical load because of the number of lights used, as well as other electrically operated accessories, which places an unusual load upon the battery generator. To take care of operations of this kind, high output generators of the voltage regulated type are available at extra cost.

STARTER MOTOR

When the starter motor is supplied with current its armature revolves at a high rate of speed. The Bendix pinion, on account of its inertia, tends to lag behind the rotation of the shaft and the screw threads draw the pinion into mesh with the flywheel gear. As soon as the engine starts firing, its increased speed of rotation causes the pinion to be driven back in the opposite direction, thus disengaging it from the flywheel.

Commutator and Brushes—The commutator and brushes are designed to run with little attention. The commutator should be cleaned occasionally with No. 00 sandpaper. Never use emery cloth. This ordinarily will not be necessary more than once every year. In case the brushes wear down so that it is advisable to replace them, this work should be performed by one experienced in work of this kind, so that a proper fitting will be obtained.

IGNITION DISTRIBUTOR—MODEL J15

The distributor is of the full automatic type, having 21° automatic advance. There is no manual advance control provided. The distributor is mounted at an angle on the left side at the center of the engine.

The breaker points should be spaced .018" to .020". To space the breaker points, the lock nut on the adjustable point must be loosened, which will permit turning the adjustable point. The bumper block on the breaker arm must be on a high point of the six lobe cam while the correct spacing is being made. The nut should then be

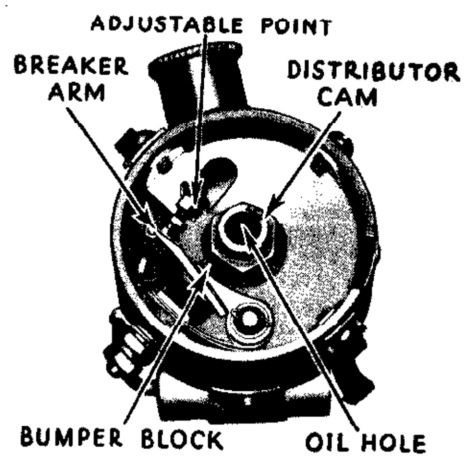


Illustration No. 25—Ignition Distributor—J-15 Models tightened and the point space rechecked to make sure that it has not been changed by the tightening of the lock nut.

The distributor is provided with a vacuum spark modifier, it being connected to the carburetor body at a point directly above the throttle valve. It does not advance the spark at idle engine speed (at closed throttle).

As the throttle is opened, the vacuum at the point of the modifier fitting above the throttle valve, rapidly increases and actuates the modifier, advancing the spark up to 12°.

This modifier advance remains practically constant except when the throttle approaches the fully opened position, as under hard pull or extreme speed operation.

The advantage of the modifier operation lies in the fact that additional spark advance is provided under normal or part load operating conditions. This advance has been found to effect a greater fuel economy.

When the engine is operated at fully opened throttle, the vacuum is reduced and the modifier becomes inoperative, thereby reducing the possibility of spark rattle on hard pulling.

The distributor and oil pump are driven as a unit by the camshaft. The distributor can be removed by removing the distributor cap, disconnecting the primary wire and loosening the bolt in the distributor clamp arm. The distributor drive shaft is so constructed that, if the distributor is removed, it can only be replaced in its original position (in a definite relation to the oil pump drive shaft). Care must be taken, however, to insure that the oil pump has been replaced in its correct position. The spark is timed with the ignition (IGN) mark, which is approximately 9/64" ahead of the U.D.C. 1-6 mark, on the crankshaft vibration damper flywheel directly under the timing pointer on the timing gear cover. In this position the breaker points should just start to open. If not, the distributor clamp arm screw should be loosened and the distributor rotated until the points have just opened. To eliminate the possibility of bind in the spark modifier hook-up, a .016" feeler gauge should be placed between the modifier and distributor control arms before tightening the clamp screw. Then tighten the clamp screw and remove the feeler gauge.

When setting the ignition timing, it is not necessary to lock the spark advance modifier with a pin.

Ignition Coil and Lock—The ignition coil is mounted on the dash and is connected to the ignition lock on the instrument panel by means of a flexible steel conduit into which the ignition wire is placed, on cab-forward models the coil mounts directly on the instrument panel. When the ignition key is in the verical position, the ignition is off and key can be removed. When the key is turned to the right, the ignition is on. The ignition key cannot be removed when it is in either the left or right position.

Ignition Distributor—Models J20, J25 and J30. The distributor is of the full automatic advance type. The cover with the rotating segment forms a rotating switch to conduct the current from the ignition coil at the proper time. The segment fits on the shaft in only one position relative to the

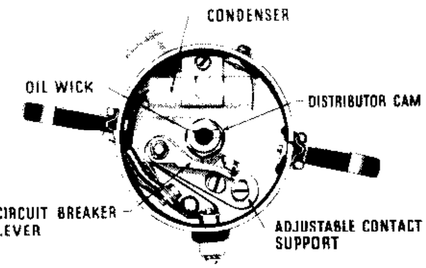


Illustration No. 26—Ignition Distributor J-20 J-25 and J-30 Models

cam, so that it is always opposite the correct terminal in the cover at the instant that the cam separates the breaker points. The distributor rotates in a counter-clockwise direction. A condenser is placed on the distributor and is used to reduce the arcing and resultant burning of the contact points as well as to give a hotter spark at the spark plugs.

Contact Points—If the points have a frosty appearance they are making good contact and should not be touched. If they are not making good contact, the surface should be smoothed with a fine file or special honing equipment.

To adjust the points, crank the engine until the cam on the distributor shaft holds the points at their widest gap and with screw driver loosen the screw, holding the fixed contact plate to the base plate. Turn the adjusting screw in the plate until the gap between the points is from .018" to .020". Turn locking screw down until it is tight and check the gap again to make sure that it is correct. The contact surfaces should be parallel, and the distributor arm spring tension should be from 17 to 22 oz., as measured on a spring scale.

Timing the Spark—To time the ignition spark, remove the spark plug from No. 1 cylinder and have an assistant crank the engine by hand until No. 1 piston has started on its compression stroke. This can be determined by holding the thumb over the spark plug hole until compression is felt. Continue to crank the engine until the flywheel timing mark (D.C.) can be located through a 7/8" hole, in the bell housing just ahead of the flywheel, on the left side of engine.

With the ignition points clean and making square contact and set to the proper gap opening of .018" or .020" the points should be just beginning to open on dead center.

To Reset Distributor—Loosen the set screw at the base of the distributor and turn the distributor body until the points are just beginning to open. Then tighten the set screw.

Removal of Headlamp Lens—All Models—To remove the lens, it is necessary to loosen completely the lens retaining screw at the bottom of the lamp which unlocks the lens retaining mechanism and permits pressing in and down on the lens at the bottom. Pressure so applied will move the lens downward and will cause it to snap out of the lamp body at the top. The pressure should be applied so the gap between the lens and the lamp body is approximately 3/8" with the lens in this position, grasp it firmly at the top and pull outward and upward.

To replace the lens in the lamp body, insert the lens at the bottom, press it on the sides and gradually work the hands around to the top until the lens snaps into place. Care should be taken to make sure that the key or lug on the bottom of the lens lines up with the slot in the lamp body when the lens is being inserted. After the lens has been replaced in the lamp body, the lens retaining screw should be tightened.

BATTERY

A 105 ampere hour Willard battery is used in the J15 Model, 136 ampere hour Willard battery in the J20 and J25 Models and 153 ampere hour Willard battery in the J30 Model.

Register the Battery—When a new truck is delivered, it is recommended that the dealer urge the purchaser to go to the nearest Willard Service Station immediately and have the battery registered in order to take advantage of the Willard 90-day insurance policy. Also to obtain a battery Service Card on which the registration date will be written.

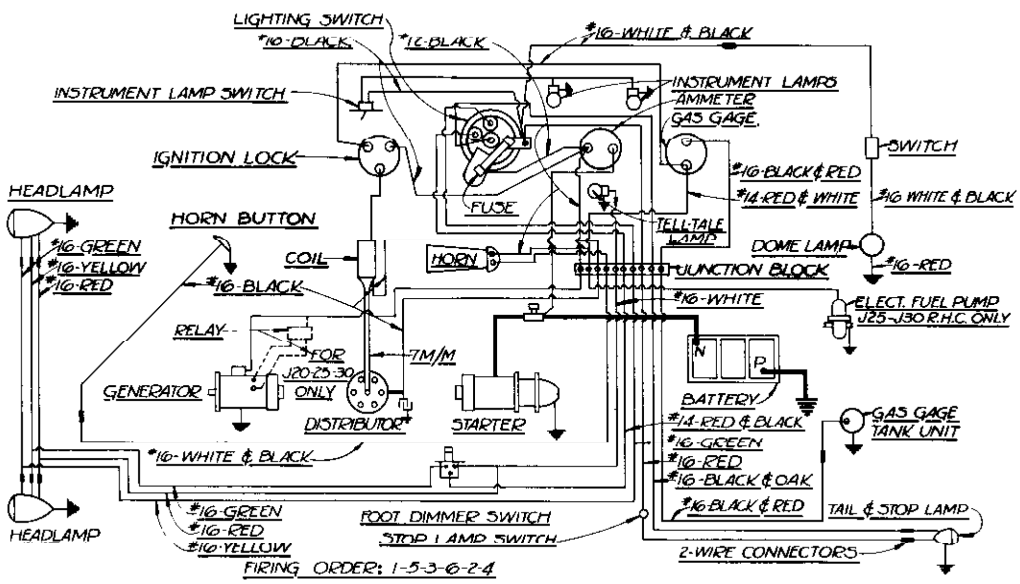


Illustration No. 27—Wiring Diagram—J-15, J-15B, J-20, J-25 and J-30 Models

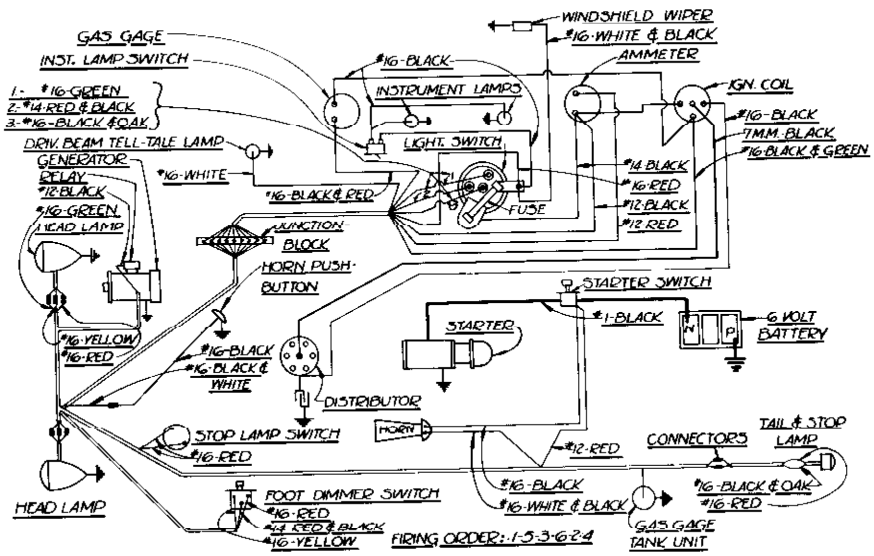


Illustration No. 28—Wiring Diagram—J-15M Models

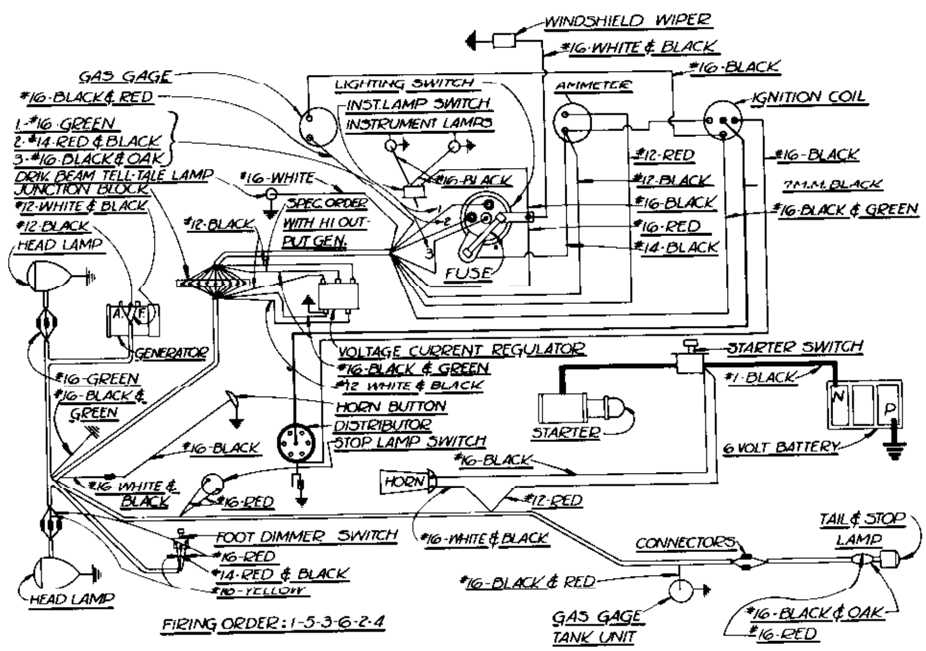


Illustration No. 29—Wiring Diagram—J-20M, J-20MB, J-25M, J-25MB, J-30M Models

Clutch—Model J15

The clutch on the above model is of the single plate dry disc type (Illustration No. 30). The driven member consists of a steel disc, on each side of which are riveted friction facings, a mechanical damper is incorporated in the hub of the driven member to prevent normal torsional vibra-

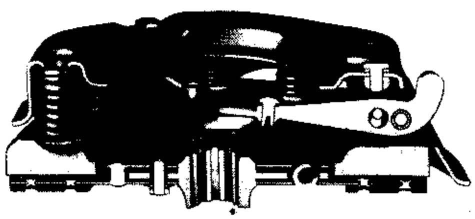


Illustration No. 30—Sectional View Clutch—J-15 Models

tion noise arising in the engine, from being transferred to the transmission gears and drive line. To insure a smooth, even clutch engagement the spring steel driven member is slightly waved, this causes integral engagement over a relatively small area which is gradual and effective. As the clutch pedal is completely released and the full pressure of the springs acts upon the driven member, the driven member friction facings come into full engagement with the pressure plate and flywheel. Moulded friction facings are used.

The frictional heat of the pressure plate is insulated from the pressure springs by the presence of asbestos and steel insulator buttons. On account of this feature, the springs should retain their strength indefinitely.

The clutch pressure plate assembly is attached to the flywheel by means of six cap screws and these provide ample strength for all torsional driving effort. The cover plate is piloted in a recess machined in the flywheel.

Service Suggestions—The only adjustment ordinarily required is that of the clutch pedal. To adjust the clutch pedal—loosen the binder bolt in the hub of the clutch operating lever, located on the clutch operating shaft in the clutch housing. Hold the clutch pedal against the floor board and with a wrench turn the operating shaft in a forward direction toward the flywheel until a clearance or free movement of one to one and one-half inch is obtained between the floor board and the clutch pedal. At least one inch of pedal lash must be present at all times, when the clutch is fully engaged and is a vital necessity for satisfactory clutch operation.

In case the original clutch is removed, care must be exercised during the reassembly operation. A dummy spline shaft should be used to align the splined hub of the driven member with the pilot bearing. The cover plate assembly must fit inside the turned shoulder of the flywheel without cramping its flange. This can easily be checked by laying the cover plate assembly in place first, without the driven member and noting its fit.

A satisfactory and rapid way of assembling the clutch is to compress the toggle levers and fit wooden wedges 7/16" thick between these levers and the inner rim of the cover, the six cap screws may then be tightened, thus precluding the possibility of the cover assembly binding against the flywheel shoulder. This practice is recommended because parallelism of the release levers will not occur if the cover plate assembly is distorted or not securely tightened.

CLUTCH—MODEL J20

The clutch used on the above model is a single plate dry disc type, no adjustment for wear being provided in the clutch itself. An individual adjustment is provided for locating each lever in manufacturing but the adjusting nut is locked in place and should never be disturbed, unless the clutch is dismantled for replacement of parts.

The release bearing is mounted on the transmission, and when the clutch pedal is depressed the bearing is moved toward the flywheel and contacts with the inner ends of the release levers. "5A." Each release lever is pivoted on a floating pin which remains stationary in the lever and rolls across a short flat portion of the enlarged hole in the eyebolt "5C," (See Fig. 2 and 3). The outer ends of the eyebolts extend through holes in the clutch cover and are fitted with adjusting nuts by which each lever is located in correct position. The outer ends of the release levers engage the pressure plate lugs by means of struts "5E" which provide knife edge contact between the outer ends of the levers and the pressure plate lugs, eliminating friction at this point. (See Fig. 2 and 3.) Thus the pressure plate "4" is pulled away from the driven plate "2" compressing the several small coil springs "7" which are assembled between the pressure plate and the clutch cover "9".

When the foot pressure is removed from clutch pedal the clutch springs force the pressure plate

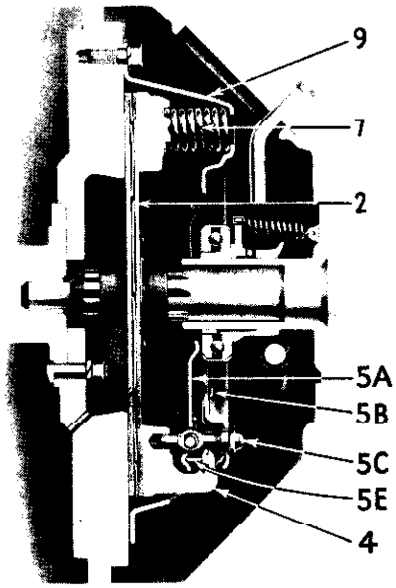


Illustration No. 31—Figure No. 1 Sectional View of Clutch J-20 Models

forward against the driven plate, gradually and smoothly applying the power of the engine to the rear wheels.

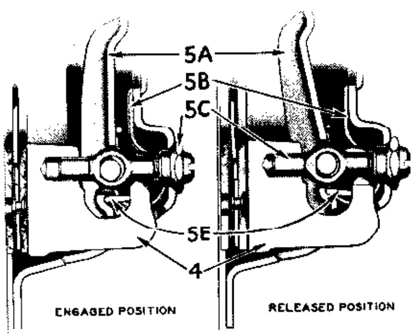


Illustration No. 31—Figures No. 2 and No. 3 Showing Positions of Release Levers—J-20 Models

As the clutch facings wear the pressure plate moves closer to the flywheel face and the outer ends of the release levers follow. This causes the inner ends of the levers to travel farther toward the transmission and decreases the clearance between the release levers and the release bearing. The effect on the clutch pedal is to decrease the

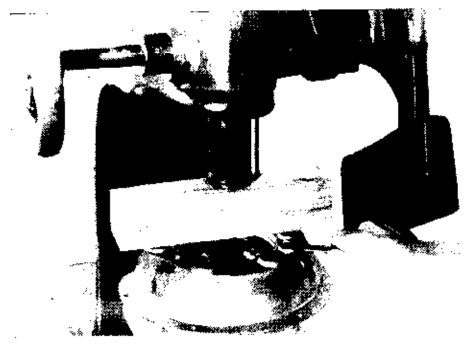


Illustration No. 31—Figure No. 4—Use of Arbor Press In Disassembling Clutch—J-20 Models

clearance or free travel under the toe board, which is the distance the clutch pedal moves down away from the under side of the toe board before the release bearing comes in contact with the release levers. Some clearance must always be maintained to prevent the clutch pedal from riding on the toe board and causing the clutch to slip. This clearance is restored by adjusting the clutch pedal.

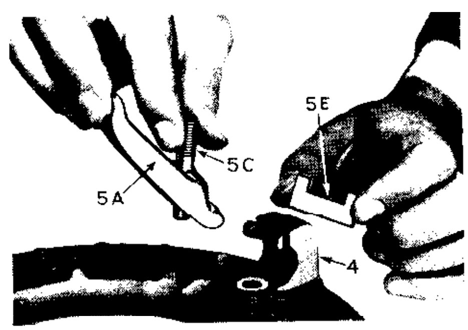


Illustration No. 31—Figure No. 5 Showing Disassembly Of Clutch Fingers—J-20 Models

To Adjust Clutch Pedal—Loosen the binder bolt in the hub of the clutch operating lever, located on the clutch operating shaft in the clutch housing. Hold the clutch pedal against the floor board and with a wrench turn the operating shaft in a forward direction toward the flywheel until a clearance or free movement of one to one and one-half inches is obtained between the floor board and the clutch pedal. At least one inch of pedal lash must be present at all times, when the clutch is fully engaged and is a vital necessity for satisfactory clutch operation.

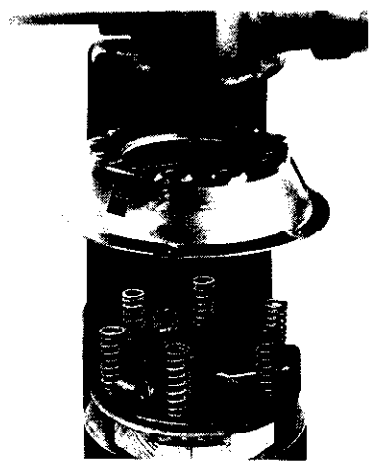


Illustration No. 31—Figure No. 6 Showing Clutch Cover Removed—J-20 Models

No other adjustment is necessary. Do not turn the adjusting nuts "5C," because this will throw the pressure plate out of position and cause the clutch to chatter.

Servicing Clutch:

1. Remove transmission and clutch housing.
2. Mark with a punch the flywheel, cover and pressure plate so that these two parts may be assembled in their same relative position. This is important because they are balanced as an assembly.
3. Loosen the holding screws a turn or two at a time until the spring pressure is relieved, (this should be carefully done to prevent springing the flanged edge of the cover). The screws can then be removed and the complete clutch lifted off of the flywheel, all parts except driven plate "2" (Fig. 1) being assembled to the cover.

If it is found necessary to replace parts of the cover assembly it can be dismantled, reassembled and adjusted with the aid of an arbor press or drill press as follows:

1. Place the cover on the bed of the press as shown in Fig 4 with a block under the pressure plate so arranged that cover is left free to move down. Place a block or bar across the top of the cover, resting on the spring bosses.
2. Compress the cover with the spindle of the press and holding it under compression remove the adjusting nuts "5C" (Fig. 1) and then slowly release the pressure to prevent the spring from getting out of position.
3. The cover can then be lifted off and all parts will be available for inspection. To remove the release levers grasp the lever and eyebolt between the thumb and fingers as shown in Fig. 5 so that the inner end of the lever and upper end of eyebolt are as near together as possible, keeping the eyebolt pin seated in its socket in the lever. The strut "5E" can then be lifted over the ridge on the end of the lever as shown in Fig. 7, making it possible to lift the lever and eyebolt off of the pressure plate.
   It is advisable to replace any parts which show wear.

To Reassemble Clutch:

1. Lay the pressure plate "4" (Fig. 1) on the block in the press.
2. Assemble a lever, eyebolt and eyebolt pin, holding the threaded end of the eyebolt between the thumb and index finger allowing the end of the lever to rest on the second finger. Hold the end of the lever and the end

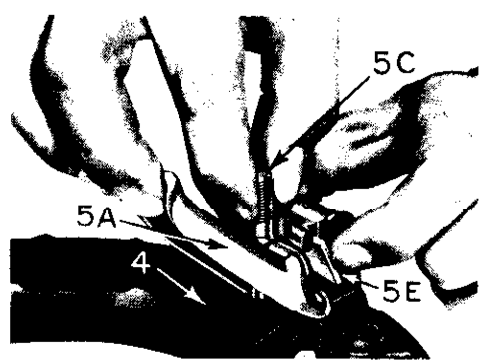


Illustration No. 31—Figure No. 7 Showing Assembly of Clutch Fingers—J-20 Models

of the eyebolt as close together as possible (See Fig. 5). With the other hand grasp strut "5E" between the thumb and first finger as shown in Fig. 5 and insert strut in the slots of the pressure plate lug. Then drop slightly and tilt the lower edge of the strut until it touches the vertical milled surface of the lug (see Fig. 7). Insert the lower end of the eyebolt in the hole in the pressure plate. The short end of the lever will then be under the hook of the pressure plate and near the strut. Slide the strut upward in the slots of the lug, lift it over the ridge on the short end of the lever and drop into its groove in the lever. (See Fig. 8.)

3. Then place springs "7" on pressure plate in a vertical position seating them on the small bosses on the pressure plate, as shown in Fig. 6. Lay the cover on top of the assembled parts as shown in Fig. 6, taking care that the anti-rattle springs "5B" are in the position shown in Fig 2 and 3 and that the tops of the springs are directly under the embossed seats on the cover. Also be sure the marks made by you on cover and pressure plate are in correct location.
4. The bar can then be laid across the cover and the assembly slowly compressed to be sure that the eyebolts and pressure plate lugs are guided through the proper holes in the cover. Care must also be taken that the springs remain in their seats.

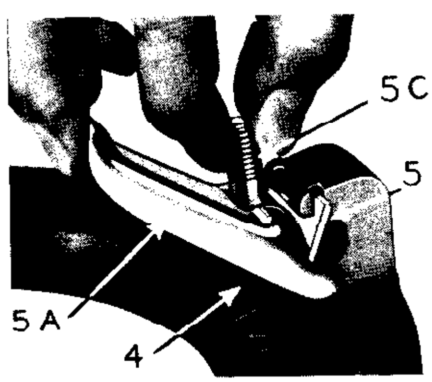


Illustration No. 31—Figure No. 8 Showing Assembly of Clutch Fingers—J-20 Models

5. Holding the clutch under compression the adjusting nuts can then be screwed down on the eyebolts until their tops are flush with the tops of the eyebolts.
6. The spindle of the press can then be released.
7. The clutch should then be released several times so that all moving parts will settle into their working positions. This can be done

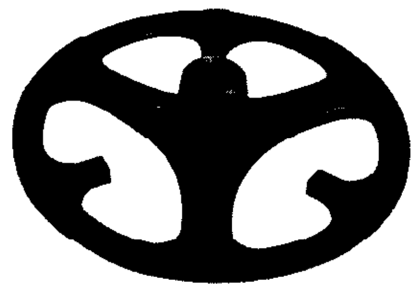


Illustration No. 31—Figure No. 9—Clutch Finger Gauge Plate—J-20 Models

with the press by applying the spindle to the inner ends of levers.

To Adjust Levers:

Satisfactory operation of this type of clutch is absolutely dependent on accurate adjustment of levers, so that pressure plate face is parallel to the flywheel face. This cannot be accomplished by setting the levers parallel to the face of release bearing after the clutch has been assembled to the flywheel, beause of variation in thickness of the driven plate. The only accurate method is to adjust the levers, while the pressure plate is held parallel to flywheel, by using the Borg & Beck A1 Type Gauge Plate, shown in Fig. 9.

1. Place this gauge plate in the flywheel in the position normally occupied by the driven plate and mount the cover on the flywheel turning the holding screws only a turn or two at a time when pulling against the spring pressure, otherwise the cover may be sprung, Before the cover is tightened down be sure the gauge plate is centered and the three flat machined lugs are directly under the levers, except in type 11A3 which has four levers. Any position of these lugs in type 11A3 will give satisfactory results. If the clutch is equipped with a release lever plate attached to the levers, the release lev-

er plate must be left off when setting the levers.

2. After the cover has been mounted a short straight edge or scale, (approximately three inches long), can then be laid across the center boss and the bearing surface of one lever. Then turn the adjusting nut until these are exactly the same height. By tilting the straight edge a "knife edge" setting can be obtained. (See Fig. 10.) The other levers can then be set in turn by the same method. If carefully done this setting will be within .005". After the adjustment is completed lock the nuts with a small chisel, peening portions of the nut into the slot in the eyebolt.

3. Loosen the holding screws a turn or two at a time until the spring pressure is relieved which will allow the clutch and the gauge plate to be removed.

4. Assemble the driven plate and clutch to the flywheel in accordance with the instructions found on the driven plate. Usually the end of the hub with machined chamfer should be towards rear of car.

Line up the driven plate and pilot bearing with a dummy shaft before tightening the cover holding screws. Tighten the screws before removing the dummy shaft.

After the transmission and floor boards have been assembled, adjust the foot pedal adjustment as directed in paragraph "to adjust clutch pedal."

Do not under any circumstances let the transmission hang in the clutch assembly.

Do not put oil or kerosene in the clutch. Keep the facings dry and free from oil.

Do not drive with your foot on the clutch pedal.

Do not slip the clutch excessively instead of shifting gears, as this causes rapid wear of the clutch facings.

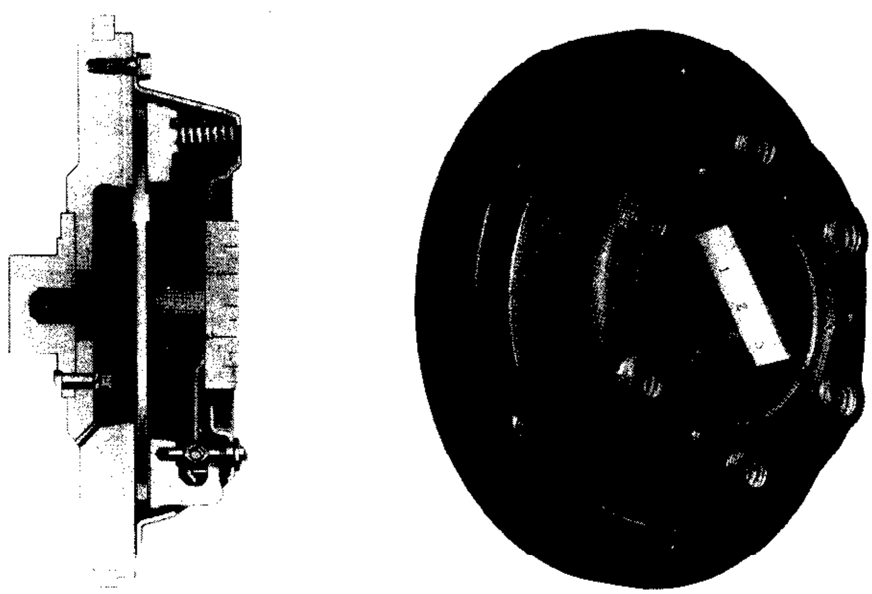


Illustration No. 31—Figure No. 10—Setting Fingers with Gauge Plate—J-20 Models

CLUTCH—MODELS J25 AND J30

The clutch used on the above models is of the single plate dry disc type. This clutch is distinguished from other clutches by two distinctively new features of particular value to heavy duty service, non-shock loading and automatic compensation for loss of spring pressure due to wear. Smooth engagement, simple adjustment that does not disturb dynamic balance and prevents incorrect adjustment, no localized heating and utilization of every square inch of friction area in picking up the load are features built into this unit. The simplicity and ruggedness of construction of this clutch is such that maintenance does not require special tools and only a few special instructions.

Normal adjustments for wear may be made on the clutch pedal in the following manner: Loosen the binder bolt in the hub of the clutch operating lever, located on the clutch operating shaft in the clutch housing. Hold the clutch pedal against the floor board and with a wrench turn the operating shaft in a forward direction toward the flywheel until a clearance or free movement of one to one and one-half inches is obtained between the floor board and the clutch pedal. At least one inch of pedal lash must be present at all times, when the clutch is fully engaged and is a vital necessity for satisfactory clutch operation. However, if the pedal adjustment does not sufficiently restore the clutch to normal operation, remove an equal num-

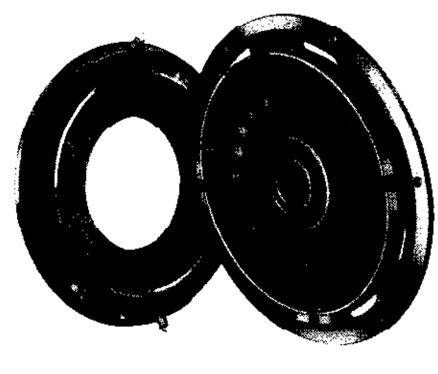


Illustration No. 32—Clutch Lever and Plate Assembly J-25 and J-30 Models

ber of shims from under each of the four adjuster straps (see illustration). After removing these shims always check the clutch pedal for the proper pedal lash as described above.

Test

Test the clutch by speeding up the engine with the transmission in direct gear, brakes set, and engage clutch rapidly. The engine should stall in approximately 3 seconds. If the clutch slips after all of the shims are removed, new facings are required.

Installing New Clutch Driven Member or New Friction Facings

Generally speaking, it is not desirable to attempt the installation of new friction facings on the original driven member, since refaced driven

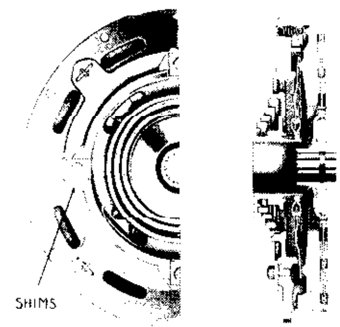


Illustration No. 33—Sectional View of Clutch J-25 and J-30 Models

members often are bent or otherwise impaired, so that difficult clutch action results. The cost of a new clutch driven member is a relatively small item and uniformly satisfactory results that are thus obtained more than justify the expenditure. Before installing a new clutch driven member assembly, the four adjuster straps should be removed, and three shims placed under each strap. Otherwise the clutch will not release properly after the new clutch driven member is installed. When making the installation of the driven member it is necessary to use a dummy spline shaft centering the driven member while bolting the clutch pressure plate in place. This insures centralization of the spline with reference to pinion pilot bearing and facilitates assembly of the transmission to the engine. It will be noted that the driven member splines on one side are chamfered so as to more readily permit the entrance of the transmission pinion shaft splines. The side of the driven member having these chamfers on the spline should be to the rear.

Replacing Pressure Plates—Ordinarily it will not be necessary to make replacement of the pressure plate. However, if, due to lack of adjustment and attention, the clutch has slipped and generated excessive heat, such replacement may be necessary. Pressure plates that are dished in excess of .006" or that are badly scored or cracked, should be replaced. No special tools or fixtures are required for this purpose. To perform the operation, proceed as follows:

A—Place the clutch pressure plate assembly on an arbor press or drill press, with the pressure plate down, and compress the release sleeve as far as possible. If no arbor press or drill press is available, use the method featured in the illustration.

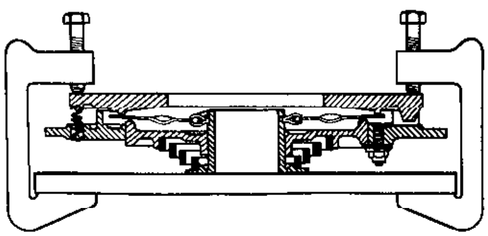


Illustration No. 34—Removing Clutch Pressure Plate J-25 and J-30 Models

B—Remove the four pull back spring pins.

C—Hold the assembly together by hand to prevent the release levers from falling out, and place the assembly on the bench with the release sleeve down and remove the pressure plate. Should the release levers become misplaced, they must be reassembled with the bent end facing rearward away from the pressure plate.

D—Hook the pull back springs in the new pressure plate and place it in position, being careful not to cramp the pull back springs or allow the release lever to project beyond the rim.

E—Place the assembly in an arbor press or drill press and draw down the release sleeve before attempting to install the pull back spring pins. NOTE: Caution must be exercised not to over-stretch the pull back springs. This is the reason for using the arbor press or drill press.

Precautions in Assembling Clutch

1. Make sure that the large coil spring has its end located at the left of the small boss on the adjusting plate.
2. Remove any burrs in the bore of the adjusting plate or on the release sleeve. The sleeve must be a free fit in the adjusting plate.
3. Before using old fulcrum rings test them on a surface plate. If they are warped use new rings.
4. Always use a new snap ring when rebuilding and be sure it is firmly seated in its slot by tapping the ring home.
5. Test each lever after assembly to make sure it has a ball bearing locking it in the fulcrum rings.
6. Use new pull back springs if the old ones are stretched.
7. The pressure plate must be free in the slots of the flywheel ring. Approximately .003" looseness must be provided. If the old plate is used, assemble the "O" marked lug in the "O" marked slot of the flywheel ring.

Replacing New Clutch Spring or Release Sleeve

If at any time the pressure plate is removed, it is desired to replace the clutch spring or release sleeve, then the following detailed steps should be carried out:

A—Place the assembly in an arbor press or drill press or the "C" clamp featured in the illustration.

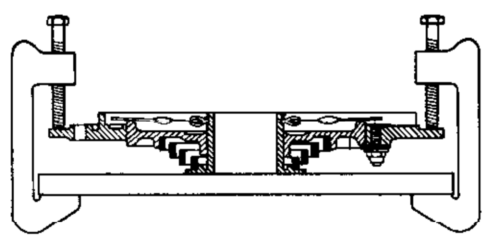


Illustration No. 35—Removing Clutch Spring or Sleeve J-25 and J-30 Models

B—Remove the snap ring and fulcrum rings and slowly release the assembly. The clutch will thus be completely disassembled and any wearing parts (sleeve, pressure plate and clutch spring) may be replaced. Reassembly is accomplished in the same manner. It is advisable, however, to use a new Woodruff non-rocking key and snap ring to save time in reassembling. Special care should be taken to prevent excessive distortion of the snap ring at the time of installation.

Clutch Release Bearing—The clutch release bearing is of the ball thrust type and should be lubricated at 5,000-mile intervals with S.A.E. No. 30 engine oil. Other than lubrication, this bearing requires no service attention.

Free Fit of Clutch in Flywheel—Important—When assembling the clutch, the cover plate should first be installed in the flywheel, without the driven plate to make sure that the clutch will go in place freely without binding. A tight fit in the flywheel will cause prolonged slippage as the clutch engages with the attendant heat and wear, as well as a reduction of pressure on the pressure plate. If necessary, the inside diameter of the flywheel can be increased slightly with a mill file to provide the necessary clearance.

Transmission

Transmission—J15 and J20 Models

The transmission used on the above models is mounted as a unit with the engine, and is of selective sliding gear type, having four speeds forward and one reverse. The mainshaft is supported at the rear by an annular ball bearing and at the front by a roller bearing carried in the end of the transmission pinion gear. The pinion shaft is supported in the transmission case by an annular ball bearing and is piloted at the front in the crankshaft by a roller bearing. The countershaft is supported at both ends by roller bearings. The transmission is piloted into the bore of the clutch housing by the transmission case front flange and is securely held against the face of the clutch housing by four large cap screws. The clutch housing is held in proper alignment with the engine crankshaft by means of four dowel bolts (two on each side) which are inserted through the flanges of the clutch housing and cylinder block.

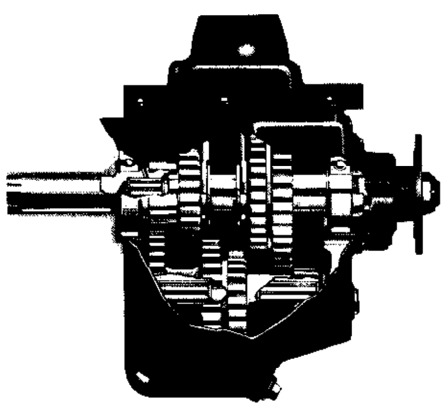


Illustration No. 36—Transmission—J-15 and J-20

By virtue of this construction, the proper alignment of the transmission with the engine assembly is maintained, even though the clutch housing is removed and installed. This alignment is essential to prevent undue wear of the transmission pinion bearings and slipping out of gear. Misalignment of the transmission with the engine assembly is very conducive to the development of both conditions. The maximum permissible misalignment of the rear machined face of the clutch housing is .006" as is also the maximum permissible eccentricity of the clutch housing bore.

Cleanliness of the respective parts is absolutely necessary in dismantling and reassembling the transmission. Dirt in its several forms, can and will cause trouble. Particularly is this true in the control cover, position finger bolts, springs and interlocking parts.

Shift gears into the second speed position for ease of removing or installing control cover. Care should be exercised in the removal or installation of ball bearings. Pounding on the outer race is sure to injure the bearings. Use a hollow mandrel and bearing puller.

Gear ratios are as follows:

Reverse 7.82 to 1 First 6.4 to 1 Second 3.09 to 1
Third 1.69 to 1 High 1 to 1

A standard large size S. A. E. opening is provided on the right side of the transmission case for power take-off installation.

Transmission—J25 and J30 Models

The transmissions used in these two models are similar in general design and construction but differ widely in dimensional details and torque capacity. Both transmissions are unit mounted with the engine, providing five speeds forward and one reverse with silent, helical gears for third and fourth speeds.

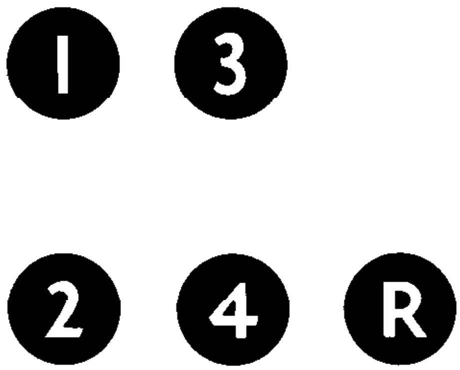


Illustration No. 37—Shifting Lever Positions—4-Speed Transmission—J-15 and J-20 Models

The transmission mainshaft is supported at the rear by an annular ball bearing which takes both the thrust and the radial load, and at the front by a roller bearing carried in the end of the transmission pinion gear. The pinion shaft is supported in the transmission case by an annular ball bearing and is piloted at the front in the crankshaft by a roller bearing.

The transmission countershaft is supported at the front by a solid type roller bearing and at the rear by an annular ball bearing. The countershaft gears are a tight press fit and keyed onto the countershaft. The reverse idler gear is carried by roller bearings. Needle bearings are employed in mounting the third and fourth speed constant mesh gears on the mainshaft.

To completely disassemble the transmission, it is necessary to remove the gear shift base assembly and both the mainshaft front and rear bearing retainers and the countershaft rear bearing retainer.

A—Remove the mainshaft rear bearing from the case and shaft, and then by slipping the mainshaft to the rear, the mainshaft assembly can be removed from the case.

B—Remove the transmission pinion and bearing from the front.

C—Remove the reverse idler gear.

D—Remove the thrust plate from the front end of the countershaft.

E—Remove the countershaft rear bearing.

F—Slip the countershaft cluster to the rear and remove from the case. The reverse procedure should be used when assembling.

G—Remove idler gear shaft lock from rear of case and remove idle shaft and gear.

If the snap ring is removed from the bearings or from the fourth speed constant mesh mainshaft gear, a new snap ring must be used when reassembling. Never attempt to use the original snap ring the second time, since distortion of the snap ring during the removal operation cannot be prevented. Failure to always use a new snap ring may result in breakage of the snap ring when in service and cause subsequent damage to the transmission gears.

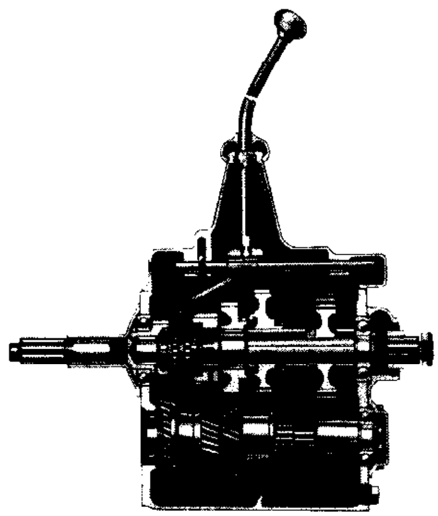


Illustration No. 38—Transmission—J-25 and J-30 Models

Standard		Overdrive (Optional Equipment)
5	Direct	Overdrive .799 to 1
4	4th	Direct
3	3rd	3rd
2	2nd	2nd
1	1st	1st
R	Reverse	Reverse

The transmission gear ratios are as follows:

	J25	J30
High gear	1 to 1	1 to 1
Fourth gear	1.48 to 1	1.48 to 1
Third gear	2.4 to 1	2.63 to 1
Second gear	4.38 to 1	4.46 to 1
First gear	7.58 to 1	7.88 to 1
Reverse gear	6.11 to 1	7.88 to 1

S. A. E. No. 90 gear lubricant is recommended for atmospheric temperatures below 32° F. The recommended quantity of transmission gear lubricant is 6 pints on Model J15 and J20; 12 pints on Model J25; and 18 pints on Model J30.

A standard large size power take-off is provided on the right side of the J25 transmission and on both sides of the J30 transmission.

Optional Overdrive Transmission—
J25 and J30 Models

The optional overdrive transmission for the above models is identical with the standard assembly with the exception of minor changes in gear reductions — direct drive being in fourth speed with silent overdrive in fifth.

The gear reductions in the overdrive transmission are as follows:

1st	6.06 to 1	7.00 to 1
2nd	3.50 to 1	3.97 to 1
3rd	1.91 to 1	1.90 to 1
4th (Direct)	1 to 1 (Direct)	1 to 1
5th	.799 to 1	.788 to 1
Reverse	4.87 to 1	7.00 to 1

	STANDARD	OVERDRIVE
5	DIRECT	OVERDRIVE
4	4th	DIRECT
3	3rd	3rd
2	2nd	2nd
1	1st	1st
R	REVERSE	REVERSE

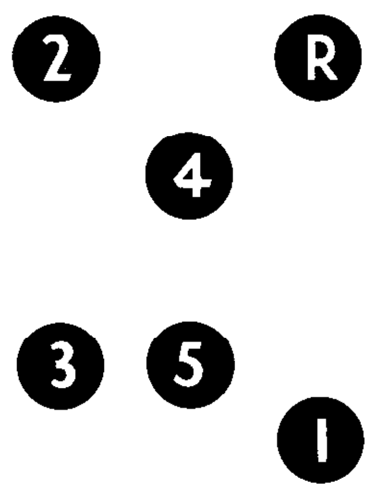


Illustration No. 39—Shifting Lever Positions—5-Speed and Overdrive Transmission J-25 and J-30 Models

Propeller Shaft and Universal Joints

All universal joints are of the Cleveland needle bearing type. Cork packing rings are used as a seal to prevent the entrance of dirt into the bearings and as a means of retaining the lubricant when the unit is not in operation.

In the external surface of the universal joint cross on the J15 and J25 models, a permanent

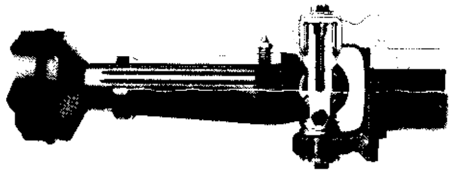


Illustration No. 40—Universal Joint—J-15 & J-20 Models

grease tube fitting is used, on the J25 and J30 models, a threaded type grease fitting is used. The joints are lubricated with pressure gun grease. The joints are protected against extreme pressure by a small escape valve and the joint should be filled until the lubricant is forced out of

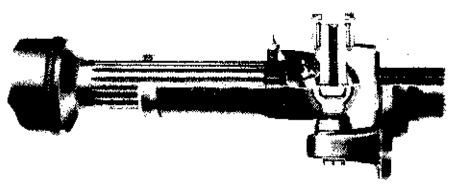


Illustration No. 41—Universal Joint—J-25 & J-30 Models

this valve. Only a good grade of light pressure gun grease of the consistency of vaseline should be used.

The universal joints and propeller shaft are balanced. The rear yoke and the splined end of the propeller shaft are marked with arrows, and should they ever be disassembled, they must be reassembled with these arrows in alignment.

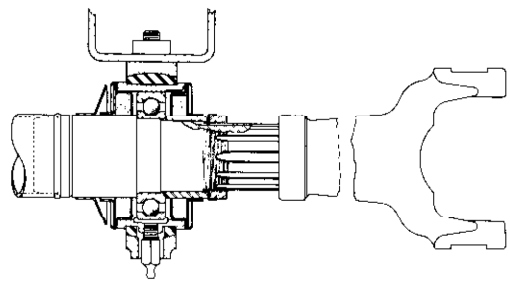


Illustration No. 42—Midship Bearing—Longer Wheelbase Models

Lubrication of the splined end of the propeller shaft is by means of a grease fitting. A light pressure gun grease should be used for the lubrication of these splines.

Midship Bearing—On the longer wheelbase models which are equipped with two propeller shafts a midship bearing is used between the two shafts. This bearing is of the single-row, loose ground, annular type and is insulated in rubber. The rubber insulator is assembled around the bearing cage and is retained by the support and support cap, the hole in the rubber insulator must always register with the grease fitting hole in the support cap so as to permit assembling the grease fitting. In assembling the rubber insulator, care must be taken not to wrinkle or pinch the rubber. The bearing support is securely anchored to the frame cross member. The grease fitting is located in the bottom of the support cap and is readily accessible from the under side of the truck. Only a good grade of high melting point grease should be used.

Rear Axle

Rear Axle—J15 Model—The rear axle is of the full floating type. The rear axle pinion, ring gear and differential assembly is mounted in a differential and pinion carrier, which may be removed as a unit from the forward side of the rear axle housing. On the rear of this housing a stamped cover is provided, which may also be removed for inspection, minor adjustments and cleaning and flushing of the differential assembly.

The rear axle shafts are splined at the inner ends and fit into female splines in the differential side gears. The outer ends of the axle shafts are provided with integral flanges that attach to the wheel hubs.

To remove these shafts it is only necessary to remove the cap screws from the hub at the shaft outer flanges. The shaft may then readily be removed for inspection or replacement. In the event the shaft is broken and difficulty is encountered in removing the inner end of the shaft, the axle shaft on the opposite side should be removed. A bar may then be inserted through the housing and the stub shaft forced out. Remove cover to remove the piece.

The rear wheels are supported on two tapered roller bearings. When lubricating, it is advisable to remove the wheels and thoroughly clean the bearings. The bearings, as well as the space in the hubs between the two bearing cups, should then be packed with a good grade of wheel bearing grease.

When adjusting the wheel bearings, turn the adjusting nut up tight and then revolve the wheel a few times by hand, thus allowing the rollers to seat in the cups. Back off the adjusting nut so that a very slight movement is felt in the cups. If this movement is more than barely perceptible it is excessive and the adjusting nut should be drawn tighter. After the proper adjustment has been obtained, install the lock washer and then the lock nut. Be sure the lock nut is securely tightened.

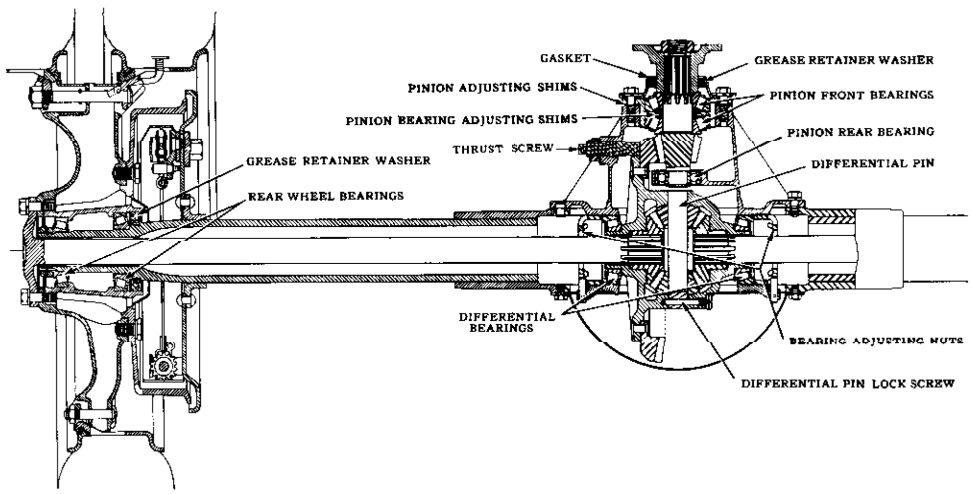


Illustration No. 43—Rear Axle Assembly—J-15 Models

Pinion and Pinion Bearing Adjustment—The pinion shaft is supported at the front by dual opposed tapered bearings and piloted at the rear by an annular ball bearing. This straddle mounting of the pinion securely holds the pinion gear in proper relation to the ring gear—thus insuring proper tooth contact under normal operating conditions. Provision is made for the adjustment of the dual opposed tapered bearings. These adjustments are as follows:

Shims are placed between the two bearings. These shims are available in several thicknesses and the proper bearing adjustment is obtained when a perceptible bearing drag can be felt while turning the pinion. If the bearings are too loose (too much end play) the required number of shims will have to be removed; and, conversely, if, due to bearing drag, abnormal resistance to rotation is encountered, the required number of shims should be installed between the two bearings.

The annular ball bearing piloting the rear of the pinion requires no adjustment.

Pinion Setting—The correct position of the pinion, in relation to the differential ring gear is obtained by shims assembled between the pinion forward bearing cage and the front machined face of the pinion carrier. Shims are available in three thicknesses; namely, thick, medium, and thin. However, the correct factory adjustment should not be changed except in the event that new gears are installed. Detailed instructions for determining the correct positioning of the pinion in relation to the ring gear will be found under "Ring Gear and Pinion Adjustment."

Differential Case Bearings—The differential and ring gear assembly is supported on tapered roller bearings. The inner race or cone of these bearings is pressed on the ground hub of the differential case and the outer race or cup is backed up by a threaded adjusting nut.

These threaded adjusting nuts are locked in position, after correct adjustment of the bearings has been obtained, by the clamping action of the bearing cap, which is held in position by cap screws. As an added precaution, a lock is assembled in one of the many slots provided in the adjusting nuts.

To adjust these differential side bearings, loosen the four bearing cap screws just enough to permit turning the nut freely with an 8" to 10" bar. Tighten one adjusting nut until it is brought up against the bearing cup with sufficient pressure to rotate the bearing cups, or in other words, tighten until the bearing rollers back of the adjusting nut begin to roll, then tighten the nut one more notch and lock it in position. Repeat this operation on the opposite nut.

Ring Gear Thrust Screw—To prevent abnormal deflection of the ring gear under heavy load and to maintain correct tooth contact with the pinion a thrust screw is installed in the differential carrier so that it comes in contact with the back side of the ring gear directly opposite the pinion gear. Under normal operating conditions there is no contact between the back of the ring gear and the thrust screw. The clearance between the thrust screw and the back of the ring gear should be .010" to .015" under no load. To obtain this adjustment, loosen the thrust screw lock nut and turn the thrust screw in or out (as required) until the above clearance has been obtained. This clearance should be determined with feeler gauges. When tightening the lock nut, make sure that the position of the thrust screw does not change.

Rear Axle—J20, J25 and J30 Models

A Timken rear axle of the full floating type is used in the above models.

The rear wheels are supported on two tapered roller bearings, which may be lubricated by removing the two grease plugs in the rear wheel housing and forcing wheel bearing grease into the hub assembly. Both plugs should be removed and the hub filled with lubricant until it escapes from the other opening. Failure to remove both plugs will result in grease being forced through the bearing seals and into the brake assembly.

Periodic examination of the rear wheel bearings should be made—especially for adjustment. If the bearings are found to be somewhat loose, it will be necessary to remove the axle shaft and loosen the bearing lock nut. Adjust the inner nut until there is only a very slight movement of the wheel on the bearings. If this movement is more than barely perceptible, it is excessive, and the adjusting nut should be drawn slightly tighter. When the adjustment has been correctly made, install the lock washer and then the lock nut. Be sure the lock nut is securely tightened.

The rear axle pinion, ring gear and differential assembly is mounted in a differential and pinion carrier which may be removed as a unit from the forward side of the rear axle housing.

The rear axle shafts are splined at the inner ends and fit into the female splines in the differential side gears. The outer ends of the axle shafts are provided with integral flanges that attach to the wheel hubs.

Over the Model J30 axle shafts a spiral wire spring is fitted which serves as an oil return—its purpose being to keep the oil in the rear axle housing from working out toward the end of the shaft. The spiral wire return spring on the left axle shaft has a right-hand spiral and the one on the right axle shaft has a left-hand spiral. Care must be taken when reassembling to make certain that the correct spring is installed on the shaft for which it is intended. If the spiral wire springs are installed in the reverse manner, they will force the lubricant out of the housing instead of retaining it in the housing.

To remove these shafts it is only necessary to remove the stud nuts from the hub at the shaft outer flanges. The shaft may then readily be removed for inspection or replacement.

Pinion and Pinion Bearing Adjustment—The pinion shaft is supported at the front by dual opposed tapered roller bearings, and at the rear by a bearing of the straight roller type. This straddle-mounted construction provides movement of the pinion along its axis and securely holds the pinion gear in proper relation to the ring gear under normal operating conditions.

The ring gear is kept in alignment by a bronze thrust block. This prevents deflection of the gear under extreme load and insures full contact on the face of the gear teeth.

Adjustment of the pinion forward bearing is secured through the medium of an adjusting nut which acts against the forward bearing cone. A ready means of positively locking this adjusting nut in position is provided. While making this adjustment, the pinion bearing should be rotated in order to seat the bearing rollers, and the correct adjustment will be obtained when a perceptible bearing drag can be felt.

The bearing at the rear of the pinion, being of the straight roller type will require no adjustment.

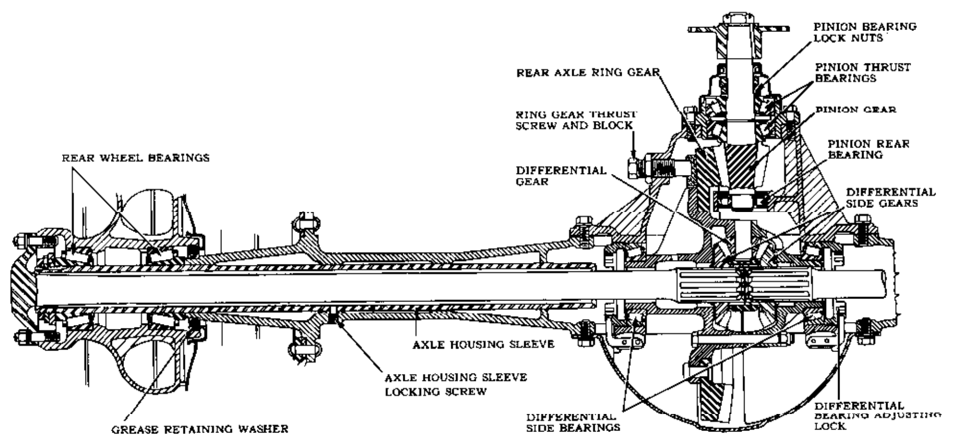


Illustration No. 44—Rear Axle Assembly—J-30 Models. Note: This Illustration Also Applies to J-20 & J-25 Models Except That the Rear Cover Is Not Removable And For Slight Differences in the Housing and Dimensions

Pinion Setting—The correct position of the pinion, in relation to the differential ring gear, on the J20, J25 and J30 Models, is obtained by shims assembled between the pinion forward bearing cage and the front machined face of the pinion carrier. Shims are available in four thicknesses; namely, .0025", .0045", .013", and 030". However, the correct factory adjustment should not be changed except in the event that new gears are installed. Detailed instructions for determining the correct positioning of the pinion in relation to the ring gear will be found under "Ring Gear and Pinion Adjustment" in the following paragraphs.

Differential Case Bearings—The differential and ring gear assembly is supported on tapered roller bearings. The inner race or cone of these bearings is pressed on the ground hub of the differential case and the outer race or cup is backed up by a threaded adjusting nut—thus providing a ready means of controlling gear lash between the ring and pinion gears.

These threaded adjusting nuts are locked in position, after correct adjustment of the bearings has been obtained, by the clamping action of the bearing cap which is held securely in position by cap screws. As an added precaution a lock is assembled in one of the many slots provided in the adjusting nut.

To adjust these differential side bearings, loosen the four bearing cap screws just enough to permit turning the nuts freely with an 8" to 10" bar. Tighten one adjusting nut until it is brought up against the bearing cup with sufficient pressure to rotate the bearing cup, or in other words, tighten until the bearing rollers back of the adjusting nut begin to roll, then tighten the nut one more notch and lock it in position. Repeat this operation on the opposite nut.

Ring Gear Thrust Block—The ring gear thrust block is normally not in contact with the back of the ring gear. Since an initial clearance of .010" to .015" is provided by adjustment of the adjusting screw. To readjust this clearance it is only necessary to loosen the adjusting screw lock nut and turn the screw in or out (as required) until the desired clearance of .010" to .015" is obtained. This clearance should be determined with a feeler gauge. When tightening the lock nut, make sure that the clearance between the thrust block and the ring gear does not change.

Ring Gear and Pinion Adjustment—All Models—The recommended lash between the ring and the pinion gear is from .007" to .010". To check this lash, mount a dial indicator on the heel of the ring gear tooth so as to be as near in line with the tooth travel as possible. With the differential and the pinion carrier assembly removed from the rear axle housing, hold the pinion stationary and attempt to rotate the ring gear. If the backlash is correct, the indicator will reveal a total movement of the ring gear of from .007" to .010".

If the backlash is under .007" or over .010" adjust the differential side bearing nuts until the desired backlash is obtained. In adjusting these differential side bearing nuts, each nut must be turned an equal amount so as to maintain the adjustment of the side bearings. The final backlash should be checked with the side bearing cap screws tight.

Obviously, if there is too much backlash, (more than .010") the bearings must be adjusted so as to move the ring gear toward the pinion. Conversely, if there is not sufficient backlash (less than .007") the side bearings must be adjusted so as to move the ring gear away from the pinion.

After the proper backlash has been obtained the pinion setting should be checked and inspected by using a small paint brush and painting eight or ten teeth of the ring gear with a few drops of engine oil mixed with ground red lead. Grasp the ring gear by hand and rotate the pinion over the painted section of the gear, placing a tension on the pinion flange with a block of wood. If the adjustment of the ring gear and pinion is correct, a tooth contact similar to Illustration No. 45, Figure No. 1 will be noted on the painted gear teeth.

If the tooth contact is high on the gear teeth, as shown in Figure No. 2, the pinion should be moved toward the ring gear by removing the shims between the pinion forward bearing cage and the front machined face of the pinion carrier.

If the tooth contact is low, as shown in Figure No. 3, the pinion should be moved away from the ring gear by idling shims between the pinion forward bearing cage and the front machined face of the pinion carrier.

If the tooth contact is decidedly toward the toe or small end of the tooth, as shown in Figure No. 3, the ring gear should be moved away from the pinion by adjusting of the differential side bearings.

If the tooth contacts favor the heel, or large end of the ring gear teeth, as shown in Figure No. 5, the ring gear should be moved toward the pin-

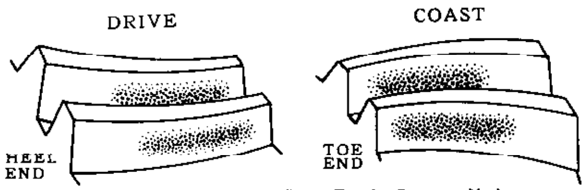


Fig. 1. Ideal Ring Gear Tooth Contact Under Light Load

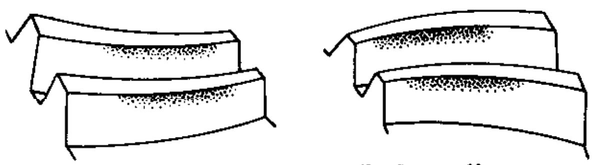


Fig. 2. High Tooth Contact—To Correct Move Pinion Toward Gear

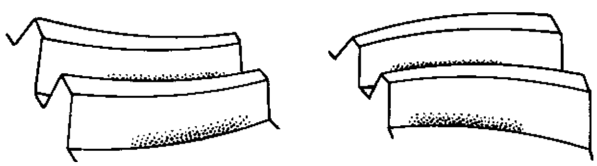


Fig. 3. Low Tooth Contact—To Correct Move Pinion Away From Gear

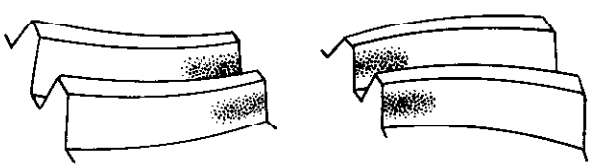


Fig. 4. Toe Contact—To Correct Move Gear Away From Pinion

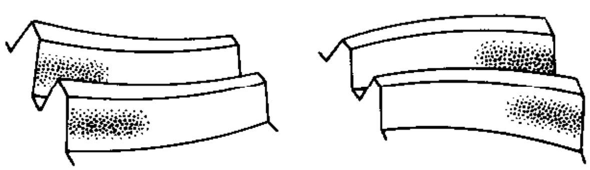


Fig. 5. Heel Contact—To Correct Move Gear Toward Pinion

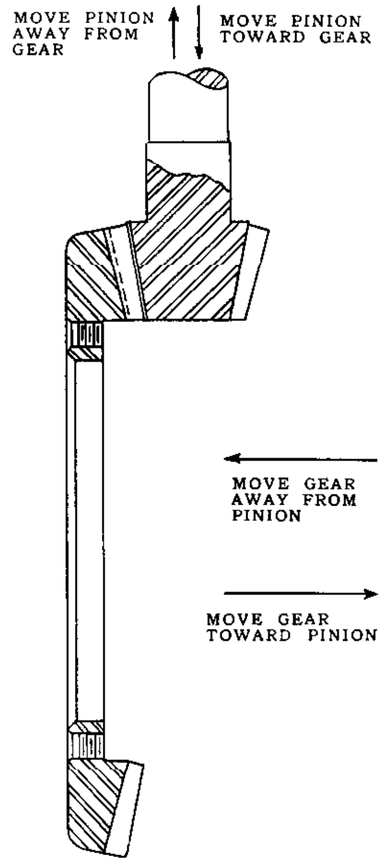


Fig. 6.

Illustration No. 45—Ring Gear Tooth Contact Under Light Load—All Models

ion by adjustment of the differential side bearings.

It must be remembered, however, that in making adjustment to correct a toe or heel contact that the backlash limits of from .007" to .010" must be maintained. A reduction of backlash, within the above limits, may correct an extreme heel contact; while an increase in backlash, within the above limits, may correct an extreme toe contact.

Moving the ring gear .005" will change the backlash approximately .0035". Moving the pinion .005" will change the backlash approximately .001". Ordinarily it will not be desirable to move the pinion when making a backlash correction, as the movement of the ring gear has a much greater effect upon the amount of backlash.

It should always be remembered that a well located tooth contact is more desirable even if the gears are slightly noisy, than a poorly located contact which may seem to produce a temporary quiet operation.

Dual Reduction Single Speed and Two Speed Rear Axle Optional Equipment

Single speed dual reduction rear axles are furnished as optional equipment on all truck models. Two speed dual reduction axles are available as optional equipment on the J15 and J20 Models.

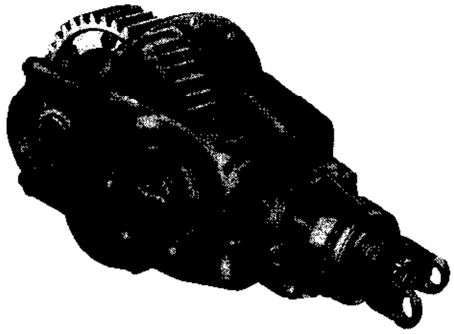


Illustration No. 46—Double Reduction, Single Speed Axle Carrier Assembly—Optional Equipment—All Models

Illustration No. 46 shows a vertical cross-section through a Timken double reduction single speed rear axle assembly. Note the arrangement of the two sets of gears which transmit the torque from the pinion shaft to the axle shafts. Each gear set provides approximately one-half of the total reduction. Due to the fewer number of teeth required, each of the driven gears is of smaller diameter than the single bevel gear which provides the total reduction. The result of this design is compactness and long life of gears due to reduced loads per tooth.

The two speed dual reduction axle answers most practically the demand for more flexibility in motor truck performance. It offers a choice of two gear ratios in the rear axle—a fast gear ratio and a slow gear ratio—each suited for certain operating conditions. Like the single speed dual reduction axle, it is a removable driving unit, similar and interchangeable with the bevel gear driving unit, or differential carrier assembly.

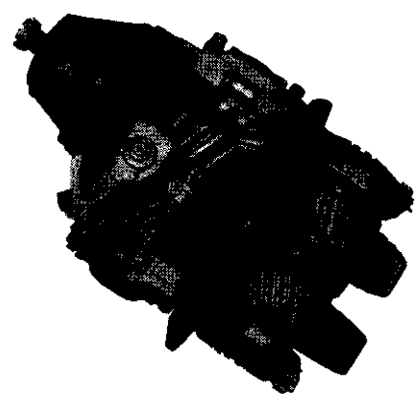


Illustration No. 47—Double Reduction, Two Speed Axle Carrier Assembly—Optional Equipment—J-15 and J-20 Models

Illustration No. 47 shows a cross section through the Timken two-speed dual reduction drive assembly. The bevel gear set mounting follows the regular conventional design.

Instead of having a single spur gear integral with the cross shaft, as in the single speed dual reduction axle, two spur gears are used in the two speed axle, both of which float on the cross shaft independently of each other. A sliding splined clutch collar slides into engagement with the splined shoulder on either spur pinion, thus positively locking the spur pinion to the cross shaft. The shifting is accomplished by sliding the clutch gear, which is manually controlled, from the cab. The clutch gear is splined to the cross shaft. The two mating sets of spur and master gears have different ratios, consequently the final drive ratio depends upon which set is engaged by the clutch gear.

Disassembly follows conventional practice in that the carrier assembly may be removed from the housing after the axle shafts have been removed. To disassemble proceed as follows:

1. Disconnect drive shaft at rear universal joint.
2. Remove carrier assembly from housing after removing axle shafts.
3. Remove shifter fork plate.
4. Remove plunger nut and plunger spring assembly.
5. Remove set screw and jam nut.
6. Remove shifter arm.
7. Remove shifter fork.
8. Remove sliding gear.
9. Remove clutch plate lock.
10. Remove bearing adjuster lock.
11. Remove differential bearing caps, right and left hand.
12. Remove bearing adjusters and bearing cups, right and left hand.
13. To remove ring gear and differential unit be sure to have one of the case bolts on center line with pinion shaft.
14. Remove ring gear bolts.
15. Pry left hand support case from ring gear.
16. Pry high speed clutch plate from differential case.
17. Remove planetary gears and pins.
18. Remove differential case from right hand support case.
19. Remove thrust washers from right and left hand support case.
20. Remove eight long and four short cap screws from differential case.
21. Pry differential case apart.
22. Remove side gears, spider and pinions.
23. Remove side gear thrust washers from differential case.
24. Remove thrust washers and differential pinions from spider.
25. Remove the pinion shaft.

In order to reassemble the two-speed axle the process is reversed but close attention must be given to some important details. The side gear and spider pinion thrust washers should be lubricated before they are put into place. Both types of washers should be between .061" and .063" thick. The four short differential bolts must be placed between the spider arms.

In assembling the four planetary gears and pins to the differential case, make sure that the pins are lubricated and that the oil holes in the pins are at the outer end. When the high speed clutch plate is placed in position, it must be with the chamfered teeth facing the planetary gears. The left and right hand support case thrust washers have to be lubricated before they are put into place. The allowable thickness for these washers is .061" to .063". When assembling the differential case assembly to the carrier be sure that one of the ring gear nuts is in line with the pinion. The ring gear is adjusted to the pinion in the conventional manner. The permissible lash is .006" to .014".

Following the adjustment of the gears the clutch plate lock must be assembled along with the bearing adjuster lock on the other side. Then the clutch gear is assembled into place followed by the shifter arm with the key in position. The shifter fork must be placed in proper alignment to receive shifter arm. Reassemble set screw and jam nut and then the plunger nut and plunger spring assembly and finally the shift lock plate. The carrier is then ready for assembly to the housing. The pinion is shim adjusted and such models as have opposed tapered roller bearings, have a spacer which comes in oversizes to adjust pinion bearings. The cross shaft bearings are adjusted by shims in the bearing cages which are machine fitted with dowel pins for alignment. The cages can be removed by removing cap screws which hold them to the housing. Pinion to ring gear adjustment is made by moving shims from one bearing cage to the other. In disassembling the whole cross shaft and two speed assembly can be withdrawn through the top cover after the bearing cages have been removed. No special lubricant is required and all adjustments remain the same as those on the conventional axle.

The lubricant capacity of the axle is 8 quarts. It is recommended that S.A.E. No. 90 gear lubricant be used for air temperatures below plus 32° F. and S.A.E. No. 110 gear lubricant be used for air temperatures above plus 32° F., except in extremely hot climates where S.A.E. No. 160 lubricant should be used.

Brakes—All Models

Wagner Lockheed hydraulic brakes are used on all models. Studebaker service men should familiarize themselves with every feature of their operation and construction. This data together with detailed instructions covering service adjustment is set forth in the following paragraphs.

The brake shoes are brought in contact with the drums by means of a column of liquid forced through special tubes. This liquid transmits pressure applied by the foot pedal to the two shoes in each wheel brake assembly by means of displacement of pistons in the wheel cylinders. Inasmuch as the pressure is equal in all parts of the system, no braking action can take place until the shoes in all brakes are in contact with the drums; therefore, the system is self-equalizing.

The system consists of a master cylinder in which hydraulic pressure is originated; a wheel cylinder operating the brake shoes against each wheel brake drum, in which wheel cylinder the hydraulic pressure is applied; a supply or re-reserve tank by which the operating fluid is maintained at a constant volume, and the "line" consisting of tubing, flexible hose, brackets and unions, connecting the master cylinder and wheel cylinders.

A vacuum power cylinder, which assists in the operation of the master cylinder piston, reducing pedal pressure, is standard equipment on the J25, and J30 models, and is optional equipment on the J15 and J20 models.

The master cylinder is fitted with a piston and the wheel cylinders are each fitted with two pistons. All of the pistons are provided with cup packings which act as seals to maintain pressures and prevent loss of brake fluid.

The brake pedal, when depressed, moves the piston within the master cylinder, thus forcing the brake fluid from the master cylinder through the tubing and flexible hose connections, into the four wheel cylinders.

As a result more brake fluid enters each of the wheel cylinders, causing the pistons to move against the brake shoes, thus bringing the shoes into contact with the drums. As pressure on the brake pedal is increased, greater hydraulic pressure is built up within the wheel cylinders, and consequently greater force is exerted by the shoes against the brake drums.

When the pressure on the foot pedal is released, the return springs on the brake shoes retract and return the wheel cylinder pistons to their normal or "off" position, thus forcing the brake fluid back through the flexible hoses and tubing into the master cylinder.

Master Cylinder—Description—All Models — The master cylinder assembly includes a reservoir (for the hydraulic fluid) which is integral with the master cylinder proper. The standard compensating features are incorporated in the fluid reservoir. If the reservoir contains fluid it will maintain the proper amount of fluid in the system at all times, regardless of expansion (heat) or contraction (cold).

The return to the "off" position (See Illustration) of the piston and primary cups is much

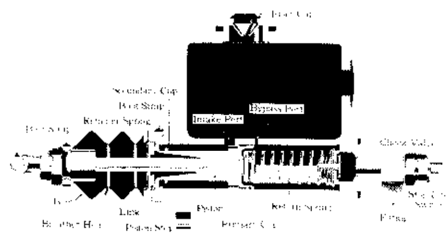


Illustration No. 48—Brake Master Cylinder and Fluid Reservoir—All Models

faster than the return of the fluid through the fitting into the master cylinder. A momentary vacuum is created in the cylinder barrel and additional fluid is drawn into the system through the drilled holes in the end of the piston and past the lip of the primary cup. Any excess fluid is passed by the by-pass port into the reservoir, thus a cylinder full of fluid is assured for the next brake application.

The primary cup must be clear of the by-pass port when the piston is in its "off" or returned position as shown in the illustrations of the master cylinders. otherwise the compensating action of the master cylinder will be destroyed and the brakes will drag. This can be determined by making sure that there is 1/2" free movement of the brake pedal. The secondary cup prevents the fluid from leaking out of the master cylinder into the boot.

The reservoir should be kept at least half full of fluid at all times, and should be checked for fluid level each 2500 miles of operation.

CAUTION: Extreme care must be used in removing the fluid reservoir filler cap to prevent dirt from entering the master cylinder.

Master Cylinder Disassembly and Reassembly—The use of other than Genuine Lockheed Fluid or the introduction of an oil with a mineral base, into the system will cause the rubber parts to swell and become inoperative. Grit and abrasive substances permitted to get into the fluid reservoir will cause the cylinder barrel to become scratched and pitted. When either of these conditions occur it becomes necessary to remove the master cylinder for inspection.

After removing the master cylinder from the truck, the unit is disassembled as follows: Remove the large boot strap that fastens the boot to the cylinder casting (See Illustration). This permits the removal of the boot, link and eyelet. With a sharp pointed screw driver remove the retainer spring from its groove. This permits the removal of internal parts. Rubber parts and the cylinder bore are then checked.

If inspection shows the cylinder walls scratched or pitted it will be necessary to have the cylinder walls honed to renew the highly polished surface necessary for efficient operation. All Wagner Electric Corporation Branches have the equipment necessary to recondition the cylinders.

After the cylinder has been honed and new cups procured it is recommended that the reassembling operation be performed in the following manner: Wash the casting and parts in clean alcohol, dip the casting and parts in Genuine Lockheed Fluid for lubrication purposes. Install the valve and return spring as shown. Assemble the primary cup and the piston assembly including the secondary cup and piston stop. Snap the retainer spring in the groove. Assemble the boot and link in place and replace the large boot strap. The unit is now ready for installation on the truck.

Description of Wheel Cylinder—The wheel cylinders on the front and rear wheels are of the opposed piston type. Under no circumstances should a rear wheel cylinder be installed on a front wheel or a front wheel cylinder on a rear

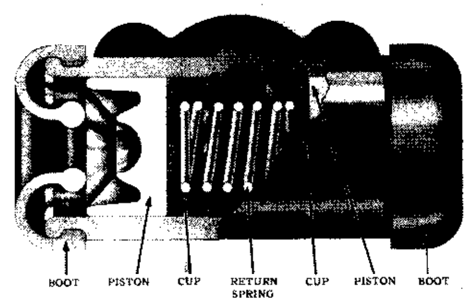


Illustration No. 49—Brake Wheel Cylinder—All Models

wheel as such an error will cause a badly unbalanced braking condition.

WHEEL CYLINDER DIAMETERS

Model	J15 and J20	J25	J30
Front	1-3/8"	1-3/8"	1-1/2"
Rear	1-1/2"	1-3/4"	1-3/4"

To Remove the Wheel Cylinder—Should it become necessary to remove a wheel cylinder for inspection, the following operations should be performed: Disconnect the cylinder from the system by removing the inlet fitting bolt. Remove the two cap screws holding the wheel cylinder to the backing plate. The shoe travel is sufficient to permit the cylinder to be withdrawn without removing the brake shoes.

Inspection of Wheel Cylinder—After removing the wheel cylinder from the brake assembly, remove the boots from the end or ends of the cylinder. The pistons and cups are forced out of the barrel by the return spring pressure. Inspect the cups for ragged edges and the bore for smoothness. Should the bore be scratched or pitted, it will be necessary to have the bore honed to prevent loss of fluid or excessive cup wear.

When reassembling the wheel cylinder, all parts must first be washed in clean alcohol. All parts must then be dipped in Genuine Lockheed Fluid for lubrication. The unit is now ready for installation. New inlet fitting gaskets must be used when installing the cylinder to the system.

Brake Pedal Adjustment—The brake pedal should be adjusted to approximately 1/2" free motion before the pressure stroke starts. More free motion than 1/2" reduces the effective travel of the master cylinder piston which in turn reduces the application of the shoes to the brake drums. On the other hand, if the pedal does not return to its proper position, as assured by the 1/2" free motion, the relief port in the cylinder will be blocked by the piston cup. The pressure in the system will then be gradually built up to a point where the brakes drag.

Free motion or backlash of the brake pedal cannot be determined on booster equipped trucks by feeling the pedal and measuring backlash. The reason for this is that backlash is also required for operation of the booster valve and initial resistance is higher. The best way to set backlash on trucks, with the booster, is to loosen the lock nut on the short rod connecting the brake pedal with the booster piston push rod, then remove the clevis pin. With the brake pedal in its release position, adjust by turning the push rod to shorten or lengthen as required so that 3/32" movement of the lower end of the pedal is required to insert clevis pin when the push rod is held back against the piston. This may be determined by the eye, looking through the clevis pin hole of the pedal rod.

BRAKE SHOE ADJUSTMENT (MINOR)

Normal Lining Wear—When the brake lining becomes worn, as indicated by the foot pedal going almost to floor board, necessary adjustment can readily be made to bring the brake shoes closer to the drum as described in the following paragraph:

1. Elevate the truck so that the wheels clear the ground.
2. Check the wheel bearings and adjust if necessary.
3. Turn adjusting cam until brake shoe drags, then back off until just free. Turn cam in the direction of wheel rotation on front side of the brake and in the opposite direction on the rear side, to tighten.

Important—All brake drums have a feeler gauge opening for checking shoe lining to drum clearances. It is imperative that trucks employed in carrying heavy loads be checked for adequate shoe lining to drum clearance after a readjustment of the brakes.

An accurate check can be readily made with the truck fully or partially loaded, with the tires on the ground, as follows: With the brake drum feeler opening at the lower end of the brake lining, insert a feeler gauge between the drum and the lining. There should be at least .005" clearance. Readjustment may be necessary.

BRAKE SHOE ADJUSTMENT (MAJOR)

In the event the anchor pin has been incorrectly adjusted or when relining the shoes, it is nec-

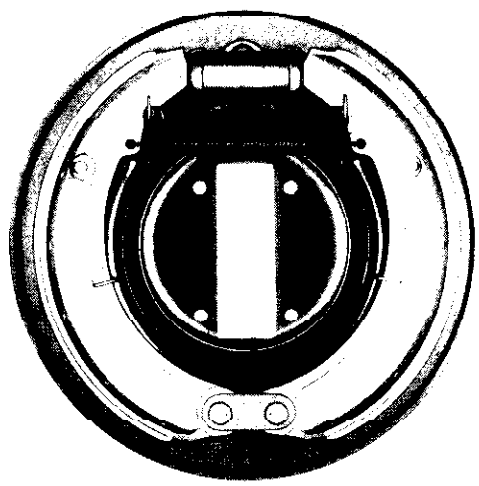


Illustration 50—Brake Shoe Assembly Front—J-15 Models

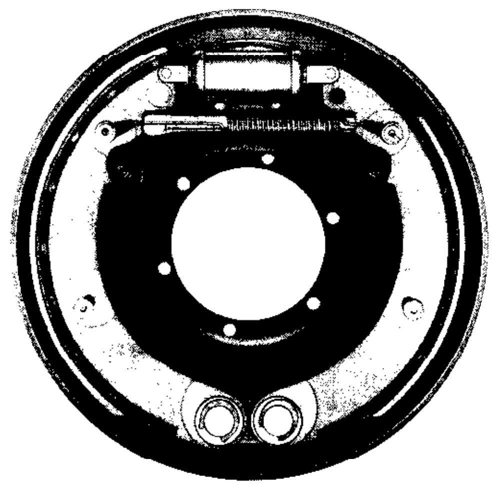


Illustration No. 51—Brake Shoe Assembly—Rear—J-15 and J-20. Note: Except for Emergency Brake Connection Is Also Same as J-20, J-25 and J-30 Front

essary to readjust the anchor pins to relocate the shoes within the drums as indicated in the following paragraphs.

Before a major adjustment of the brakes is made, the following points should be given attention:

(a) Check and tighten the spring "U" bolts and center bolts.

(b) Check the brake pedal for free action and make sure that it has 1/2" free movement.

(c) Check and, if necessary, correct the wheel bearing adjustment.

The following operations are performed with the wheels jacked up to clear the ground: Loosen anchor pin nuts just enough to permit turning the anchor pin with a short wrench.

The desired running clearance between drum and lining is .010" at the upper end of the lining and .005" at the lower or anchor pin end. A free wheel is necessary before adjustment can be made so if drag is present, turn adjusting cams or both cams and anchor pins until wheel is just free.

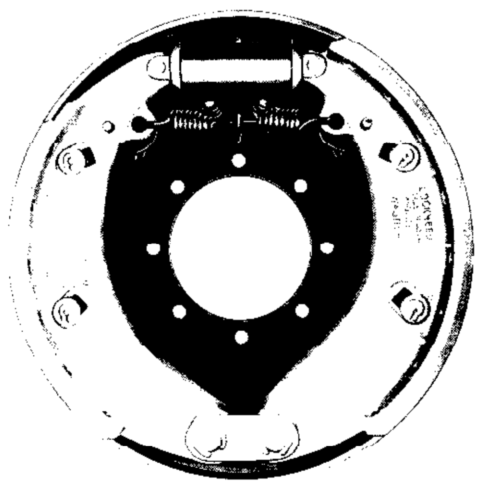


Illustration No. 52—Brake Shoe Assembly—Rear J-25 and J-30 Models

Turn anchor pins in opposite direction to cams to bring lining closer to the drum at the anchor end. Insert feeler gauge between drum and lining, through the peep hole in the drum and check clearances. Turn anchor pin and cams as required to obtain the desired clearances, remembering that tightening at the cam will also bring lining somewhat closer at the anchor pin end and that bringing the lining closer to the drum at the lower end by turning the anchor will swing the upper end of the lining away from the drum. Therefore, it is necessary to check back and forth between both adjustments to obtain correct clearance. When correct clearance is obtained, tighten anchor pin nuts tight at the same time holding the anchor pin stud with a wrench to prevent turning. Recheck clearances after tightening anchor pins.

The above procedure is followed after relining brake shoes or if shoes have been improperly adjusted. It is recommended that when re-installing shoes, all rubbing surfaces be cleaned and covered with a film of "Lubriplate."

Relining Shoes—All Models—When it becomes necessary to reline brake shoes, the following fundamentals must be kept in mind, if a satisfactory job is to be obtained:

1. Snug fit between linings and shoes.
2. Selection of proper rivets.
3. Removal of high spots on lining.

A snug fit is absolutely necessary between the linings and the shoes, if maximum efficiency is expected. Loosely applied linings contact only a small part of their area due to the humps between the rivets. The center rivets in the lining should be set first and the operator should then work toward both ends of the lining.

Rivets should be used which insure a close fit between the rivet shank and the drilled hole in the lining and shoe. Rivets with small shanks, which are loose in the holes, permit the lining to shift on the shoe under pressure, resulting in unsatisfactory brakes. The rivets should be long enough to properly upset the end, securely binding the lining. Should the rivet be too long, the upset end will split materially weakening the riveting job.

High spots, if present, must be removed from the linings with a file or by grinding, before assembling the shoes to the backing plates. This operation gives the linings greater contact area and reduces the possible necessity of a minor adjustment after a few hundred miles.

Description—Bleeding of Line—All Models—Whenever a main pipe line is removed from the master cylinder, the brake system must be air bled at all four wheels. Whenever a line is disconnected from any individual wheel, that wheel cylinder ONLY must be air bled. Fill the fluid reservoir with Genuine Lockheed Brake Fluid before commencing this operation and keep the reservoir at least half full of fluid during the bleeding operation. Remove the screw from the end of the bleeder fitting and attach the bleeder drain tube as shown in Illustration No. 53. Allow the

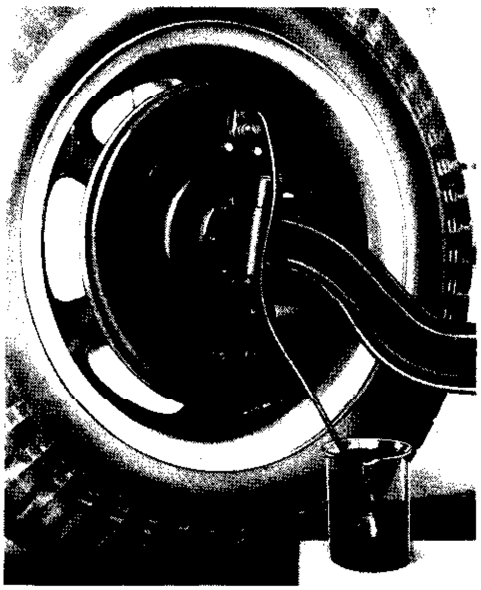


Illustration No. 53—View of Brake Backing Plate—Also Illustrating Air Bleeding Operation

tube to hang in a clean container such as a pint mason jar. Unscrew the bleeder connection three-quarters of a turn and depress the foot pedal by hand allowing the pedal to return slowly to the "off" position. This gives a pumping action which forces the fluid through the tubing and out at the wheel cylinders, carrying with it any air that may be present in the line.

CAUTION: After the brake pedal is depressed, it must be allowed to return slowly otherwise air may be drawn into the system.

Watch the flow of fluid from the bleeder drain tube, the end of which should be kept below the surface of the fluid. When all air bubbles cease to appear or when the stream is a solid fluid mass, close the bleeder connection.

Fluid withdrawn in the "bleeding" operation should not be used again. The fluid should be replenished in the fluid reservoir after each cylinder is bled. Should the supply tank be drained during the bleeding operation, air will enter the system and "rebleeding" will then be necessary. When the bleeding operation is completed, the fluid reservoir must be refilled to within 1/2" of the top.

Use Genuine Lockheed Fluid—All Models—It is of vital importance that only Genuine Lockheed Fluid be used. Any deviation from this recommendation may not only render the brakes inoperative but also automatically cancel the warranty.

Flushing the Braking System—All Models—As previously indicated, the use of fluid other than Genuine Lockheed Fluid is likely to render the foot braking system entirely inoperative. Any mineral base oil, for example, not only causes deterioration of the rubber in the connections and eventual failure, but will cause the rubber cups in the cylinder to soften and expand within a very short period of time.

In any case where mineral oil has been installed in the braking system through error, it is important that the system be thoroughly cleaned and new piston cups installed as set forth in the following operations:

1. Attach the air bleeder tube to the fitting on one wheel cylinder, open the fitting end pump out all old fluid by alternately depressing and releasing the foot brake pedal.
2. Fill the master cylinder reservoir with a good quality alcohol and pump it through the system and out the open bleeder connection. Add alcohol and continue the operation until all traces of the oil or other foreign matter have been flushed from the master cylinder and tube to the wheel.
3. After removing the bleeder tube and closing the bleeder fitting, proceed to the other wheels and repeat the flushing operation as described until all four tubes to the wheels are clean. But one bleeder fitting should be opened at a time — to maintain a maximum pressure in the tube to the open fitting.
4. Remove all wheel cylinders and the master cylinder and disassemble them.
5. After removing the old piston cups thoroughly wash and clean all parts in a good quality alcohol.
6. Install new piston cups. (New cups should be installed in every case where a mineral oil has been introduced in the system, even though there are no visible signs of failure.)

7. Reassemble the wheel cylinders and the master cylinder and install them on the truck. (Dip all parts in clean Lockheed Fluid before reassembling.)
8. Install Genuine Lockheed Fluid and air bleed the system as described in a preceding operation.

With further reference to the preceding operations in the event of complete failure of the master cylinder cups. it will be necessary to clean the master cylinder and replace the cups, before proceeding with the flushing operation.

Parking Brakes, J15, J20 and J25 Models—The hand or parking brake lever operates a band brake at the rear of the transmission. Adjustment is made as follows:

1. By means of the adjusting screws provided on the top, bottom and left side of the brake assembly, adjust the band to obtain 1/32" clearance between the lining and drum at all points. Care should be taken to make sure that the lock wire and lock nuts are properly reinstalled.
2. With the hand lever in the fully released position, adjust the front rod clevis so that when the hook on the rear rod is placed through the front rod clevis and the hole in the lower end of the rocker lever, it will take up all the slack in the cams without applying the brake. Reinstall the cotter key to complete the adjustment.

Parking Brake, Model J30—The parking brake on this model is of the disc type located at the rear of the transmission. The brake can readily be adjusted by positioning the two shoes close to each side of the disc, but with clearance so there will be no drag. The adjusting nut at the rear on right side is used to take up for wear.

VACUUM BOOSTER

The vacuum booster derives its power from the vacuum created in the intake manifold. delivered at low throttle when the engine is not called upon to deliver power for other purposes. It is connected with, and helps to operate the hydraulic brake piston in the master cylinder and greatly reduces pedal pressure.

Lubrication—At not more more than 60-day intervals two ounces of light engine oil (S.A.E. No. 10) should be placed in the booster cylinder as follows: Remove the plug from the end of the cylinder and inject oil. Remove the clevis pin and revolve the piston several times, working it back and forth to distribute the oil to all cylinder surfaces. In cold weather the oil should be thinned with an equal part of kerosene.

MAINTENANCE HINTS

No. 1—Pedal Goes to Floorboard.

Cause

A—Normal wear of lining or improper adjustment.
B—Leak in system.
C—Air in system.
D—Pedal improperly set.
E—No fluid in supply tank.

Remedy

A—When brake linings become worn or are improperly adjusted it is necessary to reset the shoes in their relation to the brake drums. (See "Minor" or "Major" adjustment operations set forth in a preceding paragraph.)

B—A leak in the system will allow the pedal, under pressure, to go to the floorboard gradually. If no leaks are found at the wheels or joints, remove the master cylinder and check the bore of barrel for score or scratches.

C—Air in the system will cause a springy, rubbery action of the pedal. Should a sufficient quantity be introduced in the system, the pedal will go to the floorboard under normal pressure. The system should be bled.

D—The brake pedal should be set with approximately 1/2" free motion before the pressure stroke starts. Additional free motion reduces the effective travel of the master cylinder piston, which in turn determines the amount of working fluid to be expelled from the master cylinder into the lines or system.

E—The fluid level in the supply tank should be checked at regular intervals. Should the tank become empty, air will be introduced into the system, necessitating bleeding.

No. 2—All Brakes Drag.

Cause

A—Mineral oil in system.
B—Pedal improperly set.

Remedy

A—The introduction of mineral oil, such as engine oil, kerosene, or any fluid with a mineral base, into the system will cause the cups to swell and distort, making it necessary to replace all cups and flush the system as described in a preceding paragraph.

B—Directly ahead of the master cylinder piston cup (when in normal released position) is a relief port. It is imperative that this port be open when the brakes are released. The brake pedal should be set with a 1/2" free movement before the pressure stroke begins. Should this port be blocked by the piston cup not returning to its properly released position, the pressure in the system will gradually build up and the brakes drag. Opening a bleeder screw will allow built-up pressure to escape and give temporary relief. The bleeder screw must be secure before the truck or bus is operated.

No. 3—One Wheel Drags.

Cause

A—Weak brake shoe return spring.
B—Brake shoe set too close to drum.
C—Piston cups distorted.
D—Loose wheel bearings.

Remedy

A—Springs sometimes lose their contracting power and take a set. Replace the spring.
B—Readjust the shoes to proper clearance.
C—If in repairing the wheel cylinders, kerosene, gasoline and other fluids are used as a cleaner, instead of alcohol, the cups will swell and distort. The return action of the shoe will be retarded and the brake drum will heat. Replace the cups, wash the unit in alcohol and dip all parts in Lockheed Fuid before reassembling. (Refer to "Flushing the system" described in a preceding paragraph.)
D—Adjust the bearings.

No. 4—Car Pulls to One Side.

Cause

A—Grease soaked lining.
B—Shoes improperly set.
C—Front backing plate loose on knuckle.
D—Front spring "U" bolts loose.
E—Different makes of lining.
F—Tires not properly inflated.

Remedy

A—Replace with new lining, as procured from our Parts and Accessories Division. Grease-soaked linings cannot be salvaged by washing or cleaning.
B—Adjust brake shoes.
C—Loose backing plates permit the brake assembly to shift on the locating bolts. This shifting changes the predetermined centers and causes unequal efficiency. Tighten the backing plates and readjust shoes.
D—Loose spring "U" bolts on the front axle permit the axle to shift on the springs and run out of line. This is noticed especially when a high braking torque is developed. Tighten "U" bolts at their proper location on spring.
E—Different makes of linings have different efficiency. Two different makes, one with high efficiency and one with low efficiency, would cause the car to pull to one side.
F—All tires should be properly inflated.

No. 5—Springy, Spongy Pedal.

Cause

A—Brake shoes not properly adjusted.
B—Air in system.

Remedy

A—Consult remedy A under No. 1.
B—Consult remedy C under No. 1.

No. 6—Excessive Pressure on Pedal, Poor Stop.

Cause

A—Brake shoes not properly adjusted.
B—Improper lining.
C—Oil in lining.
D—Lining making partial contact.

Remedy

A—Consult remedy A under No. 1.
B—Improper grades of brake lining lose their gripping qualities after a few thousand miles. As the frictional quality decreases, the pressure on the brake pedal is naturally increased to get the equivalent stop.
C—Clean or, if badly oil soaked, replace lining.
D—Remove high spots.

No. 7—Light Pressure on Pedal. Severe Brakes.

Cause

A—Brake shoes not properly adjusted.
B—Loose backing plate on axle.
C—Grease-soaked lining.

Remedy

A—Consult remedy B under No. 4.
B—Consult remedy C under No. 4.
C—Consult remedy A under No. 4.

Caution your owners to permit nothing but Genuine Lockheed Brake Fluid to be placed in the braking system of their trucks. Advise them that engine oil or any mineral oil will render the brakes inoperative and will necessitate replacement of all rubber parts in the system.

Wheels

The wheel bearings should be adjusted so that there is barely a perceptible movement attained by rocking the wheel, top and bottom, toward and away from the truck. The front wheels should be aligned with a toe-in of from 1/6 to 1/8 of an inch, measured between the tires or rims at a point approximately nine inches from the floor. Two measurements, of course, are necessary—one to the front of the axle and one to the rear of the axle, both dimensions being taken at the same height.

Installation of Dual Tires and Rims—The installation of dual rear tires and rims must be properly made if tire runout and the resulting evils are to be avoided. With this fact in mind, the following procedure should be carried out carefully to insure freedom from wheel wobble and excessive tire wear.

Installation of Continuous Type Tire Rim Side Ring—The inner edge of the continuous type side ring is cut away at two places (opposite) to facilitate its installation or removal. To install the ring, after the tire is mounted on the rim, place half of the ring over the edge of the rim and, with the foot, force the other half on beginning at either cut-away section and continuing around the rim.

To remove the rim it is only necessary to insert a small pry bar or similar tool in the notch in the ring and, holding the opposite side down in the bottom of the rim groove, pry the ring from the rim.

J15 Models—The dual tire and rim assemblies on this model are spaced and aligned by two individual spacers which have split interlocking joints. The spacers being separated by a cast lug on the end of the wheel spokes. Rim lugs on each side of the wheel draw the rims up to the spacers. Mount the inner tire and rim assembly with the tire rim locking ring on the outer side. Then with the joint open and the flanged edge toward the rim, work the first spacer over the lugs on the ends of the wheel spokes. Tap the latch end of the spacer down into place. Install the second spacer with the flanged facing out, then mount the outer tire and rim assembly with the tire rim locking ring on the inner side. The tire and rim assembly is held in place against the outer spacer with rim lugs. Draw the tire rim lugs up evenly.

J20, J25 and J30 Models—The dual tire and rim assemblies on these models are spaced and aligned by a solid band type spacer. The inner tire and rim assembly should be mounted on the wheel with the tire rim locking ring on the outer side, then mount the spacer band and the outer tire rim assembly with the tire rim locking ring on the inner side. Draw the tire rim lugs up evenly.

When mounting front tire and rim assemblies the rim lugs must be drawn up evenly if tire runout is to be avoided. It is important that the front and rear tire rim lugs be checked for tightness at regular intervals.

Steering Gear

In order to make adjustment properly of the steering gear, the construction must be understood. The steering mechanism proper consists of only two parts; namely, the cam and lever shaft.

The steering gear used on all models is the Ross cam and lever type with integral studs, they are all similar in construction, the only difference be-

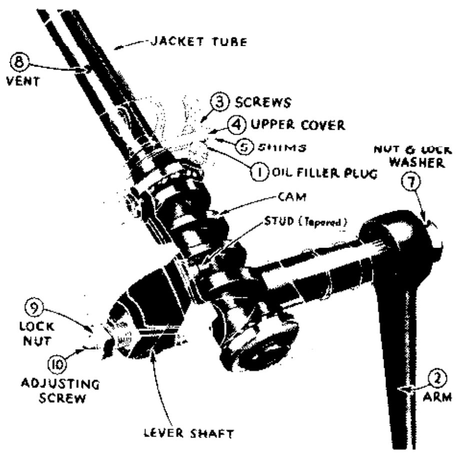


Illustration No. 54—Phantom View of Steering Gear J-15 and J-20 Models

ing, the size of the gear and a slight difference in the method of adjustment.

Note No. 1: In making adjustment on J15 and J20 models, of the ball and thrust bearing to take up end play of cam. Unscrew the four cap screws (3) and move up the housing upper cover (4) as far as possible (about 1/4") to permit removal of shims (5). (Combination of .003", .010" and .030" shims are used in between paper gaskets.

Clip and remove a .003" shim or more as required, re-assemble and test and if necessary, remove or replace shims until adjustment is correct.

With the exception of the above all adjustments on all models are similar and are as follows:

Adjustment should not be made unless required and then these instructions should be followed carefully and in the order given. It should be noted that each adjustment is made independent of the other. The steering gear must be placed in the proper adjustment without regard to the condition of the front end of the truck, and after this has been done the "STEERING GEAR SHOULD NEVER BE FURTHER ADJUSTED IN AN ATTEMPT TO DAMPEN OUT OTHER STEERING TROUBLES."

Adjustment

1. Disconnect drag link from steering gear (preferably by removing drag link at rear ball socket).
2. If the jacket tube is held in the adjusting plug by means of a clamp bolt, loosen the bolt. If there is no clamp bolt, the tube is pressed into the plug — the dash bracket clamp must be loosened so that the tube will turn when the adjusting plug is turned.
3. Note: "A" AND "B" are the only adjustments. Always make adjustment "A" first.

   A—Adjust thrust bearing to take up end play of cam.
4. End play of cam shows up as end play in steering wheel tube.
5. Before making this adjustment loosen the housing side plate adjusting screw (9-10) to free the stud in the cam groove.

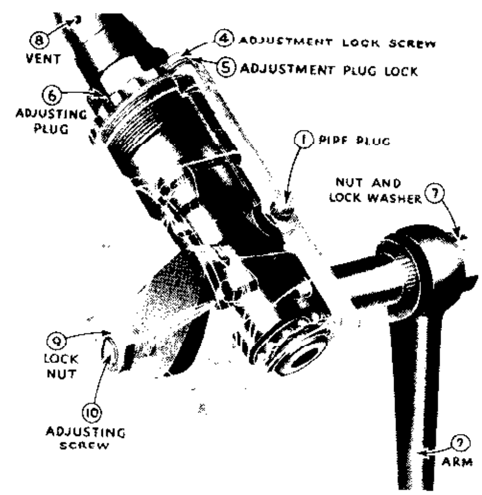


Illustration No. 55—Phantom View of Steering Gear J-25 and J-30 Models

6. Back off lock screw (4-5) and turn down adjusting plug (6) to adjust to a barely perceptible drag so that the steering wheel can be turned freely, (with thumb and forefinger lightly gripping the wheel rim). Tighten lock screw and nut.
   Note: FOR ADJUSTMENT OF J15 AND J20

   MODELS SEE NOTE NO. 1.

B—Adjust lever shaft stud in cam groove for blacklash.

7. Backlash at this point shows up as end play of lever shaft, also as back lash at the steer-wheel and at the ball on steering arm.
8. Note:—The groove is purposely cut deeper in the ends of the cam than in the mid-position. This produces a high range through mid position and makes the groove narrower through this range. This permits take-up of backlash in the mid-position, after normal wear of the groove, without causing a bind at the end positions.
9. Adjust to this mid-position high range. (Wheels straight.)
10. Do not adjust in end positions. (Wheels cramped either to right or left.) Play in end positions is not objectionable.
11. Tighten side cover adjusting screw (10) until slight drag is felt through the mid-position high range when turning the steering wheel slowly from one extreme to the other.
12. **Important**—The gear must not bind any place. ONLY A SLIGHT drag should be felt. To close an adjustment will not correct any steering condition, but will damage and wear the parts, and impair the operation.
13. When the proper adjustment has been made, tighten the lock nut (9) and then give the gear a final test.
14. Make sure steering gear ball arm (2) is tight on the splined shaft and that the lock washer and nut (7) are in place and tight.
15. Tighten instrument board bracket clamp on steering column or adjusting plug clamp bolt (See Par. 4). Turn the steering wheel to see if any stiffness exists. If so, the gear has been adjusted too tightly or the steering column is out of alignment. THE STEERING COLUMN MUST NOT BE SPRUNG IN ANY DIRECTION.
16. Turn the steering wheel as far to the right as possible, then rotate the wheel in the opposite direction as far as possible and note the total number of turns. Turn the wheel back just one-half of this total movement, thus placing the stud lever in mid-position. Place the front wheels in position for straight ahead driving. It should then be possible to connect the drag link to ball on the end of the steering gear arm without moving the gear to any appreciable extent. If this cannot be done, remove the arm from the steering gear and place it on the spline shaft in the proper position. Otherwise it will not permit the front wheels to swing equally to the left and right.

Lubrication

1. Through the pipe plug hole (1), fill housing slowly with Steering Gear Lubricant (See Lubrication Section) until it begins to run out of vent hole (8). DO NOT USE ORDINARY GREASE.
2. Check and fill every 5000 miles as necessary.

Lubrication

Engine Oil—Model J15:

S.A.E. No. 10 for air temperatures below 0° F.

S.A.E. No. 20 for air temperatures between 0° F. and +45° F.

S.A.E. No. 30 for air temperatures above +45° Fahrenheit.

S.A.E. No. 40 for high speed high temperature operation.

Engine Oil—Models J20, J25 and J30:

J20 and J25	J30
S.A.E. No. 20 for air temperatures below 0° F.	S.A.E. No. 30
S.A.E. No. 30 for air temperatures between 0° F. and +32° F.	S.A.E. No. 40
S.A.E. No. 40 for air temperatures above +32° F.	S.A.E. No. 50

Transmission—All Models

S.A.E. No. 90 gear lubricant for air temperature below +32° F.

S.A.E. No. 110 gear lubricant for air temperatures above +32° F.

Rear Axle—All Models

S.A.E. No. 90 gear lubricant for air temperature below +32° F.

S.A.E. No. 110 gear lubricant for air temperatures above +32° F.

All Models

Proper and systematic lubrication at regular mileage intervals is of vital importance if effective results and protection are to be obtained. The importance of using only lubricants of the best quality and recommended specifications cannot be over-emphasized.

Simplify your lubricant problem by using only recommended lubricants manufactured by a responsible oil company of established reputation in your locality. A number of the special lubricants recommended are obtainable through the Studebaker Parts and Accessories Division or its Parts Depots.

Crankcase Draining—The crankcase should be drained after the first 500 miles the truck is driven and refilled with new oil of the proper grade as indicated in the above specification table.

Oil Level in Crankcase—It should be understood that oil changes have no reference to the addition of oil in amounts necessary to keep the oil in the crankcase at the proper level, as shown by the oil level indicator at the side of the crankcase. The oil level should be checked daily, or more frequently if required.

OIL PAN CAPACITY

	J15	J20	J25	J30
U. S. Quarts	6	6	6	8
Imperial Quarts	5.85	5.85	5.85	6.65
Liters	6.6	6.6	6.6	7.57

Oil Filters—J15, J20 and J25 models, are equipped with a Fram oil filter. The oil filter is provided with a replaceable filter cartridge. In addition to the regular periodic changing of oil, a new Fram filter cartridge should be installed whenever the oil appears dirty on the oil level indicator.

The engine oil filter on the J30 model should be cleaned every 1000 miles or every 50 hours of service. To do this, remove the drain plug on the bottom of the filter and the small knurled nut on the top of the filter. Place a can or other receptacle under the drain plug and force air through the top fitting of the filter. Compressed air from an ordinary tire hose can be used.

Carburetor Air Cleaner—The carburetor air cleaner must be serviced regularly if serious damage to the internal engine parts is to be avoided.

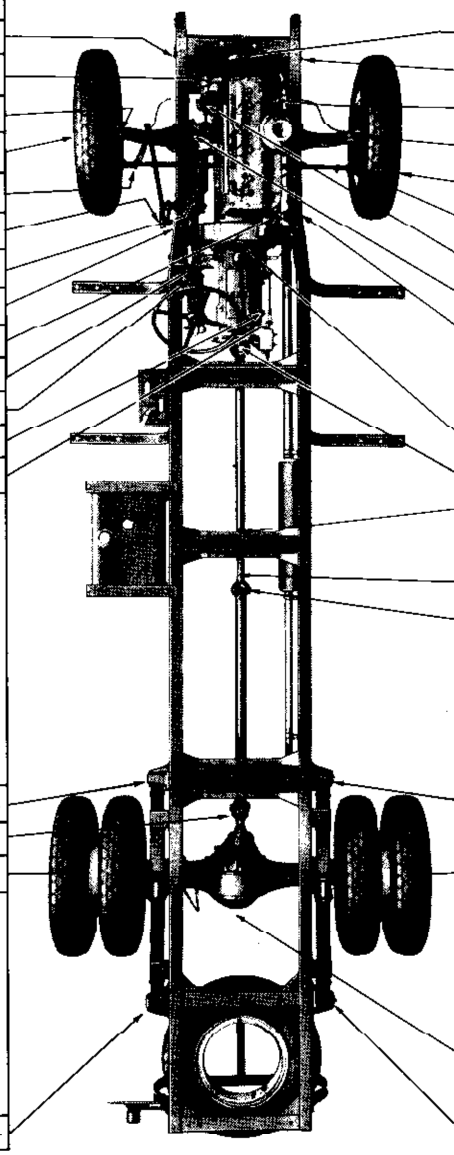
Because of the varied type of operation to which a truck may be subjected, it is not practical for the manufacturer to attempt to set any specific time or mileage intervals for the servicing of this unit. In unusual dusty areas it may be necessary to service the unit daily; whereas, if the operation is confined to the metropolitan areas where little or no dust is encountered, a weekly servicing of the unit should suffice. Instructions for servicing the different type carburetor air cleaners will be found stamped on the body of the cleaner.

CHASSIS LUBRICATION—ALL MODELS

Points Requiring Lubrication Every 1000 Miles:

1. **Front of Front Spring**—Lubricate with pressure gun grease.
3. **Steering Knuckle**—Lubricate with pressure gun grease.
5. **Steering Cross Tube**—Lubricate with pressure gun grease.

	5000 MILES	1000 MILES
SPRING BOLT PRESSURE GUN GREASE		ALL
ENGINE FRONT SUPPORT PRESSURE GUN GREASE	J20 J25 J30	
STEERING KNUCKLE PRESSURE GUN GREASE		ALL
WHEEL BEARINGS WHEEL BEARING LUBRICANT	ALL	
STEERING CROSS TUBE PRESSURE GUN GREASE		ALL
STEERING REACH ROD PRESSURE GUN GREASE		ALL
STEERING GEAR SPECIAL STEERING LUBRICANT	ALL	
SPRING SHACKLES PRESSURE GUN GREASE		ALL
STARTER MOTOR ENGINE OIL SAE NO 20	ALL	
CLUTCH SHAFT PRESSURE GUN GREASE (515 & 520 NOT LUBRICATED)	ALL	
PEDAL ARM HUB BEARING ENGINE OIL SAE 30	ALL	
TRANSMISSION GEAR LUBRICANT	ALL	
PARKING BRAKE LINKAGE PRESSURE GUN GREASE (ENGINE OIL SAE 30)	J15 J20 J25	
SPRING BOLT PRESSURE GUN GREASE		ALL
UNIVERSAL JOINT LIGHT PRESSURE GUN GREASE	ALL	
WHEEL BEARINGS WHEEL BEARING LUBRICANT	ALL	
SPRING SHACKLE PRESSURE GUN GREASE		ALL



1000 MILES	5000 MILES	
J20 J25 J30		FAN PRESSURE GUN GREASE
ALL		SPRING BOLT PRESSURE GUN GREASE
	ALL	GENERATOR ENGINE OIL SAE 20
ALL		STEERING KNUCKLE PRESSURE GUN GREASE
	ALL	WHEEL BEARINGS WHEEL BEARING LUBRICANT
ALL		STEERING CROSS TUBE PRESSURE GUN GREASE
	ALL	DISTRIBUTOR ENGINE OIL SAE NO. 20
J20 J25 J30		WATER PUMP WATER PROOF GREASE
ALL		SPRING SHACKLES PRESSURE GUN GREASE
	ALL	CLUTCH RELEASE BEARING SLEEVE ENGINE OIL SAE NO 30
	ALL	UNIVERSAL JOINT LIGHT PRESSURE GUN GREASE
ALL		PROPELLER SHAFT BEARING SPECIAL GREASE
ALL		PROPELLER SHAFT SPLINES LIGHT PRESSURE GUN GREASE
	ALL	UNIVERSAL JOINT LIGHT PRESSURE GUN GREASE
ALL		SPRING BOLT PRESSURE GUN GREASE
	ALL	WHEEL BEARINGS WHEEL BEARING LUBRICANT
	ALL	REAR AXLE GEAR LUBRICANT
ALL		SPRING SHACKLE PRESSURE GUN GREASE

6. **Steering Reach Rod**—Lubricate with pressure gun grease.
8. **Spring Shackle Rear of Front Spring**—Lubricate with pressure gun grease.
14. **Front of Rear Spring**—Lubricate with pressure gun grease.
17. **Spring Shackle Rear of Rear Spring**—Lubricate with pressure gun grease.
18. **Fan—Models J20, J25 and J30**—Lubricate with pressure gun grease.
25. **Water Pump**—Lubricate by means of the water pump grease cup with special water proof grease—turning the cup two or three turns on Models J20, J25 and J30.

    NOTE: The J15 water pump is prepacked with lubricant and under normal operating conditions should not require additional lubricant.
19. **Front of Front Spring**—Lubricate with pressure gun grease.
21. **Steering Knuckle**—Lubricate with pressure gun grease.
23. **Steering Cross Tube**—Lubricate with pressure gun grease.
26. **Spring Shackle Rear of Front Spring**—Lubricate with pressure gun grease.
29. **Propeller Shaft Bearing**—Lubricate with grease having a high melting point (not below 300° F.—149° C.).
30. **Propeller Shaft Splines**—Lubricate with light pressure gun grease.
32. **Spring Bolt Front of Rear Spring**—Lubricate with pressure gun grease.
35. **Spring Shackle Rear of Rear Spring**—Lubricate with pressure gun grease.

Points Requiring Lubrication Every 5000 Miles:

2. **Engine Front Support—J20, J25 and J30 Models**—Lubricate with pressure gun grease.
4. **Front Wheel Bearings**—Remove the wheel and bearings and pack the bearings with wheel bearing grease. Replace the wheel and adjust the bearings. Do not fill the hub cap.
7. **Steering Gear**—Remove the pipe plug and fill with one of the following lubricants: Gargoyle steering gear lubricant, Standard Oil of Indiana Special Steering gear Lubricant No. 20, Ross Special Steering gear Lubricant, Elco No. 10, Sunoco Special Steering gear Lubricant, (light for winter and heavy for summer) and Whitmore's (No. 65 for summer and No. 70 for winter).
9. **Starter Motor**—Lubricate with from two to four drops of light engine oil (S.A.E. No. 20). The starter motor is located on the right side on J20, J25 and J30 models and on the left side of J15 model.
10. **Clutch Shaft** — Lubricate (both ends of shaft) with pressure gun grease.
11. **Pedal Arm Hub Bearing**—Lubricate with S.A.E. No. 20 engine oil.
12. **Transmission**—Inspect and fill to level of filler plug hole (right side) with lubricant specified in General Lubricant Specification Table.
13. **Parking Brake Linkage J30**—Lubricate with pressure gun grease; on J15, J20 and J25; lubricate with S.A.E. No. 20 engine oil.

    NOTE: Lubricate parking brake cables on all Cab-Forward Models with graphite grease.
16. **Rear Wheel Bearings**—Remove the wheels and spread wheel bearing lubricant directly on the bearings and in the hub.

    NOTE: In trucks equipped with wheel bearing grease plugs, it is only necessary to remove both plugs and insert grease in one opening until it escapes from the other. Both plugs must be removed, however, to prevent over-lubrication and damage to the brakes.
20. **Generator**—Lubricate with not more than two to four drops of S.A.E. No. 20 engine oil. Caution: More than this amount at the commutator end may work through to the brushes.
22. **Front Wheel Bearings**—Remove wheel and bearings and pack the bearings with wheel bearing grease. Replace the wheel and adjust the bearings. Do not fill the hub caps.
24. **Distributor**—Remove the distributor cover and the rotor, placing from two to four drops of light S.A.E. No. 20 engine oil on the exposed wick. Place a very small amount of pressure gun grease on the distributor cam. Lubricate the distributor shaft by means of the grease cup.
27. **Clutch Release Bearing Sleeve**—Lubricate with S.A.E. No. 30 engine oil in cup on right side of clutch housing on J20, J25 and J30 models. On J15 model the cup is located in the clutch inspection hole cover.

    NOTE: Lubricate all clutch and brake linkage with S.A.E. No. 30 engine oil.
15. **Universal Joint**—Lubricate with only a good grade of light pressure gun grease of the consistency of vaseline. Fill until lubricant is

forced out the air vent. If a heavy grease is used the grease retaining washers will be forced out of place.

28. **Universal Joint**—Same as Item Nos. 15 and 30.

33. **Rear Wheel Bearings**—Remove the wheels and spread wheel bearing grease directly on the bearings and in the hub.

    NOTE: In trucks equipped with wheel bearing grease plugs, it is only necessary to remove both plugs and insert grease in one opening until it escapes from the other opening. Both plugs must be removed, however, to prevent over-lubrication and consequent damage to the brakes.

34. **Rear Axle**—Inspect and, if necessary, fill to level of filler plug opening with lubricant specified.

31. **Universal Joint**—Lubricate with only a good grade of light pressure gun grease of the consistency of vaseline. Fill until it is forced out the air vent. If a heavy grease is used the grease retaining washers will be forced out of place.

Preparing Truck for Delivery

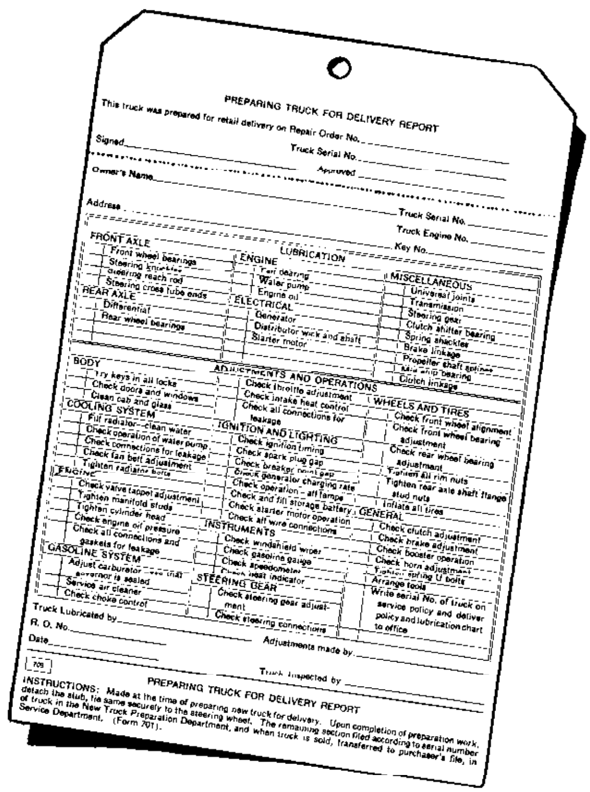
The following form No. 709 "Preparing Trucks For Delivery Report" is placed in the instrument panel compartment of each new truck before it leaves the factory and should be used by every dealer's service organization as a guide when preparing new trucks for demonstration or delivery to owners.

The Repair Order number, date, truck serial number, key number and engine number should be recorded on this form as soon as work is started on the truck.

The mechanic who performed the mechanical operations as well as the man who performed the lubrication must sign the form when they have completed the work specified. The inspector who approved this work must also sign his name in the space allotted. This provides a positive check upon every man who worked upon the truck during its preparation.

When the work is completed the top of the form should be detached and tied to the radiator cap or door handle of the truck. This indicates the truck has been completely serviced and will only require washing at the time of delivery.

The lower part of the form should be forwarded to the general office where it is filed until the truck is sold. The owner's name, address and telephone number is then recorded and the form sent to the service manager's office where it is inserted in a manila folder and filed in alphabetical order according to the owner's name, thus starting the individual service file on that owner.



PREPARING TRUCK FOR DELIVERY REPORT

This truck was prepared for retail delivery on Repair Order No.____

Signed____ Truck Serial No.____

Approved____

Owner's Name____

Address____ Truck Serial No.____

Truck Engine No.____

Key No.____

LUBRICATION

FRONT AXLE
- Front wheel bearings
- Steering knuckles
- Steering reach rod
- Steering cross tube ends

REAR AXLE
- Differential
- Rear wheel bearings

ENGINE
- Fan bearing
- Water pump
- Engine oil

ELECTRICAL
- Generator
- Distributor wick and shaft
- Starter motor

MISCELLANEOUS
- Universal joints
- Transmission
- Steering gear
- Clutch shifter bearing
- Spring shackles
- Brake linkage
- Propeller shaft splines
- Mid ship bearing
- Clutch linkage

ADJUSTMENTS AND OPERATIONS

BODY
- Try keys in all locks
- Check doors and windows
- Clean cab and glass

COOLING SYSTEM
- Fill radiator—clean water
- Check operation of water pump
- Check connections for leakage
- Check fan belt adjustment
- Tighten radiator bolts

ENGINE
- Check valve tappet adjustment
- Tighten manifold studs
- Tighten cylinder head
- Check engine oil pressure
- Check all connections and gaskets for leakage

GASOLINE SYSTEM
- Adjust carburetor — see that governor is sealed
- Service air cleaner
- Check choke control

- Check throttle adjustment
- Check intake heat control
- Check all connections for leakage

IGNITION AND LIGHTING
- Check ignition timing
- Check spark plug gap
- Check breaker point gap
- Check generator charging rate
- Check operation — all lamps
- Check and fill storage battery
- Check starter motor operation
- Check all wire connections

INSTRUMENTS
- Check windshield wiper
- Check gasoline gauge
- Check speedometer
- Check heat indicator

STEERING GEAR
- Check steering gear adjustment
- Check steering connections

WHEELS AND TIRES
- Check front wheel alignment
- Check front wheel bearing adjustment
- Check rear wheel bearing adjustment
- Tighten all rim nuts
- Tighten rear axle shaft flange stud nuts
- Inflate all tires

GENERAL
- Check clutch adjustment
- Check brake adjustment
- Check booster operation
- Check horn adjustment
- Tighten spring U bolts
- Arrange tools
- Write serial No. of truck on service policy and deliver policy and lubrication chart to office

Truck Lubricated by____

R. O. No.____

Date____

Adjustments made by____

709

Truck Inspected by____

PREPARING TRUCK FOR DELIVERY REPORT

INSTRUCTIONS: Made at the time of preparing new truck for delivery. Upon completion of preparation work, detach the stub, tie same securely to the steering wheel. The remaining section filed according to serial number of truck in the New Truck Preparation Department, and when truck is sold, transferred to purchaser's file, in Service Department. (Form 701).

Illustration No. 57—Preparing Truck for Delivery Chart

Diagnosis

ENGINE

1. ENGINE STARTS HARD OR WILL NOT START.

Causes

1. **Improper carburetion due to:**

A. Carburetor passages restricted by water, ice, or corrosion.

B. Insufficient quantity or lack of gasoline in carburetor.

1. Clogged or restricted fuel line from pump to carburetor.
2. Clogged or dirty carburetor screen.
3. Inoperative fuel pump.
4. Low carburetor float level.

C. Choke valve not fully closed.

D. Air leaks at intake manifold or carburetor due to:

1. Loose manifold and carburetor attaching nuts.
2. Leaking intake manifold or carburetor gaskets.
3. Leaks occurring in vacuum line connections at intake manifold.
4. Loose or missing intake manifold core plugs.
5. Warped carburetor manifold attaching flanges.
6. Cracked intake manifold.
7. Leak at air horn gasket or throttle shaft bearing.

E. Poor grade, old or stale fuel in combination with cold weather.

F. Cylinders and manifold flooded with gasoline.

2. **Electrical Difficulties.**

A. Battery.

1. Battery low or completely discharged.
2. Battery terminals loose or badly corroded.
3. Improper ground from battery to frame or from frame to engine.

B. Ignition.

1. Primary circuit.

a. High resistance due to corroded, dirty or loose connections.
b. Ignition out of time.
c. Weak or grounded condenser.
d. Distributor breaker points improperly spaced, dirty, or loose.
e. Breaker arm sticking, springs weak or broken or arm grounded.
f. Loose or grounded distributor terminal posts.

2. Secondary circuit.

a. Corroded cable terminals.
b. Chafed or cracked insulation on cables.
c. Ignition coil weak, improperly grounded or inoperative.
d. Moisture on ignition coil, terminals, distributor cover, spark plug porcelains, or in distributor.
e. Cracked distributor cover.
f. Improper installation of secondary cables. (Not correct for engine firing order.)
g. Spark plugs damaged, dirty, wet, porcelains cracked or gap improperly spaced.
h. Rotor contact spring bent or broken.
i. Distributor rotor grounded.
j. Distributor cap center terminal (inner) broken or missing.

3. Ignition switch.

a. Loose contacts.
b. Corroded or burnt contacts.

C. Starting Motor.

1. Starting motor inoperative or not operating properly.
2. Congealed engine oil due to the use of too heavy a grade of oil or to formation of sludge.
3. Starting motor pinion stuck in flywheel gear.
4. Starting switch.

a. Manual starting switch not operating properly.

3. **Poor Engine Compression resulting from:**

A. Loose cylinder head cap screws.

B. Spark plugs loose in head.

C. Improperly installed or damaged cylinder head gasket.

D. Poorly seating valves.

E. Weak or broken valve springs.

F. Valves holding open due to insufficient tappet clearance.

G. Valves holding open due to stems being warped, corroded or gummed.

H. Badly worn, broken, weak or stuck piston rings.

4. **Unusual Possibilities.**

A. Valves improperly timed.

B. Broken or loose camshaft or distriutor drive gear.

C. Cracked cylinder block.

D. Water in cylinders.

E. Excessive internal friction of engine assembly.

F. Broken or jammed internal parts of clutch or transmission.

G. Exhaust passages restricted.

2. UNEQUAL OR LOSS OF ENGINE COMPRESSION.

Description

Unequal compression between cylinders can be generally detected by listening to the exhaust at the rear of the car when the car is standing and the engine running at a speed equivalent to a road speed of 15 and 20 miles per hour. Unequal compression will give an uneven exhaust. Items affecting ignition and carburetion should also be checked to definitely determine that a compression loss is occurring before any corrective measures are undertaken. A loss of compression in all cylinders can be generally detected by a decrease in power, speed and acceleration.

Test

If a pressure gauge is available it can be used to advantage in determining the compression pressures of the various cylinders. Remove the spark plugs and thread the pressure gauge into the spark plug hole of each cylinder. With the carburetor throttle open crank the engine by use of the starting motor and make a note of the maximum pressure indicated on the gauge. After the gauge readings have been taken for all cylinders the check may be repeated, if desired, by placing a teaspoonful of engine oil in the spark plug holes of all cylinders. If the pressure indicated on the gauge shows a decided increase, the difficulty is probably due to a compression loss past pistons and rings as the added oil is acting as a seal. If the pressure does not increase over the initial readings, improperly seating valves are at fault. A head gasket leakage between two cylinders will be indicated by a low pressure reading for the two adjacent cylinders.

A weak cylinder can also be detected by the sound of the starting motor, as the starting motor speed will increase when cranking against the weak cylinder.

Causes

1. **Improperly seating valves.**
   - A. Valves holding open due to insufficient tappet clearance.
   - B. Sticking valves.
     1. Insufficient stem to guide clearance.
     2. Gum or carbon deposits on valve stems and in valve guides.
   - C. Warped or broken valve heads or bent valve stems.
   - D. Burned, pitted or distorted valve seats.
   - E. Weak or broken valve spring.
2. **Compression loss past pistons and rings.**
   - A. Excessive clearance between pistons and cylinder walls.
   - B. Eccentric or tapered cylinder bores.
   - C. Scored cylinder walls.
   - D. Scored pistons or piston ring faces.
   - E. Excessive piston ring end gap.
   - F. Piston rings stuck in ring grooves. (Gum or carbon deposit.)
   - G. Insufficient piston ring tension.
   - H. Broken piston head.
   - I. Excessive clearance of rings in ring grooves. (Worn grooves or undersize rings.)
3. **Cylinder head gasket leakage.**
   - A. Faulty head gasket.
   - B. Loose cylinder head cap screws.
   - C. Incorrect type of gasket.
   - D. Spark plug gasket leakage.

3. LACK OF PERFORMANCE.

Description

In attempting to diagnose and correct for lack of performance the service man should first of all determine if the performance is normal and that the complaint is not the result of excessive overloading, or the use of an incorrect rear axle gear ratio.

Causes

1. Insufficient or unequal engine cylinder compression.
2. Improper ignition.
3. Inoperative automatic heat control valve. (Valve held in closed position.)
4. Improper carburetion.
5. Restricted carburetor air inlet resulting from:
   - A. Dirty carburetor air cleaner.
   - B. Choke valve not completely opening.
6. Improper setting of economizer valve. See carburetor adjustment instructions.
7. Carburetor throttle lever loose on shaft.
8. Manual carburetor throttle linkage not properly adjusted and carburetor throttle valve not completely opening.
9. Improper fuel pump operation.
10. Partially restricted or clogged exhaust pipe, muffler or tail pipe.
11. Excessive engine temperatures.
12. Pre-ignition.
13. Excessive engine friction resulting from:
    - A. Inadequate internal clearances. (Especially Connecting Rods.)
    - B. Internal misalignment. (Especially Connecting Rods.)
    - C. Use of heavy engine oil.
    - D. Use of piston inner rings.
14. Engine clutch slippage.
15. Excessive rolling resistance resulting from:
    - A. Dragging brakes.
    - B. Tight wheel, pinion, differential or transmission bearings.
    - C. Misalignment in power transmitting units.
    - D. Misalignment of rear axle.
    - E. Under-inflated tires.
16. Use of too fast a rear axle gear ratio.
17. Incorrect valve timing.

4. ENGINE MISFIRES WHEN IDLING NORMAL ENGINE TEMPERATURES.

Causes

1. Improper carburetion resulting from:
   - A. Float level too high.
   - B. Float level too low.
   - C. Restricted or partially clogged idle air passage.
   - D. Restricted or partially clogged idle gasoline jet or passage.
   - E. Carburetor idle adjustment incorrect.
   - F. Air leak occurring between upper and lower carburetor body around idle tube
   - G. Air leak occurring around the carburetor throttle shaft.
2. Air leaks in intake manifold or carburetor resulting from:
   - A. Loose manifold connections or leaks occurring in vacuum lines.
   - B. Loose manifold nuts.
   - C. Broken or damaged intake manifold or carburetor gaskets.
   - D. Crack in manifold.
   - E. Warped or damaged manifold contacting surfaces.
3. Improper ignition.
4. Weak ignition coil.
5. Spark plug difficulties.
6. Uneven compression.
7. **Unusual Causes.**
   - A. Slight water leaks occurring in the cylinder or combustion chamber.
   - B. Slight leak occurring at check valves in the fuel pump.
   - C. Air leak occurring around the intake valve stem due to excessive valve stem to guide clearance.

5. ENGINE MISFIRES AT LOW SPEED (BELOW 20 M.P.H.) ON PULL.

Causes

Same causes as listed under Engine Misses When Idling —Normal Engine Temperatures.

6. ENGINE MISFIRES AT HIGH SPEEDS.

Causes

Please refer Lack of Performance, causes 1, 2, 3, 4, 5, 9, 10, 11, 12, and 17.

7. ENGINE MISFIRES AT ALL SPEEDS.

Causes

Any cause or combination of causes listed under Engine Misfires When Idling—Normal Engine Temperatures, and Lack of Power or High Speed Performance.

8. CRANKSHAFT KNOCKS.

Description

Noises classified as crankshaft knocks are usually dull, heavy, metallic knocks which either increase in frequency as the speed and load on the engine is increased, or are more noticeable at extremely low speed when the engine is idling unevenly.

The most common crankshaft knock—excessive bearing clearance—can usually be detected when the engine is pulling hard under load or on acceleration and causes an audible "bump" with every explosion of the engine or when starting a cold engine after it has set over night. If excessive clearance exists at only one or two of the crankshaft journals the "bump" will be less frequent and less pronounced. By alternately short circuiting each spark plug the approximate location of the loose bearing can usually be determined. Causes 6, 7 and 8 can easily be confused with excessive clearance and should be checked before attempting any other corrections. Causes 3, 4 and 5 will cause a knock very similar to loose main bearings and it is usually impossible to accurately diagnose these causes without removing the crankshaft.

Excessive crankshaft end play causes a sharp noise or rap which occurs at irregular intervals, usually at idling speeds and in bad cases can generally be detected by releasing and engaging the clutch. A loose flywheel can be detected by speeding the engine idle to an equivalent speed of 10 to 15 M.P.H., turn off ignition switch until engine has almost stopped and then snap on ignition switch. If this operation is repeated several times one distinct knock will be noted every time the switch is snapped on if the flywheel is loose.

Causes

1. Excessive bearing clearance (radial).
2. Excessive end play.
3. Eccentric or out-of-round journals.
4. Sprung crankshaft.
5. Bearing misalignment.
6. Insufficient oil supply.
7. Low oil pressure.
8. Badly diluted oil (thin).
9. Loose fly wheel.
10. Loose vibration damper.
11. Loose crankshaft gear.
12. Unusual Causes.
    - A. Broken crankcase web.
    - B. Distorted crankcase.
    - C. Loose crankshaft counter weights.

9. CONNECTING ROD NOISES.

Description

Connecting rod noises are usually a light pound or knock of much less intensity than main bearing knocks. The noise is usually evident with the engine idling and becomes louder when the engine speed is slightly increased. On some engines connecting rod noise is most pronounced at a speed of approximately 30 M.P.H. when running with light engine load. Connecting rod noises should not be confused with Piston or Piston Pin Noises, as described in items 10 and 11.

Test

Connecting rod noise can best be located by short circuiting the spark plugs. The noise can not generally be entirely eliminated by short circuiting, but will be considerably reduced. If causes 2, 3, and 4 are causing the noise, it may be impossible to reduce the noise to any extent by short circuiting, however, a slight change should be noted as each spark plug is shorted.

Causes

1. Excessive bearing clearance on crank pin (radial).
2. Insufficient oil supply.
3. Low oil pressure.
4. Badly diluted oil (thin).
5. Misaligned connecting rods.
6. Eccentric or out-of-round crank pin journal.

10. PISTON NOISES.

The most common piston noise is slap due to the piston rocking from side to side in the cylinder. Piston slap usually causes a hollow, muffled bell-like sound, although in some engines a clicking sound is heard. Slight piston noises that occur with a cold engine and disappear after the engine is warm, do not ordinarily warrant a correction. Piston ring noises generally cause a click, snap, or sharp rattle on acceleration.

Test

Piston and ring noises can be reduced on some engines by short circuiting the spark plugs, however, this method is sometimes confusing with other noises and piston slap can be more accurately detected by driving the engine at low speeds under load. The noise generally increases in intensity as the throttle is opened and additional load applied.

Piston and ring noises can be momentarily eliminated by putting one to two ounces of very heavy engine oil into each cylinder through the spark plug hole. Crank the engine by hand for several revolutions with the ignition off, until the oil has worked down past the piston rings. Replace the spark plugs, start the engine and determine if the noise still exists. If not, the noise is probably due to one of the following causes. As the engine operates for a short time the oil will get hot and run from the rings and pistons and the noise will reoccur.

Causes

1. Excessive piston to cylinder bore clearance.
2. Eccentric or tapered cylinders.
3. Insufficient piston pin clearance.
4. Connecting rod misalignment.
5. Piston or rings interfering with ridge at top of cylinder bore.
6. Piston interfering with carbon accumulation at top of cylinder bore.
7. Piston interfering with cylinder head gasket.
8. Collapsed piston skirts.
9. Broken piston rings.
10. Excessive vertical clearance of ring in ring groove.
11. Pin hole out-of-square with piston.
12. Ring lands not properly relieved.

11. PISTON PIN NOISES.

Description

The most common piston pin noise is the result of excessive piston pin or bushing clearances. This provides a sharp metallic double knock, generally audible with the engine idling and the spark fully advanced. Piston pins striking cylinder walls will cause a rubbing noise and blow-by into the oil pan. Interference between upper end of connecting rod and pin boss is difficult to diagnose and can be mistaken for a loud valve tappet noise.

Test

Allow the engine to run at idle speed with the spark fully advanced. In most cases a sharp metallic double knock will be noted, when the spark plugs are short circuited in the cylinder with loose piston pin. The knock will become more audible when the spark plug is shorted. Retarding the spark will generally reduce the intensity of the knock. If the pins in all cylinders are loose a metallic rattle will be heard which is impossible to short out in any one cylinder.

As piston, piston pin, and connecting rod noises are easily confused, it is suggested that the piston and connecting rod be removed and a bench test be made by feeling for piston pin looseness before actual corrective work is undertaken.

Causes

1. Excessive piston pin clearance.
2. Piston pin bushings loose.
3. Piston pin loose in upper end of connecting rod.
4. Piston pin rubbing cylinder wall.
5. Connecting rod upper end-rubbing piston pin boss.
6. Insufficient piston pin clearance. (Causes Piston Slap.)

12. VALVE AND VALVE LIFTER (PUSH ROD) NOISES.

Description

Noisy valve action has a characteristic clicking noise occurring usually at regular intervals. The frequency of valve action noise is generally less than other engine noises, inasmuch as the valves are operated by the camshaft running at one-half engine or crankshaft speed. If one or two of the valves or valve lifters are causing the noise, the clicking sound will be intermittent, however, if the difficulty occurs with the majority of the valves, the noise may be continuous and will increase in intensity as the engine speed is increased.

Test

The most common cause of valve action noise is that of excessive valve stem to tappet clearance. To check, insert a thickness gauge between the bottom of the valve stem and the tappet adjusting screw with the engine idling. If the clicking noise ceases, the clearance is probably excessive and the adjusting screw should be readjusted. It is important, however, that this clearance not be reduced below factory specifications for the various models, otherwise burned valves are likely to result.

If readjustment of the valve stem to tappet clearance does not eliminate the noise, the condition and clearances of all parts of the valve action would be checked as outlined in the following causes.

Causes

1. **Common Causes.**
   - A. Excessive valve stem to tappet clearance.
   - B. Excessive clearance of push rod in guide.
   - C. Push rod assembly loose on block.
   - D. Push rod assembly misaligned on block.
   - E. Push rod (mushroom end) scored, chipped, rough, worn or broken.
   - F. Push rod adjusting screws.
     1. Face worn.
     2. Face not properly machined.
     3. Threads stripped or crossed.
   - G. Weak valve springs.
2. **Uncommon Causes.**
   - A. Excessive valve stem to guide clearance.
   - B. Insufficient valve stem to guide clearance.
   - C. Warped valve head.
   - D. Valve head face that is not eccentric with stem axis.
   - E. Valve seat face that is not concentric with stem axis.
   - F. Very rough surface on cams.
   - G. Very rough surface in push rod bore.

13. SPARK KNOCK (PRE-IGNITION OR DETONATION).

Description

Spark Knock and Pre-ignition or Detonation causes a metallic ringing sound which is often described as a "ping" and is usually encountered when the engine is laboring, accelerating rapidly or overheated.

Test

Drive the truck until the engine temperatures have become normal, then rapidly accelerate in high gear. If a spark knock is present, a "pinging" sound will be heard during at least a portion of the accelerating period. The intensity of the "ping" can be increased by covering the radiator and causing the engine to labor at excessive engine temperatures.

Causes

1. Large carbon deposits in combustion chamber.
2. Ignition timed too early.
3. Faulty automatic distributor advance (weak springs).
4. Inoperative spark advance modifier (acceleration only).
5. Spark plugs.
   - A. Incorrect type of plug. (Using a plug which is too hot.)
   - B. Porcelains or electrodes carbonized or burned.
6. Sharp metallic edges in combustion chamber.
7. Cylinder head gasket projecting in combustion chamber.
8. Hot engine valves resulting from:
   - A. Incorrect width of valve seats.
   - B. Insufficient tappet clearance.
   - C. Use of wrong type of valve.
   - D. Thin edged valves.
9. Excessive engine temperatures.
10. Poor grade of fuel.
11. Old or stale fuel.
12. Excessively lean carburetor mixture.
13. Inoperative automatic heat control valve. (Valve held in closed position.)

14. ENGINE BACK FIRING THROUGH CARBURETOR.

Description

Engine back firing through the carburetor when starting a cold engine is many times unavoidable and should not be considered, as it is the result of the incorrect air-gasoline mixture entering the engine and will automatically correct itself after the engine reaches normal operating temperatures if carburetor and choke adjustments are correct. Continued back firing after the engine has become warm or back firing after considerable operation should be corrected by checking the following causes:

Causes

1. Cold engine in conjunction with improper choke action.
2. Improper ignition timing.
3. Improperly seating valves, especially intake.
4. Incorrect valve timing.
5. Pre-ignition from any source.
6. Excessively lean or abnormally rich carburetor mixture.
7. Intake manifold air leaks.
8. Defective cylinder head gasket. (Especially between cylinders.)
9. Poor quality of fuel.
10. Secondary wires improperly installed (crossed) in distributor cap.

15. MISCELLANEOUS ENGINE NOISES.

Description

Miscellaneous noises about the engine are sometimes very difficult to find and it is impossible to accurately describe and suggest methods for locating all of the noises which may occur. The following causes are those most frequently encountered. Cause Nos. 1, 2, and 4 usually cause a heavy thud while a manifold heater valve rattle is apparent as a light metallic rattle or vibration. No. 8 causes roaring noise when the engine is running. No. 9 causes a whistle at all engine speeds while a similar whistle is encountered from No. 13 when the engine is accelerated. No. 10 will be apparent by an exhaust leak while Nos. 11, 12 and 16 cause squeaks and rattles.

Frequent Causes

1. Engine loose in frame.
2. Engine supports loose (rear brackets and front cross member).
3. Engine supports at front or rear of cylinder block loose or broken.
4. Flywheel loose on crankshaft.
5. Crankshaft fan pulley or vibration damper loose on crankshaft.
6. Manifold heat control valve rattling.
7. Thin walled manifold (roaring noise).
8. Foreign object in exhaust manifold or passages.
9. Loose exhaust pipe at manifold connections.
10. Interference of exhaust line with engine side pan, or frame.
11. Engine side pan loose.
12. Exhaust to inlet manifold gaskets blown.
13. Engine striking dash.
14. Transmission rubbing floor boards.
15. Loose engine accessories such as generator, generator coupling, water pump, water pump coupling, accessory bracket, engine fan, fan bracket, horn, etc.

16. ENGINE TORSIONAL VIBRATION.

Description

Torsional vibration is more severe in some engines than in others due to unavoidable manufacturing tolerances. Torsional vibration is generally apparent as a high pitched whir at definite speed ranges. Torsional vibration will not be apparent throughout the entire engine speed range but may be apparent at a definite speed within a range of three or four M.P.H. A slight torsional vibration may be normal and the service man should not attempt to correct unless the vibration becomes severe.

Causes

1. Improperly functioning vibration damper resulting from:
   - A. Improper assembly.
   - B. Improper adjustment.
   - C. Stuck damper (inoperative).
   - D. Damper loose on crankshaft.
2. Excessive timing gear lash (.002" or more).
3. Eccentric timing gear (usually result of high key).
4. Timing gears loose on cam or crankshaft.
5. Excessive clearance at camshaft forward bearing.
6. Excessive clearance at crankshaft forward bearing.
7. Engine slightly loose in mountings.
8. Clutch linkage cross shaft not free, or lubricated properly.

17. ENGINE VIBRATION—ESPECIALLY HIGH SPEED.

Causes

1. Unequal compression of engine cylinders.
2. Ignition distributor points not synchronized.
3. Engine misfires at high speeds.
4. Unbalanced fan or loose fan blade.
5. Incorrect adjustment of biscuit type engine mounting.
6. Variation in weight of reciprocating parts (Piston and ring assemblies or connecting rods).
7. Unbalanced flywheel.
8. Unbalanced engine clutch assembly.
9. Engine loose mountings.
10. Engine support loose on frame or cylinder block.
11. Unbalanced or sprung crankshaft.
12. Excessive engine frictional resistance resulting from:
    - A. Insufficient internal clearances.
    - B. Scored pistons.
    - C. Use of too heavy engine oil.

18. EXCESSIVE ENGINE OIL CONSUMPTION.

Description

Speed and the general condition of the engine has a decided effect upon oil consumption. It must be remembered that sustained road speeds under load require greater oil consumption to provide adequate lubrication. It must also be remembered that the modern engine holds from a pint to a quart of oil in suspension for from 5 to 10 minutes after stopping the engine. For this reason an accurate check of the oil level can not be obtained until after the engine has been stopped and allowed to stand for several minutes with the truck sitting level. If the engine is actually burning excessie oil, it will be indicated by gray smoke emerging from the exhaust pipe whenever the engine is accelerated after running at idle speed for a short period of time.

Test

Before any corrections for oil consumption are made, a test drive of 50 or 100 miles should be made with oil known not to be excessively diluted. This test should be made under the usual load and operating conditions. Before the test is started, the engine should be operated for a sufficient length of time to reach normal operating temperatures; the oil allowed to drain for 10 minutes and the quantity carefully measured and sufficient oil added to the container so that the oil pan may be re-filled with the factory recommended amount. After the test has been run, the oil should be drained as soon as possible and the truck allowed to stand for 10 minutes before the quantity of oil drained out is measured. If the amount of oil used is excessive, a very careful check for leaks should be made before the engine is disassembled. A check for leaks can be made by spreading papers on the floor of the garage under the forward part of the truck and running the engine idle for several minutes at an equivalent speed of from 20 to 25 M.P.H. A severe leak will be apparent by oil dropping on the paper.

Causes

1. Loss from external leaks:—
   - A. Oil pan gasket damaged or improperly installed.
   - B. Oil pan gasket flange distorted or cap screws loose.
   - C. Oil pan drain plug loose or gasket damaged.
   - D. Oil pan cracked.
   - E. Oil pan rear main bearing cap packing missing or improperly installed.
   - F. Rear main bearing cap oil seal plugs improperly installed or loose.
   - G. Timing gear housing gasket damaged or improperly installed.
   - H. Timing gear housing flange distorted or cap screws loose.
   - I. Timing gear housing cracked.
   - J. Valve cover plate gasket damaged or improperly installed.
   - K. Valve cover plate gasket surface dirty, distorted or plates loose.
   - L. Oil pump cover gasket loose or improperly installed.
   - M. Crankshaft fan pulley:—
     1. Eccentric pulley hub.
     2. Timing gear housing not properly centered on pulley hub.
     3. Rough pulley hub.
     4. Restricted or absence of oil return groove on pulley hub.
     5. Failure to properly install starting crank jaw nut washer or gasket.
   - O. Camshaft rear bearing Welsh plug loose or improperly installed.
   - P. Leaks at oil filter lines.
   - Q. Leaks at flexible oil gauge pipe connector.
2. Poor quality or improper grade of engine oil.
3. Badly diluted engine oil.
4. More than recommended amount of oil in engine pan.
5. Excessive oil pressure.
6. Sustained high road speeds. (Requires greater oil consumption for adequate lubrication.)
7. Abnormal piston to cylinder wall clearance or scuffed pistons.
8. Eccentric or tapered cylinder bores.
9. Piston ring difficulties.
   - A. Badly worn or scuffed piston rings.
   - B. Broken piston rings.
   - C. Piston rings stuck in ring grooves, (Gum or carbon deposit.)
   - D. Improper piston ring combination.
   - E. Piston rings loose in ring grooves.
   - F. Insufficient end gap clearance of rings.
   - G. Insufficient ring tension.
10. Excessive radial or axial clearance of main or connecting rod bearings or out of round crankshaft journals.
11. Abnormally high crankcase temperatures.

19. OIL PRESSURE—ENGINE.

Description

The engine oil pressure gauge should register from 20 to 40 lbs. at 40 M.P.H. with warm oil, depending upon the truck model being tested. A pressure reading in excess of 40 lbs. at the higher speeds is not necessary and should be avoided.

Causes

1. **Low oil pressure.**
   - A. Use of very light or badly diluted engine oil.
   - B. Water, sludge, ice or dirt restricting oil pump intake screen.
   - C. Oil relief valve not properly seating, due to:
     1. Foreign substance on valve seat or valve face.
     2. Distorted valve seat or valve face.
     3. Improper adjustment of reilef valve spring.
     4. Weak or broken valve spring.
   - D. Air leaks occurring in oil pump suction line.
   - E. Loose oil pump body, cover or improperly installed gaskets.
   - F. Badly worn or damaged oil pump gears.
   - G. Excessive clearance of pump gears in pump body.
   - H. Pressure loss in the distributing line due to:
     1. Improperly installed or loose gaskets.
     2. Fractured tubes, pipes, webs or loose connections.
   - I. Excessive clearance of main, connecting rod or camshaft bearings.
   - J. Inaccurate oil pressure gauge.
2. High oil pressure.
   - A. Use of heavy engine oil.
   - B. Relief valve not opening resulting from:
     1. Improper adjustment.
     2. Heavy or stiff relief valve spring.
     3. Relief valve stuck.
   - C. Restricted or partially clogged, distributing line or oil passage at relief valve.
   - D. Inaccurate oil pressure gauge.

20. INOPERATIVE ENGINE OIL FILTER.

Causes

1. Filter inlet or outlet passages or pipes clogged or restricted.
2. Filter inlet or outlet passages, pipes or connections leaking.
3. Filter body clogged and should be changed.

21. OIL PUMP AND DISTRIBUTOR DRIVE NOISES.

Description

Oil pump and distributor drive noises are usually encountered when the engine is idling. A grind or growl usually indicates causes Nos. 1 and 2 while a whine indicates causes Nos. 3 and 9. A chatter usually accompanies causes 4 and 7 inclusive while a fairly heavy bump indicates a loose oil pump mounting. Hydraulic rap is similar to a main bearing knock and increases in frequency as the engine speed is increased.

Test

Causes 1 to 9 inclusive can generally be located without disassembling any parts with the use of a sounding rod in the region of the oil pump and distributor. A sounding rod is particularly beneficial on the models using the inclined oil pump and distributor drive shaft. Cause No. 10 can be diagnosed by firmly gripping the oil pressure gauge with the hand and noting if pulsation or bump is apparent.

Causes

1. Worn or damaged oil pump and distributor driven gear.
2. Worn or damaged camshaft drive gear.
3. Improper mesh of drive and driven gears.
4. Couplings loose on shaft.
5. Excessive clearances of shaft in oil pump body or distributor bracket bushings.
6. End play in distributor drive shaft.
7. End play in oil pump drive shaft.
8. Oil pump not rigidly mounted.
9. Damaged or scuffed oil pump gears.
10. Oil pump hydraulic rap.

GASOLINE SYSTEM

1. EXCESSIVE GASOLINE CONSUMPTION.

Description

Many complaints of excessive gasoline consumption are entirely due to the type of truck operation and are not caused by mechanical difficulties of any nature. Before any corrective measures are undertaken, a test run should be made under normal load and operating conditions, using a test tank or an accredited mileage tester. An accurate record of the mileage obtained should be kept. The test should be made on a level road where a constant speed can be maintained without undue interference from other traffic. It is also advisable to conduct the test using both directions of the road. If the gasoline economy obtained is low the following causes should be checked and a second test run made over the same course as the first test under similar conditions so that a definite record of the improvement is available. It is often advisable to invite the owner to accompany the service man on a test run to insure that the owner is familiar with the actual economy obtained during the test. At this time the service man can explain that the type of operation has a material effect upon gasoline economy.

Causes

1. **Caused by type of operation:**
   - A. Sustained high speed.
   - B. Long periods of idle operation.
   - C. Abnormally fast engine idle speed (throttle not closed).
   - D. Numerous starts and stops in congested traffic.
   - E. Truck operated on short trips only.
   - F. Failure to use engine warming devices in cold weather such as engine cooling system thermostat, radiator covers, etc.
   - G. Driving with retarded spark.
2. **Caused by units other than the carburetor:**
   - A. Faulty ignition:
     1. Incorrect timing (Especially late ignition).
     2. Improperly spaced distributor points.
     3. Incorrect distributor point synchronization.
     4. Weak ignition condenser.
     5. Weak ignition coil.
     6. Cracked or chafed wiring insulation.
     7. Defective or incorrectly spaced spark plugs.
   - B. Restricted or partially clogged carburetor air cleaner.
   - C. Abnormal rolling resistance due to:
     1. Dragging brakes.
     2. Tight wheel bearings.
     3. Excessive front wheel toe in or toe-out.
     4. Excessive friction in power transmitting units.
     5. Under inflated tires.
   - D. Fuel pump diaphragm leakage
   - E. Poor engine compression.
   - F. Partially clogged or restricted exhaust pipe, muffler or tail pipe.
   - G. Pre-ignition.
   - H. Engine clutch slippage.
   - I. Use of too slow or too fast a rear axle gear ratio.
3. **Condition caused by improper carburetor adjustment.**
   - A. Float level too high.
   - B. Float leaking and partially filled with fuel.
   - C. Float needle valve leaking.
   - D. Improper adjustment of accelerating pump.
   - E. Economizer valve comes into operation too quickly. (Improper adjustment of linkage or if vacuum type—a loss in manifold vacuum.)
   - F. Economizer piston stuck in cylinder or valve stem sticks in guide.
   - G. Improper adjustment of linkage controlling accelerating pump and economizer valve.
   - H. Internal leakage in carburetor due to:

1. Improperly seating accelerating pump valve.
2. Improperly seating economizer or high speed valve.
3. Improperly seating warming up valve.
4. Fractured passages.

I. Use of incorrect size or adjustable metering jets or metering pin.
J. Loose plugs or damaged gasket at base of main discharge jet nozzles.
K. Carburetor throttle stop screw set too fast.
L. External carburetor leaks.

4. **Leaks occurring in the gasoline tank or lines.**

2. MANIFOLD LEAKS—INTAKE AND EXHAUST.

Causes

1. Loose manifold connections or leaks occurring in vacuum lines (Intake manifold).
2. Loose manifold nuts.
3. Insufficient threads on manifold attaching studs permitting nuts to bottom.
4. Distortion or misalignment existing at gasket surfaces on:
   A. Intake manifold.
   B. Exhaust manifold.
   C. Carburetor attaching flange.
   D. Carburetor to manifold spacer (When used).
5. Loose or missing intake manifold core plugs.
6. Damaged or improperly installed gaskets.
7. Improper registry between parts in manifold and cylinder block.
8. Restriction in exhaust pipe, muffler or tail pipe (Excessive back pressure.)

3. FUEL PUMP LEAKAGE AND INSUFFICIENT FUEL DELIVERY.

Causes

1. Restricted gasoline tank vent.
2. Restricted or partially clogged gasoline tank to fuel pump line.
3. Air leak occurring at connections or in gasoline tank to fuel pump lines.
4. Restricted or partially clogged gasoline tank outlet pipe assembly.
5. Air leak occurring above fuel level in gasoline tank outlet pipe assembly.
6. Restricted or partially clogged fuel pump screen.
7. Fuel pump filter bowl loose.
8. Damaged or improperly installed bowl gasket.
9. Punctured or worn out diaphragm.
10. Leak around diaphragm shaft or pull rod.
11. Loose valve seats in fuel pump.
12. Improperly seating fuel pump valves (replace).
13. Sticking fuel pump valves.
14. Rocker arm shaft (pin) out of position.
15. Broken rocker arm.
16. Vapor in line between tank and pump (Vapor lock).

4. FUEL PUMP NOISE.

Description

Fuel pump noise very closely resembles a tappet noise although at times the noise is somewhat lighter than a tappet noise. Like tappet noises, a fuel pump noise is encountered at camshaft speed.

Test

Allow the engine to idle and check for noise with a sounding rod against the fuel pump body. In some instances fuel pump noise can be detected by tightly gripping the pump body with the hand and noting if a "bump" or vibration is felt.

Causes

1. Weak or broken rocker arm contact spring.
2. Worn rocker arm or rocker arm pin.
3. Diaphragm spring rubbing on fibre bushing.
4. Linkage striking the diaphragm protector.
5. Fuel pump body loose on engine.
6. Scored operating lever or camshaft eccentric.
7. Interference of fuel pump lever with inner surface or crankcase.

6. ELECTRIC GASOLINE GAUGE — INOPERATIVE OR INACCURATE.

Causes

1. **Gauge shows "Full" under all conditions.**
   A. Leads reversed at dash unit.
   B. Line to tank unit grounded.
   C. Poor ground at dash unit.
2. **Gauge shows "Empty" under all conditions.**
   A. Line to tank unit open.
   B. Tank unit burned out.
   C. Tank unit improperly grounded due to loose screws or paint under the screw heads.

ELECTRICAL SYSTEM

1. FAULTY IGNITION.

Causes

1. **Primary circuit.**
   A. Wiring.
      1. Loose or corroded terminals.
      2. Insulation cracked or worn through.
      3. Faulty ground connection.
   B. Ignition switch.
      1. Loose contacts.
      2. Corroded or burned contacts.
   C. Distributor.
      1. Ignition not properly timed.
      2. Distributor points not properly spaced or synchronized.
      3. Distributor points dirty, pitted or loose.
      4. Sticking breaker arm or broken breaker arm spring.
      5. Low cam lobe.
      6. Excessive clearance of distributor shaft bushings.
      7. Bent or sprung distributor shaft.
   D. Condenser weak or grounded.
2. **Secondary circuit.**
   A. Wiring.
      1. Corroded or loose terminals.
      2. Cracked or leaking cable insulation.
   B. Distributor.
      1. Cracked distributor cap.
      2. Moisture or dirt accumulation in distributor cap.
      3. Distributor cap terminals burned or corroded.
      4. Distributor rotor burned or corroded.
   C. Weak ignition coil.
   D. Faulty or incorrectly spaced spark plugs.
   E. Use of spark plug to coil suppresser on radio installations.

2. DISTRIBUTOR — INCORRECTLY ADJUSTED OR DAMAGED.

Causes

1. Breaker point gap incorrect.
2. Breaker points burned, cracked, pitted or dirty.
3. Ignition timing too late or too early.
4. Distributor cap cracked.
5. High tension cable sockets corroded.
6. Condenser open or shorted (check with new condenser).
7. Breaker arm spring weak or broken.
8. Breaker arm rubbing block loose or badly worn.
9. Breaker arm plate loose or not properly grounded.
10. Automatic advance plate free on distributor base.

11. Distributor cap inserts bent, loose or badly burned.
12. Insufficient clearance between distributor cap inserts and rotor.
13. Grounded rotor or broken rotor spring.
14. Distributor shaft or bushings worn.
15. Distributor drive gear or coupling sheared or loose on shaft.
16. Distributor drive gear or oil pump drive gear not properly assembled (Timed).

3. IGNITION COIL DIFFICULTIES.

Causes

1. Primary winding.
   A. Shorted (Ignition current draw abnormally large —weak spark).
   B. Grounded (Ignition current does not drop to zero when contacts separate).
   C. Open (No primary current).
2. Secondary winding shorted or grounded (weak spark).
3. Improper ground between coil and attachment.
4. Loose or faulty ignition switch contacts.
5. Loose contact of distributor to coil secondary cable in coil tower.
6. Use of a coil other than standard equipment.
7. Faulty ammeter.

4. SPARK PLUG DIFFICULTIES.

Causes

1. Plug does not fire or spark is weak.
   A. Porcelain cracked.
   B. Porcelain carbonized or burned.
   C. Moisture or dirt accumulation on porcelain.
   D. Electrode gap not properly spaced (Spark will not jump at high speed).
   E. Weak ignition coil.
2. Electrodes and porcelain burn at low mileages.
   A. Use of too hot an operating plug.
   B. Use of high compression in combination with sustained high speed.
3. Fouled plugs.
   A. Use of too cold an operating plug.
   B. Excessively rich carburetor mixture.
   C. Engine oil passing piston rings.
4. Use of some types of spark plug and coil suppressors in radio installations.

5. STARTING MOTOR INOPERATIVE OR NOT OPERATING PROPERLY.

Causes

1. Dead or undercharged battery.
2. Poor battery ground or corroded battery terminals.
3. Starting motor to battery cable broken or terminal cracked.
4. Teeth on starter pinion or flywheel broken.
5. Use of heavy engine oil in cold weather.
6. Teeth on starter pinion or flywheel burred causing starter to stick.
7. Poor ground for starting motor due to broken ground cable.
8. Manual starting switch not operating properly.
9. Excessive resistance to rotation due to:
   A. Bent armature shaft.
   B. Distorted or cracked housing.
   C. Misaligned or tightly fitted bearings.
   D. Lack of lubrication.
   E. Starter not properly aligned with engine.
13. Armature shorted.
14. Dirty, burned, pitted or excessively lubricated commutator surface.
15. High mica between commutator segments due to commutator wear.
16. Brush ring grounded or set incorrectly.
17. Excessive brush spring tension causing rapid commutator and brush wear.
18. Brushes not functioning properly due to:
   A. Sticking brush holders.
   B. Weak or broken springs.
   C. Bent brush holder arms.
   D. Brushes worn too short.
   E. Brushes sticking in guides.
   F. Incorrect type of brushes.
   G. Brush connections or pig tails loose.

6. STARTER DRIVE NOISES.

Description

The most common of starter drive noises due to causes Nos. 1, 2 and 5 is a pronounced grind when the starter motor is operating. This grind is similar to but louder than, the normal starter noise when the engine is being cranked and should not be confused. A hissing noise will indicate cause No. 3 while cause No. 4 will be indicated by an intermittent rubbing noise. If the starting motor is not rigidly attached a knock or "bump" will be heard when the starter pinion engages. Cause No. 7 will be indicated by a squeak.

Causes

1. Starter pinion teeth chipped or damaged.
2. Flywheel gear teeth chipped or damaged.
3. Sprung or distorted drive shaft.
4. Starter motor not properly mounted (misaligned).
5. Starter motor loose on engine.
6. Starter motor armature shaft bearing worn, broken or dirty.

7. GENERATOR INOPERATIVE OR NOT CHARGING PROPERLY.

Causes

1. Slipping fan belt.
2. Ammeter indicates incorrect or no charging rate (Check with master ammeter).
3. Generator pulley loose on shaft.
4. Relay points remaining open.
5. Third brush in retarded position (Low charging rate)
6. Third brush in advanced position (High charging rate).
7. Too low an engine idle speed.
8. Armature overheating caused by too high a charge rate, or shorted armature.
9. Open armature (Low or zero charging rate).
10. Grounded armature.
11. Grounded third brush.
12. Loose pole (Armature cannot be rotated easily).
13. Short between commutator bars.
14. Worn armature or bent shaft (Generator noisy).
15. Improperly seating or worn brushes.
16. Incorrect type of brushes.
17. Commutator out of round.
18. High mica between commutator bars.
19. Weak or broken brush springs.
20. Greasy, charred or glazed commutator.
21. Sticking brush holder arms—brushes worn too short.
22. Brushes soft or oily (Excessive lubrication).
23. Shorted, open or burned out field coils.

8. GENERATOR AND GENERATOR DRIVE NOISES.

Description

The most common of generator noises is a squeak resulting from causes Nos. 1, 2 and 10. Causes Nos. 3 and 5 are usually apparent by a knock at low speed although cause No. 3 may sometimes also cause a squeak. An intermittent knock increasing in frequency as the speed is increased, will indicate cause No. 4. A whine usually indicates causes No. 7 and 8 while a "thud" usually indicates causes Nos. 6 and 9.

Causes

1. Worn, damaged or defective generator bearings.
2. Insufficient bearing lubrication.
3. Pulley loose on shaft.
4. Cracked pulley.
5. Generator coupling worn or loose.

6. Excessive end play of generator shaft.
7. Misalignment of generator belt.
8. Generator loose on engine.
9. Generator brush noises resulting from:
   A. High mica insulators between commutator bars.
   B. High commutator bars.
   C. Rough commutator.
   D. Dirty commutator.
   E. Improperly seating brushes.
   F. Hard spots in generator brushes.
   G. Insufficient or excessive brush spring tension.
   H. Generator brushes loose in holder.

9. INCORRECTLY ADJUSTED OR DAMAGED RELAY.

Causes

1. Cuts in too soon (Ammeter indicates discharge after relay closes—Points may chatter).
2. Cuts in too late (Charging current in excess of 3 amperes before relay closes).
3. Cuts out too soon (Contacts open before zero charging rate).
4. Cuts out too late (Contacts do not open until approximately 2 amperes discharge current).
5. Open or shorted shunt winding (Generator does not charge until contacts are closed by hand).
6. Open series winding (Relay closes normally, but generator does not charge).
7. Shorted series winding (Relay does not stay closed at low charging rates—contacts chatter).
8. Contact points burned, dirty or badly pitted (Action erratic).
9. Proper ground not established between relay and generator.

10. FREQUENT RECHARGING OF BATTERY NECESSARY.

Causes

1. **Insufficient current flow to battery.**
   A. Inoperative generator.
   B. Too low an engine idle speed.
   C. Loose connections in external circuit.
   D. Corroded connections in external circuit (Especially at battery terminals and frame ground strap).
   E. Slipping fan belt.
   F. Relay points out of adjustment.
   G. Ammeter registering higher charging rate than actual (Check with master ammeter).
2. **Excessive starting load causing abnormal current flow from battery.**
   A. Frequent use of the starter motor.
   B. Excessive use of the starter motor due to difficulty in starting.
   C. High mica between commutator bars or badly worn or burnt commutator.
3. **Excessive lighting load due to:**
   A. Truck operation confined largely to night driving and excessive lamp load on truck and trailer.
   B. Use of high candle power bulbs in headlights.
   C. Tail and stop light wires reversed.
   D. Stop light switch inoperative (closed at all times).
   E. Use of spot lights.
   F. Unnecessary use of headlights while parking.
   G. Ground or short in the lighting circuit.
4. **Abnormal accessory load due to use of**
   A. Radio.
   B. Heater (Electrically operated).
   C. Windshield defroster.
   D. Cigar lighter.
5. **Internal discharge of battery.**
   A. Plates badly sulphated.
   B. Cell leak due to cracked jar or sealing compound.
   C. Water level not at proper height.
   D. Plate separators ineffective.

11. ERRATIC HEAD LIGHTS.

Causes

1. Bulbs loose in sockets.
2. Loose or dirty connections between bulbs and cable terminals.
3. Poor contacts in light switch.
4. Low or discharged battery.
5. Battery plates badly sulphated.
6. Improperly grounded head lamp bodies or reflectors.
7. Faulty frame to battery ground (Bulbs burn out quickly).
8. Loose contact between lamp body and reflector.
9. Faulty generator action.
10. Faulty relay operation.
11. Intermittent short circuit or ground in wiring assembly.
12. Loose connections at ammeter.
13. Overcharged battery.

12. HORN DIFFICULTIES.

Causes

1. **Vibrator type horn does not blow or does not have proper tone.**
   A. Horn button not making good contact.
   B. Loose connections at horn.
   C. Horn wires broken or shorted.
   D. Tone adjustment incorrectly set.
   E. Contact points dirty.
   F. Diaphragm cracked or loose in horn body.
   G. Trumpet loose in horn body.

COOLING SYSTEM

1. EXCESSIVE ENGINE TEMPERATURES.

Causes

1. Ignition timing too late or too early.
2. Engine fan belt slipping.
3. Abnormal water loss from cooling system.
4. Radiator tubes restricted or clogged.
5. Radiator core surface restricted by license plate, emblems, etc.
6. Radiator core covered with heavy paint or dirt accumulation.
7. Engine thermostat not properly opening or improperly installed.
8. Deteriorated or collapsed water pump inlet hose.
9. Pump impeller loose on shaft.
10. Abnormal clearance of impeller in pump housing.
11. Abnormal sludge or dirt accumulation in radiator or water jacket of engine block.
12. Any condition that will result in pre-ignition.
13. Restriction of water transfer holes in engine block or cylinder head.
14. Cylinder head gasket installed upside down and restricting water flow.
15. Engine fan blades not set at proper pitch.
16. Foreign object such as wooden plug in cylinder head which floats and occasionally obstructs water circulation.
17. High frictional resistance in engine assembly resulting from:
    A. Insufficient internal clearance.
    B. Internal misalignment.
    C. Use of heavy engine oil.
    D. Insufficient oil circulation.
18. Dragging brakes.
19. Tight wheel bearings.
20. Abnormal frictional resistance in power transmitting units.
21. Use of certain types of anti-freeze solutions in warm weather.

2. WATER LOSS FROM THE COOLING SYSTEM.

1. Radiator leaks.
2. Radiator or water pump hose leakage.

3. Cooling system drain plug or valve leakage.
4. Water pump leakage.
5. Cooling system gasket leakage.
6. Cylinder block or cylinder head cracked (leaking externally or internally).
7. Loose radiator upper tank baffle plate.
8. Combustion gases leaking into cooling system because of poor seal of cylinder head gasket due to faulty gasket or loose cylinder head cap screws.
9. Engine thermostat not functioning properly or operating without a thermostat.
10. Engine overheating resulting in water boiling and loss through overflow pipe.

3. WATER PUMP NOISES.

Description

Water pump noises are rare and are often difficult to locate. However, a noisy water pump can generally be detected by the use of a sounding rod against the water pump body. Water pump noises are usually indicated by a scraping sound, squeal or bump depending upon the type and conditions of the water pump.

Causes

1. Coupling or pulley loose on pump shaft.
2. Pump impeller loose on pump shaft.
3. Excessive end play or pump shaft.
4. Excessive clearance of water pump shaft in bushings.
5. Impeller blades rubbing water pump housing.
6. Impeller broken or pin sheared.
7. Misalignment of water pump.

4. FAN NOISES.

Description

Fan noises due to a condition of the fan belt are usually apparent by a squeak or squeal in the forward part of the engine when the engine is idling or when the engine is rapidly accelerated.

Fan noises have various characteristics but can generally be located when the engine is idling. Paragrahps A, B and F under the following cause No. 2 will be indicated by a continuous squeak or squeal while paragraph C will cause an intermittent thud. Paragraph D causes a light metallic rattle at low speed with an uneven engine idle while paragraph E will be indicated by an intermittent knock. The fan blades striking the radiator or fan belt will cause a decided scraping sound. Paragraphs H, I and J will generally cause a whir or hum at the higher engine speeds.

Causes

1. **Fan belt noises.**
   - A. Belt adjusted too tight (Squeak).
   - B. Belt adjusted too loose (Squeak on acceleration).
   - C. Grease, rust or foreign matter on fan belt or pulleys.
   - D. Incorrect type or make of fan belt.
   - E. Fan belt badly worn or burned.
   - F. Misalignment of fan belt pulleys.
2. **Fan noises.**
   - A. Fan shaft bearings not properly lubricated.
   - B. Fan shaft bearings loose or cracked.
   - C. Excessive fan shaft end play.
   - D. Fan blades loose on spider or hub.
   - E. Crankshaft, generator, accessory shaft or fan pulleys cracked or distorted.
   - F. Fan hub loose and turning on shaft.
   - G. Fan blades striking fan belt or radiator.
   - H. Unbalanced fan blade assembly.
   - I. Uneven pitch of fan blades.
   - J. Bent or distorted fan blades.

5. PREMATURE FAN BELT BREAKAGE OR RAPID WEAR.

Causes

1. Tight adjustment causing abnormal stretch.
2. Loose adjustment causing excessive slippage.
3. Use of incorrect type belt.
4. Oil on belt causing deterioration.
5. Misalignment of belt pulleys.
6. Belt striking or rubbing on fan blades.
7. Excessive friction in water pump, generator or fan causing overload on belt.
8. Sustained high speeds.

REAR AXLE

1. REAR AXLE AND DIFFERENTIAL CARRIER ASSEMBLY NOISE.

Description

Rear axle noise is usually apparent as a hum in moderate cases or a growl in severe cases. Usually the tone of a rear axle noise changes, when the truck is coasting, from the noise noticed when the engine is driving the truck. Quite often a rear axle will be noisy when the engine is driving the truck while no noise will be heard when coasting or vice versa.

Often times difficulties with rear wheel bearings, universal joints, muffler or tire noise are improperly diagnosed as rear axle and differential carrier noise. The possibility of an incorrect diagnosis of these difficulties is great and must not be disregarded when attempting a diagnosis and correction of rear axle noise.

Causes

1. Insufficient lubricant in housing.
2. Use of a poor quality or incorrect grade of lubricant.
3. Brinnelled rear wheel bearings.
4. Ring gear and pinion not correctly adjusted to provide ideal tooth contact.
5. Ring gear and pinion not matched.
6. Ring gear or pinion teeth badly worn, scuffed, chipped or improperly cut.
7. Excessive or insufficient ring gear back lash.
8. Loose pinion bearings.
9. Loose differential side bearings.
10. Pitted or broken pinion or differential bearings.
11. Ring gear does not run true; (Intermittent hum).
    - A. Loose or broken differential bearings.
    - B. Differential case sprung or cracked.
    - C. Ring gear drawn up unevenly on case.
    - D. Warped ring gear.
    - E. Foreign substance between ring gear and differential case.
12. Carrier assembly noisy on turns only, resulting from.
    - A. Differential pinion gears tight on cross or pinion shaft.
    - B. Differential side gears tight in differential case.
    - C. Differential pinion of side gears, chipped, scuffed or otherwise damaged.
    - D. Differential side gears or case thrust bearings rough, scored or otherwise damaged.
    - E. Excessive back lash between differential gears and differential pinions.

2. RAPID REAR AXLE LUBRICANT LOSS.

Causes

1. Loss at rear axle shafts:
   - A. Lubricant level too high in rear axle housing.
   - B. Incorrect grade or poor quality of lubricant.
   - C. Rear axle shaft grease retainers improperly installed or badly worn.
   - D. Rear axle shaft felt retainer distorted or loose in bearing retainer.
   - E. Rear wheel bearing retainer loose on end of housing.
   - F. Rear wheel bearing gasket damaged or improperly installed.
   - G. Cracked rear axle housing.
2. Loss at rear axle pinion shaft:
   - A. Lubricant level too high in rear axle housing.
   - B. Incorrect grade or poor quality of lubricant used.

C. Pinion oil seal improperly installed or badly worn.
D. Pinion oil seal retainer distorted, loose in housing or improperly installed.
E. Lubricant return passage in carrier housing restricted.
F. Universal joint companion flange hub rough, scored or out of round.
G. Universal joint companion flange loose on pinion shaft.
H. Forward end of pinion carrier tilted downward by use of wedges at spring seats.

3. PROPELLER SHAFT DOES NOT ROTATE — ENGINE RUNNING AND TRANSMISSION IN GEAR.

Causes

1. Engine clutch slippage.
2. Transmission pinion or mainshaft broken.
3. Transmission gear teeth stripped.
4. Transmission main shaft flange key sheared.
5. Lower end of gear shift lever not in shifter fork groove or broken.
6. Gear shift forks broken.
7. Propeller shaft broken.

4. REAR WHEELS WILL NOT ROTATE — ENGINE RUNNING, TRANSMISSION IN GEAR AND PROPELLER SHAFT ROTATING.

Causes

1. Rear axle shaft key sheared.
2. Rear axle shaft broken.
3. Rear axle pinion flange key sheared.
4. Ring gear or pinion teeth stripped.
5. Differential side gear or differential pinion teeth stripped.
6. Differential pin or cross broken.
7. Propeller shaft rear yoke welds broken loose and yoke turning inside propeller shaft tubing.

STEERING

1. ABNORMAL FREENESS IN STEERING SYSTEM.

Description

To provide ease of steering a small amount of backlash of the steering wheel is necessary and the entire steering system must not be adjusted so as to cause a binding action in any part. A free movement of the rim of the steering wheel in excess of 2" without moving the front wheels is generally considered excessive and is objectionable to many drivers.

Causes

1. Excessive looseness in steering gear assembly due to:
   A. Improper adjustment.
   B. Camshaft lever bushings oversize or badly worn.
   C. Cam lever follower worn, chipped or brinnelled.
   D. Steering gear cam worn, chipped, brinnelled, distorted or adjusted off center.
   E. Steering gear cam bearings worn, broken or in correctly adjusted.
   F. Steering wheel loose on post.
2. Steering tie rod and drag link connections loose:
   A. Improper adjustment or worn parts.
   B. Broken ball seat springs.
   C. Cross tube ends loose on cross tube.
3. Loose front wheel bearings.
4. Loose or worn steering knuckle bushings or pins.
5. Steering knuckle arms loose at steering knuckles.
6. Steering knuckle arm balls loose in arms.
7. Steering drop arm loose on cam lever shaft.
8. Unusual causes:
   A. Steering gear case loose on chassis frame.
   B. Steering post clamp loose on cowl bracket.
   C. Excessive clearance of steering post in upper jacket bushing.

2. HARD STEERING.

Causes

1. Tires under inflated or unequal inflation.
2. Tires oversize or abnormally worn.
3. Abnormal friction in steering tie rod or drag link joints, due to
   A. Lack of lubrication or improper type of lubricant.
   B. Too tight adjustment.
   C. Dirt accumulation.
   D. Ball seat or arm ball scored, rough or galded.
   E. Arm ball worn out of round (Tight on turns).
   F. Excessive ball seat spring pressure.
4. Abnormal friction in steering gear assembly, due to
   A. Lack of lubrication or improper type of lubricant.
   B. Steering cam shaft follower meshed too deeply with steering gear cam (Not sufficient end play of cross shaft).
   C. Steering gear cam bearings adjusted too tightly.
   D. Steering gear cam lever shaft bearings rough, scored, or otherwise damaged.
   E. Insufficient clearance of cam lever shaft in bushings.
   F. Cam lever shaft bushings not in proper alignment.
   G. Steering gear cam thrust bearings broken, galded, rough or chipped.
   H. Insufficient clearance of steering post upper bushing on post.
   I. Steering gear cam or tube sprung or distorted.
   J. Misalignment of steering gear assembly due to method of mounting at chassis frame and cowl bracket.
5. Excessive friction of steering knuckles, resulting from
   A. Lack of lubrication of steering knuckles, bushings (upper and lower) and knuckle thrust bearings.
   B. Galded, rough or scored king pins.
   C. Insufficient clearance between steering knuckle bushings and king pins.
   D. Insufficient end play of steering knuckle.
   E. Thrust bearing races galded, brinnelled, rough, scored or full of dirt.
6. Unusual causes.
   A. Insufficient king pin inclination.
   B. Improper front wheel camber (Reverse or excessive).
   C. Improper front axle caster (Excessive).
   D. Incorrect front wheel toe-in.

3. LOW SPEED SHIMMY OR FRONT WHEEL WOBBLE.

Description

High and low speed shimmy are many times confused by the service man. Although many of the causes of high and low speed shimmy are identical, the two conditions have absolutely different characteristics.

Many times a vibration or movement in the steering wheel only is termed shimmy, however, this is an incorrect term and should be avoided. Front wheel shimmy oftentimes causes steering wheel movement but originates at the front wheels and is transferred to the steering wheel.

Low speed shimmy or front wheel wobble as the name implies can be simply described as a rapid series of oscillations of the wheel and tire assembly about the king pin. In other words the front wheels attempt to alternately point to the right and left.

High speed shimmy or front wheel tramp can be simply described as a gallop. In other words the condition encountered is very similar to a condition which would be evident if the front wheels were decidedly "egg shaped." In cases of severe high speed shimmy, the front tires actually leave the pavement, while in mild cases the condition is the same as if the front tires were very rapidly deflated and then inflated. In high speed shimmy one front tire appears deflated while the other is inflated. This condition alternates between the front wheels.

Causes

1. Tires under inflated or unequally inflated.
2. Too much or insufficient axle caster resulting from:
   - A. Use of incorrect angle caster shims at spring seats.
   - B. Front springs sagged or settled.
   - C. Frame bent or distorted (Especially between spring hangers).
3. Unequal caster on ends of axle (Variation of more than 1/2 degree).
4. Excessive freedom or looseness of steering knuckle thrust bearings.
5. Incorrectly adjusted front wheel toe-in:
   - A. Incorrect adjustment of steering cross tube.
   - B. Bent or sprung steering cross tube.
   - C. Steering cross tube end loose on threads.
   - D. Steering cross tube end parts worn or loose.
6. Worn or loose steering gear parts.
7. Worn or loose steering linkage parts.
8. Loose front spring "U" bolts.
9. Front springs too flexible, resulting from
   - A. Weak chassis springs.
   - B. Springs overlubricated.
   - C. Inadequate shock absorber control, due to
     1. Insufficient or incorrect type of fluid in instrument
     2. Improper adjustment.
     3. Incorrect type of valve.
     4. Abnormal internal clearances.
10. Incorrect front wheel camber, resulting from:
    - A. Front wheel bearings adjusted too loose.
    - B. Recess cut on underneath side of steering knuckle spindle by rotation of outer bearing cone.
    - C. Steering knuckle bushings or pins worn or loose.
    - D. Bent steering knuckle yoke or spindle.
    - E. Distorted front axle I-beam.
11. Unequal front wheel camber (Variation of more than 1/2 degree).
12. Abnormal side play in front spring shackles.
13. Improper position of steering knuckle arm ball.
14. Irregularities in front wheel tire tread.

4. HIGH SPEED SHIMMY OR WHEEL TRAMP.

Causes

1. Items affecting low speed shimmy or wheel wobble.
2. Front wheel hub, brake drum and tire assembly out of balance.
3. Front tires and wheels wobble or do not run true (Maximum permissible 1/8").
4. Front wheel tire tread eccentricity or run-out (Maximum permissible 1/16").
5. Rear wheel and tire assemblies out of balance.
6. Rear wheel wobble or run out.
7. Unusual cause:
   - A. Dragging front wheel brakes.

5. STEERING WANDER OR ROAD WEAVE.

Causes

1. Tires under inflated or unequally inflated (Front and rear).
2. Zero or negative front axle caster.
3. Unequal front axle caster.
4. Incorrect or unequal front wheel camber.
5. Worn or loose king pins and bushings.
6. Excessively tight king pins and bushings.
7. Improperly adjusted steering gear or linkage.
8. Front wheels toed-out.
9. Rear axle shifted on rear springs.
10. Cross wind.
11. Type of road surface.
12. Incorrect steering knuckle arm ball height.
13. Tight tie rod ends.

6. STEERING KICK BACK.

Description

Steering kick back is registered on the steering wheel as a very rapid movement of the steering wheel and is the result of the front wheels having encountered a bump or obstruction in the road surface and the subsequent transfer of this shock to the steering wheel. A small amount of steering wheel movement must be expected and is normal when the car is driven over an excessively rough road or when the front wheels strike an unusual obstruction.

Causes

1. Tires improperly inflated.
2. Chassis springs sagged.
3. Incorrect height of steering knuckle arm ball.
4. Over lubrication of chassis springs.
5. Insufficient shock absorber control.
6. Front spring center bolt sheared and axle I-beam shifted on spring.
7. Loose spring U-bolts.
8. Incorrect front axle caster.
9. Worn, loose or improperly adjusted steering gear parts.
10. Worn, loose or improperly adjusted steering linkage parts.

7. STEERING GEAR RATTLES.

Causes

1. Insufficient lubricant in steering gear assembly.
2. Incorrect grade of lubricant used in steering gear assembly.
3. Excessive lash between cam lever follower and cam.
4. Steering post loose in post jacket upper bushing.
5. Steering gear cam bearings broken, damaged or incorrectly adjusted.
6. Excessive radial clearance of cam lever shaft in case bushings.
7. Abnormal clearance at drag link connections.
8. Steering post jacket clamp loose on jacket or cowl bracket.
9. Steering post jacket loose at lower end of adjusting nut sleeve.
10. Steering gear loose on chassis frame.
11. Steering drop arm loose on cam lever shaft.

SPRINGS AND SHOCK ABSORBERS

1. CHASSIS SPRINGS SAG OR SPRING BOTTOMING.

Causes

1. Unusually severe operation or excessive overloading.
2. Spring leaves broken.
3. Loose U-Bolts.

2. CHASSIS SPRING NOISES.

Causes

1. Loose U-bolts permitting abnormal side movement of leaves.
2. Spring leaf ends not properly sheared leaving high spot on upper surface of ends.
3. Spring leaves not properly lubricated.

3. ABNORMAL CHASSIS SPRING BREAKAGE.

Causes

1. Unusually severe service or excessive over load.
2. Spring U-bolts loose (Breakage near center bolt).
3. Spring center bolt loose (Breakage at center bolt).
4. Tight spring shackle (Breakage of main leaf near spring eye).
5. Axle to frame bumper not of correct type or omitted.
6. Sprung frame or bent frame horn causing misalignment of springs.

4. SPRING SHACKLE NOISES.

Causes

1. Spring shackles or hinge bolts lack lubrication.
2. Spring shackle pins or hinge pins loose in spring ends or in frame brackets.
3. Spring hangers or frame horns loose on frame, bent or broken.

WHEELS AND TIRES

1. FRONT TIRES WORN ABNORMALLY.

Causes

1. Tires under inflated.
2. Incorrect front wheel toe-in.
3. Tire runout or wobble in excess of 1/8" due to:
   - A. Tires improperly mounted.
   - B. Tire rim clamp nuts drawn up unevenly.
   - C. Sprung wheel.
4. Excessive front wheel camber.
5. Harsh or unnecessary use of brakes.
6. Improperly adjusted front wheel brakes (Dragging).
7. Eccentric front wheel brake drums.
8. Tire eccentricity (In excess of 1/16").
9. Front wheel, hub, brake drum and tire out of balance.

2. FRONT WHEEL NOISES.

Causes

1. Wheel rattles, resulting from:
   - A. Loose bearings.
   - B. Broken or pitted bearings.
   - C. Brake drums loose.
   - D. Brake shoe or backing plates loose.
   - E. Hub caps loose in wheel hub.
   - F. Hub cover retaining spring broken and loose in wheel hub.
2. Wheel squeaks, resulting from:
   - A. Tire rim clamp nuts loose or unevenly drawn up.
   - B. Slight movement of brake drums on hubs.
   - C. Dust washer retainer sprung or broken.
   - D. Lack of lubrication of front wheel bearings.
   - E. Front wheel bearings adjusted too tightly.
   - F. Front wheel bearing broken or pitted.
3. Variation in tire tread surface due to repaired section or broken place in casing.
4. Type or condition of tire tread (Noise similar to a gear growl).
5. Under inflated tires (Noise similar to a gear growl).
6. Foreign object imbedded in tire tread.

3. ABNORMAL HEATING OF FRONT WHEEL BEARINGS.

Description

Front wheel bearings, when correctly adjusted and lubricated, will give off considerable heat after the car has been in operation for some time. The service man should not become alarmed if the wheel hubs are warm immediately after extended use of the car.

Causes

1. Insufficient lubricant.
2. Use of a poor quality or incorrect grade of lubricant.
3. Bearings adjusted too tightly.
4. Bearings broken or pitted.
5. Foreign particles such as dirt, grit, etc. in bearings.
6. Dragging front wheel brakes or abnormal use of the brakes.
7. Steering knuckle spindle bent.
8. Eccentric front wheel hub.
9. Very tight felt lubricant seal.

4. REAR TIRES ABNORMALLY WORN.

Causes

1. Tires under inflated.
2. Rear wheels out of alignment, due to
   - A. Rear axle housing sprung or broken.
   - B. Rear spring center bolt broken or sheared permitting rear axle housing to shift on rear spring.
   - C. Broken rear spring main leaf.
   - D. Use of incorrect rear spring or rear spring main leaf.
   - E. Chassis frame bent or broken in rear.
3. Rear wheel runout or wobble, due to
   - A. Tire rims improperly mounted on wheels.
   - B. Tire rim clamp nuts loose or drawn up unevenly.
   - C. Wheel or rim distorted.
   - D. Rear axle shaft bent or sprung.
   - E. Rear wheel loose on axle shaft.
   - F. Rear wheel hub does not fit shaft taper.
4. Harsh and unnecessary use of brakes.
5. Sustained high speed driving (Especially on curves).
6. Differential gears seized and not permitting differential action.
7. Tire tread not concentric with axle shaft center.
8. Wheel, hub, drum and tire assembly out of balance.

5. REAR WHEEL AND REAR WHEEL BEARING NOISE.

Causes

1. Rear wheel noise, resulting from:
   - A. Wheel hub and drum stud nuts loose.
   - B. Interference of brake drum with brake shoes.
   - C. Interference of axle shaft with wheel bearing felt retainer.
   - D. Brake backing plate loose.
2. Rear wheel bearing noise, resulting from:
   - A. Insufficient lubrication.
   - B. Use of poor quality or incorrect grade of lubricant.
   - C. Wheel bearing cup or cone rough, scored or brinnelled.
   - D. Wheel bearing rollers chipped, cracked, worn flat, etc.
   - E. Wheel bearing improperly adjusted.
3. Type or condition of tire tread (Noise similar to rear axle gear noise).

TRANSMISSION

1. TRANSMISSION NOISY IN NEUTRAL.

Description

Transmission noises in neutral, when the engine is idling, can generally be classified as a hiss or growl. Bearing difficulty is generally apparent as a hiss although in severe cases a bump or thud will be heard. Rough, worn, chipped or scuffed gears are apparent as an intermittent growl or hum. An out of alignment condition between the transmission and the engine assembly will cause a grind after the transmission has been in service for some time.

Causes

1. Misalignment of transmission with engine assembly.
2. Transmission pinion bearing worn, rough or dirty.
3. Transmission constant mesh gears worn, scuffed, chipped, burred or improperly machined.
4. Transmission counter shaft bushings or bearings scored, worn, dirty or rough.
5. Transmission constant mesh gears not properly meshed or matched.
6. Replacement of but one constant mesh gear instead of the complete set.
7. Reverse idler gear shaft or bushing rough, scored or worn.

8. Reverse idler gear worn, scuffed, chipped, burred or improperly machined.
9. Eccentric counter shaft gear assembly.
10. Counter shaft sprung or badly worn.
11. Too much lash in constant mesh gear train.
12. Abnormal end play of counter shaft gear, reverse idler gear or pinion.
13. Transmission main shaft pilot bearing badly worn or broken.
14. Gear shift forks improperly positioned on shifter bars —Forks rubbing in groove or causing gear interference.
15. Insufficient lubricant in transmission.
16. Incorrect grade or poor quality of transmission lubricant.
17. Use of gear shift lever ball which amplifies normal transmission noises.
18. Absence of felts in gear shift tower or improperly installed felts.

2. TRANSMISSION NOISY IN GEAR.

Description

Most transmission noises apparent in neutral will also be noticed when in gear although the frequency of the noise will increase. Transmission noises due to engine torsional periods occur at definite speeds and are not apparent throughout the entire speed range. Torsional transmission noises are usually a high pitched, high frequency, metallic rattle.

Causes

1. Conditions causing noise in neutral — usually more pronounced at low road speeds.
2. Engine torsional periods being transmitted to transmission:
   - A. Clutch plate mechanical damper inoperative or improperly adjusted.
   - B. Clutch plate mechanical damper springs weak or broken.
   - C. Use of a clutch plate not employing a dampened hub.
3. Transmission main shaft rear bearing rough, worn or dirty.
4. Transmission sliding gear teeth rough, worn, burned, scuffed, pitted, chipped or tapered.
5. Noisy speedometer gears.

3. TRANSMISSION OIL LEAKS.

Causes

1. Lubricant level too high in transmission case.
2. Damaged, improperly installed or missing gaskets.
3. Damaged or improperly installed oil seals.
4. Damaged, improperly installed or missing oil throw rings.
5. Transmission case plugs loose or threads damaged.
6. Transmission case bolts loose, missing, or threads stripped.
7. Gear shift lever felt oil seal damaged, saturated or improperly installed.
8. Transmission cover vent restricted with dirt or paint.
9. Sand hole or crack in transmission case or cover.
10. Use of a lubricant which foams excessively.

4. TRANSMISSION—DIFFICULT SHIFTING INTO GEAR.

Causes

1. Failure to completely release engine clutch.
2. Engine clutch spinning.
3. Gear shift rods sprung and binding.
4. Sliding gear tight on main shaft splines.
5. Insufficient chamfer of sliding gear teeth.
6. Main shaft splines distorted, burred or otherwise damaged.

5. TRANSMISSION STICKING IN GEAR.

Causes

1. Engine clutch not completely released.
2. Abnormal spring tension on gear shift rod lock balls.
3. Insufficient chamfer at edge of gear shift rod lock ball notch.
4. Sliding gear tight on main shaft splines.
5. Distorted, burred or otherwise damaged main shaft splines.

6. TRANSMISSION—SLIPPING OUT OF HIGH GEAR.

Causes

1. Misalignment of transmission with engine assembly.
2. Transmission pinion gear teeth worn or tapered.
3. Insufficient spring tension on gear shift rod lock ball.
4. Too much chamfer on edge of gear shift rod lock ball notch.
5. Gear shift rod lock ball notch not machined sufficiently deep

CLUTCH

1. ENGINE CLUTCH SLIPPING.

Causes

1. Driver riding clutch pedal.
2. Insufficient or no clutch pedal lash.
3. Clutch release shaft tight in housing.
4. Weak or broken clutch pressure springs.
5. Grease or oil on clutch friction facings.
6. Badly worn or burned clutch friction facings.
7. Friction facings improperly installed on clutch driven plate.
8. The use of incorrect type of friction facings.
9. Clutch toggle levers improperly adjusted.
10. Improper assembly of unit parts of clutch.

2. ENGINE CLUTCH GRABS OR CHATTERS DURING ENGAGEMENT.

Causes

1. Loss of tension in clutch facing cushioning plates.
2. Use of incorrect type of clutch facing.
3. High spots on clutch friction facing.
4. Clutch friction facings coated with gum.
5. Clutch shifter shaft tight in housing.
6. Facings loose on driven plate.
7. Driven plate loose at hub.
8. Excessive lash in power transmitting units.
9. Clutch driven plate tight on transmission pinion shaft splines.
10. Clutch case or pressure plate assembly loose on fly wheel.
11. Clutch pressure plate badly cracked or broken.
12. Incorrect assembly of unit parts of clutch.

3. ENGINE CLUTCH NOISES.

Description

Engine clutch noises are usually encountered when the engine is idling. It is important that a noisy release bearing is correctly diagnosed as insufficient clutch pedal lash, a weak or broken pedal or release bearing collar spring and an incorrectly adjusted positive lock operating rod may cause release levers are not in alignment. Transmission pinion bearing noise is similar to clutch release bearing noise and must not be confused.

Causes

1. Clutch noisy when disengaged (Pedal depressed).
   - A. Clutch release bearing worn, dirty, damaged, broken or inadequately lubricated.
   - B. Clutch release bearing binding in clutch release shaft arms.
   - C. Crankshaft clutch pilot bearing worn, damaged, broken or inadequately lubricated.

D. Clutch toggle levers improperly adjusted and bottoming against driven plate hub.
E. Interference of transmission pinion shaft with crankshaft clutch pilot bearing retainer due to improper installation of retainer.

2. Clutch noisy when engaged (Pedal released).

A. Misalignment of transmission with engine assembly causing slight movement of clutch driven plate hub on hub insulator (Noise noticeable with engine idling or at low road speeds).
B. Clutch driven plate hub loose on transmission pinion splines.
C. Clutch driven plate hub bolts loose.
D. Clutch driven plate mechanical dampener springs weak or broken.

4. ENGINE CLUTCH SPINNING (DRAGGING) WHEN DISENGAGED.

Causes

1. Incorrect clutch pedal adjustment (Too much pedal lash).
2. Incorrect release lever adjustment.
3. Warped or distorted clutch center drive plate.
4. Clutch facing cushioning plates distorted.
5. High spots on friction facings.
6. Clutch driven plate facings incorrectly installed or loose.
7. Clutch driven plate hub tight on pinion shaft splines.
8. Rough, distorted or burred pinion shaft splines.

5. ABNORMAL OR PREMATURE ENGINE CLUTCH FACING WEAR.

Causes

1. Insufficient pedal lash.
2. Driver rides clutch pedal.
3. Driver slips clutch excessively during time of engagement.
4. Abnormal and unnecessary use of clutch.
5. Weak or broken clutch pressure plate springs.
6. Badly warped clutch pressure plate.
7. Use of incorrect type of friction facing.
8. Friction facing improperly installed.

6. ENGINE CLUTCH PEDAL PULSATION.

Description

Clutch pedal pulsation has often times been termed a nervous pedal. When a slight pressure is applied on the pedal, with the engine running, the pedal will vibrate or bounce with every revolution of the engine. As the pressure on the pedal is increased the pulsation will cease.

Causes

1. Clutch toggle levers unevenly adjusted.
2. Clutch case sprung by improper installation.
3. Clutch release shaft arms not parallel.
4. Clutch release shaft bent.
5. Clutch pedal pull back spring missing or broken.
6. Severe case of misalignment between transmission and engine assembly.
7. Fly wheel not properly seated on crankshaft flange.
8. Bent crankshaft fly wheel flange.

BRAKES

1. PEDAL GOES TO FLOORBOARD.

Causes

1. Normal wear of lining.
2. Brake shoes not properly adjusted.
3. Leak in system.
4. Air in system.
5. Pedal improperly set.
6. No fluid in supply tank.

2. ALL BRAKES DRAG.

Causes

1. Mineral oil in system.
2. Pedal improperly set.

3. ONE WHEEL DRAGS.

Causes

1. Weak brake shoe return spring.
2. Brake shoe bearing sized to anchor pin.
3. Brake shoe set too close to drum.
4. Piston cups distorted.
5. Loose wheel bearings.

4. TRUCK PULLS TO ONE SIDE.

Causes

1. Grease soaked lining.
2. Shoes improperly set.
3. Backing plate loose on axle.
4. Front spring U bolts loose.
5. Different makes of lining.
6. Tires not properly inflated.

5. SPRINGY, SPONGY PEDAL.

Causes

1. Brake shoes not properly adjusted.
2. Air in system.

6. EXCESSIVE PRESSURE ON PEDAL, POOR STOP.

Causes

1. Brake shoes not properly adjusted.
2. Improper lining.
3. Oil in lining.
4. Lining making partial contact.

7. LIGHT PRESSURE ON PEDAL SEVERE BRAKES.

Causes

1. Brake shoes not properly adjusted.
2. Grease-soaked lining.

Service Tool Equipment

The following list of service tool equipment is provided for your convenient reference and guidance in determining upon the equipment required in Studebaker truck and bus service work. Check over the list carefully and obtain any necessary equipment which you do not have, keeping the fact in mind that the proper tool at hand may save many times its cost.

Note: The prices shown are subject to change without notice. Orders for these and other items of tool equipment should be placed with the Tool and Equipment Division of the Studebaker General Service Department.

Tool No.	Name	Net Price
L1	Lodi Valve Lifter complete for removing and replacing valves and valve springs on all truck models	$ 14.00
312	KD valve lifter complete with seven interchangeable jaws	2.85
720	Sioux universal valve seat replacement set (Hand operated)	74.50
	Hall eccentric valve seat grinder complete with diamond dresser	129.00
ST8	Special pilot for 110 model Waukesha engine	5.00
620	Sioux valve refacer complete	145.00
EF	Black and Decker valve refacer	113.00
HM865	Cam gear puller (Studebaker engines)	4.00
J907	Cam gear puller (Waukesha BK & BM Engines)	
	Cam gear puller (Waukesha 6-110 BM engines)	4.30
HM-925	Note HM925 is a utility puller set and can be used for removing crankshaft gears on all engines, companion flanges, etc.	12.90
HM-861A	Cam gear pusher body, thrust bearing, and handle. Necessary for use on all engines	2.75
HM-861F	Cam gear pusher body collar. Necessary for use on all engines	.55
HM-861D	Crank and cam gear pusher screw (for Studebaker engines)	2.25
HM-861K	Crank and cam gear pusher plug (for Studebaker engines)	1.25
HM-861M	Cam gear pusher screw (Waukesha 110 engine)	2.25
HM-861N	Cam gear pusher screw collar (Waukesha 110 engine)	.85
HM-861	Cam and crank gear pusher screw (Waukesha BK & BM engines)	2.60
HM-890	Fixture for assembling and extracting camshaft bushings	2.75
W-17725B	Manifold Wrench	.34
HMJ-336	Piston feeler scale	3.80
	Feeler gauge stock .016 per ft.	.05
HMJ-89	Vacuum gauge	2.50
HMJ-759	Compression gauge	5.75
A-68	Ames Cylinder Gauge	17.50
T-1	Stromberg Neon Timing light	3.50
	Special cutters for reconditioning intake valves on 110 Waukesha engine....	
Sioux X 41	1-2-3/16—45° finish reamer	3.20
Sioux X 101	1-2-3/16—45° rough reamer	3.20
Sioux X 375	1-2-5/8—45° finish reamer used for chamfering top of intake shroud	4.50
Sious X 802	No. 2 Taper Sleeve	1.05
	The 7/16 Standard Pilot and .001 Oversize Pilot .002 " " .003 " " .004 " " are	1.25 ea.

CLUTCH

F-6	Frisz Universal clutch pilot (for all clutches)	9.00
HM-912-A	Clutch housing refacing tool less gauges (all clutch housings)	18.50
HM-912-X	Clutch housing refacing tool adapter (all Ace Models)	4.30
HM-912-Y	Clutch housing refacing tool adapter (Waukesha engines)	3.75
No. 196-A	Universal dial indicator set—Starrett	13.50

REAR AXLE

HMJ-321	Rear wheel bearing adjusting nut wrench (small end 3-1/4" large end 3-7/8 for Chief & Mogul models)	7.40
HMJ-320	Rear wheel bearing adjusting nut wrench (2-3/4" end for Ace Model)	3.00
HMJ-311	Rear wheel bearing adjusting nut wrench (3" end for Boss model)	4.35
HM-872	Differential side bearing puller	5.50

STEERING AND FRONT AXLE

HM-863	Steering wheel puller	5.50
HMJ-371	Pitman arm puller	3.85
HMJ-911	Spindle bushing extractor and replacement set (Timken 33020 axle)	6.00
HMJ-910	Spindle bushing extractor and replacement set (all models except above)....	7.00
HMJ-912	Spindle bushing reamer set (All Models)	23.95
P-2	Portable wheel aligner — including caster and camber gauge (Bean Manufacturing Co.)	87.50
DU-361	Duby toe-in gauge (Not needed with P-2)	10.00

BRAKES

636761	Hydraulic brake bleeder hose nut wrench	.23
636762	Hydraulic brake bleeder hose	.23
	Frisz brake shoe adjusting tool complete — for all current model truck brakes	26.30

Note: Recommended for obtaining perfect brake shoe clearance between shoes and drum at all points.

GENERAL SPECIFICATIONS

	J15	J20	J25	J30
ENGINE				
Number of cylinders	6	6	6	6
Cylinder bore	3 1/4"	3 5/8"	4"	4 1/4"
Stroke	4 3/8"	4 1/4"	4 1/4"	4 1/2"
Piston displacement—cu. ins.	217.8	263	320	383
Horsepower (A.M.A.)	25.35	31.54	38.4	43.3
Horsepower (brake)	85 at 3200	79 at 2800	86 at 2600	98 at 2500
Compression ratio—Standard	6.0 to 1	5.83 to 1	5.63 to 1	5.5 to 1
PISTONS AND RINGS				
Piston material	Plated Cast Iron	Aluminum	Aluminum	Aluminum
Oil rings per piston	1	1	1	1
Width of oil ring	3/16"	3/16"	3/16"	3/16"
Oil ring gap	.013" to .018"	.015" to .020"	.015" to .020"	.015" to .020"
Compression rings per piston	2	3	3	3
Width of compression rings	1/8"	1/8"	1/8"	1/8"
Compression ring gap	.013" to .018"	.015" to .020"	.015" to .020"	.015" to .020"
Piston clearance	.002"	.003"	.0035"	.004"
RODS AND PINS				
Pin diameter	7/8"	1"	1"	1 1/8"
Pin locked or floating	Locked	Locked	Locked	Locked
Pin clearance in pistons	.0004"	.00015"	.00015"	.00015"
Crank pin journal—diameter	2 3/16"	2"	2"	2 1/4"
Crank pin journal—length	1 3/8"	1 1/2"	1 1/2"	1 1/2"
Connecting rod bearing clearance	.002"	.0015" to .0035"	.0015" to .0035"	.002" to .004"
Connecting rod bearing end play	.005" to .009"	.005" to .010"	.005" to .010"	.005" to .010"
Rods and pistons removed	Top	Top	Top	Top
CRANKSHAFT				
End thrust carried on	No. 1 Main Bearing	No. 7 Main Bearing	No. 7 Main Bearing	No. 7 Main Bearing
Crankshaft end play	.003" to .006"	.002" to .004"	.002" to .004"	.003" to .004"
Main bearing clearance	.002"	.003"	.003"	.003"
Main bearing journal—diameter	2 1/2"	2 1/2"	2 1/2"	2 5/8"
Main bearing journal—length—No. 1	1 3/8"	1 5/16"	1 5/16"	1 3/4"
No. 2	1 1/8"	1 5/16"	1 5/16"	1 1/2"
No. 3	1 1/8"	1 5/16"	1 5/16"	1 1/2"
No. 4	1 27/32"	2 1/8"	2 1/8"	2 3/4"
No. 5		1 5/16"	1 5/16"	1 1/2"
No. 6		1 5/16"	1 5/16"	1 1/2"
No. 7		2 1/8"	2 1/8"	2 3/4"
CAMSHAFT				
Camshaft drive	Gear	Gear	Gear	Gear
VALVES				
Valve stem diameter	11/32"	3/8"	3/8"	3/8"
Valve lift	11/32"	23/64"	21/64"	25/64"
Operating tappet clearance—Inlet	.016" (Cold)	.008" (Hot)	.008" (Hot)	.006" (Hot)
Exhaust	.016" (Cold)	.010" (Hot)	.010" (Hot)	.010" (Hot)
Valve seat angle	45°	45°	45°	45°
Narrowing cutter angle—Top	15°	15°	15°	15°
Bottom	75°	75°	75°	75°
Valve head diameter—Inlet	1 15/32"	1 3/4"	1 3/4"	1 3/4"
Exhaust	1 9/32"	1 5/8"	1 5/8"	1 3/4"
Valve spring pressures—Open	123 lbs. at 1 3/4"	56 lbs. to 61 lbs. at 1.594"	56 lbs. to 61 lbs. at 1.594"	88 lbs at 2.126"
Closed	57 lbs. at 2 3/32"	41 lbs. to 45 lbs. at 1.920"	41 lbs. to 45 lbs. at 1.920"	65 lbs. at 2.482"
VALVE TIMING				
Tappet clearance—(for checking timing)	Int. .020"—Exh. .020"	Int. .010"—Exh. .016"	Int. .010"—Exh. .010"	Int. .010"—Exh. .016"
Intake opens	5° B.U.D.C.	1°-52 1/2' A.U.D.C.	5° A.U.D.C.	1°-52 1/2' A.U.D.C.
Intake closes	40° A.L.D.C.	46°-52 1/2' A.L.D.C.	45° B.U.D.C.	46°-52 1/2' A.L.D.C.
Exhaust opens	40° B.L.D.C.	43°-7 1/2' B.L.D.C.	35° B. L. D. C.	43°-7 1/2' B.L.D.C.
Exhaust closes	5° A.U.D.C.	1°-52 1/2' A.U.D.C.	5° A.U.D.C.	1°-52 1/2' A.U.D.C.

Note:—B.U.D.C.—Before upper dead center.
A.L.D.C.—After lower dead center.
B.L.D.C.—Before lower dead center.
A.U.D.C.—After upper dead center.

	J15	J20	J25	J30
LUBRICATION				
Capacity—oil pan — U. S. Qts.	6	6	6	7
Imp. Qts.	5	5	5	5.85
Liters	5,6	5,6	5,6	6,62
Minimum pressure—high speed	20 lbs.	35 lbs.	35 lbs.	35 lbs.

GENERAL SPECIFICATIONS—(Continued)

		J15	J20	J25	J30
FUEL					
Gasoline tank capacity	U. S. Gals.	20	20	20	30
	Imp. Gals.	16.66	16.66	16.66	25
	Liters	75,7	75,7	75,7	113,4
Fuel pump—make		AC	AC	AC	AC
Carburetor		Carter	Carter	Carter	Carter
Carburetor size		1 1/4"	1 1/4"	1 1/4"	1 1/2"
Governor		Not Std. Equip.	Hoof	Hoof	Hoof
COOLING					
Capacity cooling system	U. S. Qts.	16	21	21	23
	Imp. Qts.	13.3	17.4	17.4	19.1
	Liters	15,14	20,1	20,1	22
IGNITION					
Automatic advance—crankshaft degrees		25°	18°	18°	20°
Spark timing		2° B.U.D.C.	U.D.C.	U.D.C.	U.D.C.
Distributor point gap		.020"	.020"	.020"	.020"
Spark plug gap		.025"	.025"	.025"	.025"
Firing order		1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
BATTERY					
Battery make		Willard	Willard	Willard	Willard
Battery number		WH2-105	WH-4-17	WH-4-17	RH-5-19
Ampere hours		105	136	136	153
SPARK PLUGS					
Make		Champion	Champion	Champion	Champion
Type		No. 8	No. 2—Commercial	No. 1—Commercial	No. 1—Commercial
STARTER					
Lock torque		25 ft. lbs.	15 ft. lbs.	15 ft. lbs.	15 ft. lbs.
Lock voltage		4	3	3	3
Flywheel teeth		130	112	112	126
GENERATOR					
Armature speed at cutout closing		700 to 800 R.P.M.	800 R.P.M.	800 R.P.M.	700 R.P.M.
Voltage at cutout closing		6.4	6.4	6.4	6.4
Truck speed at cutout closing		7 to 8 M.P.H.	7 to 8 M.P.H.	7 to 8 M.P.H.	7 to 8 M.P.H.
Cutout opens		−2 AMP.	1 AMP.	1 AMP.	1 AMP.
Maximum normal charging rate	Hot	14.6 AMP.	18 AMP.	18 AMP.	18.5 AMP.
	Cold	17 AMP.	21.5 AMP.	21.5 AMP.	23.5 AMP.
Armature speed, maximum charge		2000 R.P.M.	1800 R.P.M.	1800 R.P.M.	1800 R.P.M.
Voltage at normal charging		6.8	6.8	6.8	6.8
CLUTCH					
Make		Long	Borg & Beck	W. C. Lipe	W. C. Lipe
Vibration damper type		Mechanical	Mechanical	Mechanical	Mechanical
Clutch driven disc		1	1	1	1
Clutch facings		Moulded	Woven Asbestos	Woven Asbestos	Woven Asbestos
Facing inside diameter		6"	6 1/8"	7 1/4"	7 1/4"
Facing outside diameter		10"	11"	11 7/8"	12 7/8"
Facing thickness		.137"	.133"	.125"	.125"
Facings required		2	2	2	2
TRANSMISSION					
Gear ratio—high		1 to 1	1 to 1	1 to 1	1 to 1
Gear ratio—fourth		—	—	1.48 to 1	1.48 to 1
Gear ratio—third		1.69 to 1	1.69 to 1	2.4 to 1	2.63 to 1
Gear ratio—second		3.09 to 1	3.09 to 1	4.38 to 1	4.46 to 1
Gear ratio—first		6.4 to 1	6.4 to 1	7.58 to 1	7.88 to 1
Gear ratio—reverse		7.82 to 1	7.82 to 1	6.11 to 1	7.88 to 1
Transmission oil capacity	U. S. Pts.	6	6	12	18
	Imp. Pts.	5	5	10	15
	Liters	2,85	2,85	5 7/10	17
Transmission lubricant	Winter	S.A.E. 90	S.A.E. 90	S.A.E. 90	S.A.E. 90
	Summer	S.A.E. 110	S.A.E. 110	S.A.E. 110	S.A.E. 110
UNIVERSAL JOINTS					
Make		Cleveland	Cleveland	Cleveland	Cleveland
Type		Needle Bearing	Needle Bearing	Needle Bearing	Needle Bearing

GENERAL SPECIFICATIONS—(Continued)

REAR AXLE

	J15	J20	J25	J30
Type	Full Floating	Full Floating	Full Floating	Full Floating
Type of drive	Hotchkiss	Hotchkiss	Hotchkiss	Hotchkiss
Axle shaft diameter (minimum)	1 3/8"	1 1/2"	1 5/8"	1 11/16"
Axle spline diameter	1 5/8"	1 3/4"	1 7/8"	1 15/16"
Spring center distance	39 1/2"	40 1/8"	40 1/8"	40 3/16"
Type gear	Spiral Bevel	Spiral Bevel	Spiral Bevel	Spiral Bevel
Gear ratio—standard	5.57 to 1	6.8 to 1	6.833 to 1	6.833 to 1
Gear ratio—optional	5.125 and 6.83	4.857 and 5.833	7.4 and 6.167	7.8 and 6.142
Backlash—pinion and ring gear	.007" to .010"	.007" to .010"	.007" to .010"	.007" to .010"
Back up screw to gear clearance	.010" to .015"	.010" to .015"	.010" to .015"	.010" to .015"
Road clearance — Single	8 3/4"	11 1/16"	11 1/16"	11 1/16"
Road clearance — Dual	8 5/16"	8 13/16"	8 11/16"	7 5/8"
Lubricant capacity — U. S. Pts.	8	10	14	12
Lubricant capacity — Imp. Pts.	6 3/4	8 1/3	11.65	10
Lubricant capacity — Liters	3,78	4,78	13,25	11,36
Lubricant — Winter	S.A.E. 90	S.A.E. 90	S.A.E. 90	S.A.E. 90
Lubricant — Summer	S.A.E. 110	S.A.E. 110	S.A.E. 110	S.A.E. 110

STEERING

	J15	J20	J25	J30
Type	Cam and Lever	Cam and Lever	Cam and Lever	Cam and Lever
Make	Ross	Ross	Ross	Ross
*Caster	1/2° to 1°	1/2° to 1 1/4°	1/2° to 1 1/4°	1/2° to 1 1/4°
Camber	1°	1°	1°	1°
Inclination king pin	9°	8°	8°	8°
Toe-in	1/16" to 1/8"	1/16" to 1/8"	1/16" to 1/8"	1/16" to 1/8"

*Caster for all Cab-Forward Models (J15M, J20M, J25M, J30M) is —1/2° to +1°.

BRAKES

	J15	J20	J25	J30
Type	Lockheed Hydraulic	Lockheed Hydraulic	Lockheed Hydraulic	Lockheed Hydraulic
Drum material	Cast Iron	Cast Iron	Cast Iron	Cast Iron
Lining width — Front	2"	2"	2 1/4"	2 1/4"
Lining width — Rear	2 1/4"	3"	4"	4"
Lining thickness — Front	1/4"	1/4"	1/4"	1/4"
Lining thickness — Rear	1/4"	1/4"	5/16"	5/16"
Total braking area	253 Sq. In.	296 1/2 Sq. In.	418 1/2 Sq. In.	421 Sq. In.
Drum size — Front	14" x 2"	14" x 2"	15" x 2 1/4"	16" x 2 1/4"
Drum size — Rear	16" x 2 1/4"	16" x 3"	17 1/4" x 4"	17 1/4" x 4"

SPRINGS—FRONT

	J15	J20	J25	J30
Length	36"	39"	39"	39"
Width	2"	2 1/2"	2 1/2"	2 1/2"
Number of leaves	9	9	10	11
Thickness at center	2.331"	2.556"	2.840"	3.1525"
Deflection rate—lbs. per inch	650	750	825	1000

SPRINGS—REAR

	J15	J20	J25	J30
Length	48"	54"	54"	54"
Width	2 1/2"	3"	3"	3"
Number of leaves	12	13	14	15
Thickness at center	4 1/8"	4 15/16"	5 9/16"	6 3/16"
Deflection rate—lbs. per inch	1000	1175	1375	1870

AUXILIARY SPRINGS

	J15	J20	J25	J30
Standard or optional	Optional	Standard	Standard	Standard
Length	36"	36"	36"	36"
Width	2 1/2"	3"	3"	3"
Number of leaves	8	9	9	9
Thickness at center	2.072"	2.331"	2.331"	2.331"
Deflection rate—lbs. per inch	660	900	900	900

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All prices published in this Manual are subject to change without notice.