Detroit Diesel

Service Manual

6-V71, 8V-71 & 12V-71 Diesel Engines

Service® Manual

DD-S-V-71 SER

TABLE OF CONTENTS

INFORMATION REGARDING THE MANUAL AND ITS USE

Engine Models Covered

This manual covers the basic V-71 diesel engines built by the Detroit Diesel Engine Division of General Motors Corporation.

Scope of the Manual

This manual contains complete instructions on operation, adjustment (tune-up), preventive maintenance (including lubrication) and repair (including complete overhaul). It was written primarily for persons servicing and overhauling the engine, but in addition contains all instructions essential to the operators and users.

Basic maintenance and overhaul procedures are common to all V-71 engines, and hence apply to all engine models.

Section Numbers

This manual is divided into arabic numbered sections. The first section covers the basic engine, and the following sections cover a complete system, such as the fuel system, lubrication system or special equipment, etc. Each section is divided into sub-sections which contain complete maintenance and operating instructions for a subassembly on the engine. For example, Section 1 which covers the basic engine contains sub-section 1.1 pertaining to the cylinder block, sub-section 1.2 covering the cylinder head, etc. The subjects and sections are listed in the Table of Contents on the preceding page.

Page Numbers

Pages are numbered consecutively, starting with a new Page 1 at the beginning of each sub-section.

Illustration Numbers

The illustrations are numbered consecutively, beginning with a new Figure 1 at the beginning of each sub-section.

How to Locate Information

Information regarding a general subject such as the lubricating system can best be located by using the Table of Contents. Opposite each subject in this Table of Contents is printed a section number which registers with a tab printed on the divider page preceding the first page of each section throughout the manual. Information on a specific subassembly or accessory can then be found by consulting the list of contents printed

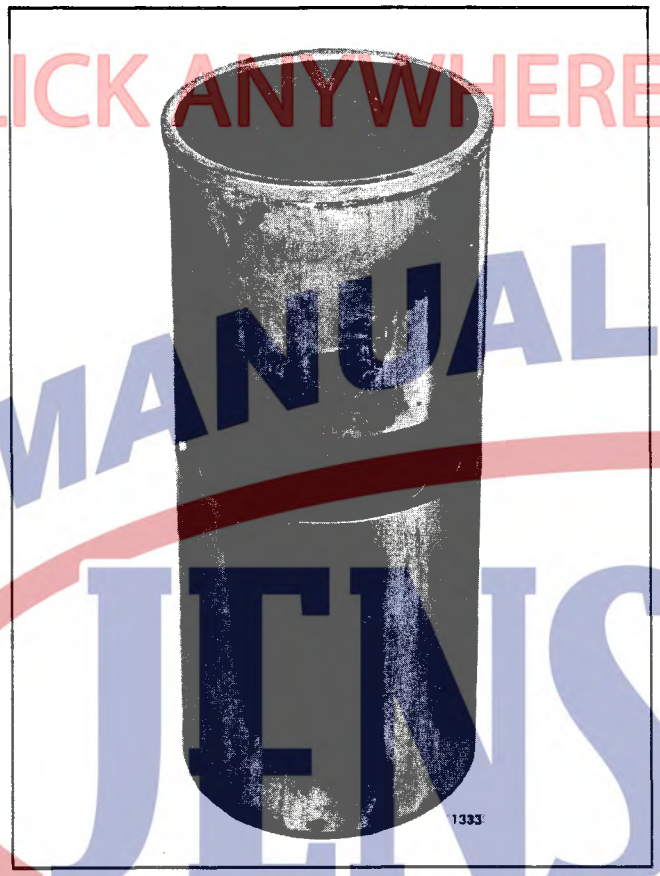


Fig. 5 - High Pressure Areas on Cylinder Liner

In addition, each bore must be within .001" of out-of-round or taper on a new block.

The maximum bore out-of-round of a used block is .003" and maximum taper is .002".

The cylinder block of an engine is alternately expanding and contracting, during engine operation, due to temperature variations. This may result in irregularities in the block bores (out-of-round and taper), the effects of which will be seen as high pressure areas on the outside of the cylinder liner as seen in Fig. 5.

If a new liner and piston is installed in the block without honing out the bore, galling and seizing of the piston may result. This is caused by the new piston having to travel over the irregularities without time to conform to the particular shape of the block bore.

d. If the block bores do not meet the specifications for diameter, taper and out-of-round, or if the liner-to-block fit is greater than .003", the bores should be increased for oversize liners as shown in the table below. Liners are available in .005", .010", .020" and .030" oversize on the outside diameter.

Regardless of the outside diameter of the cylinder liner, whether standard or oversize, the block bore must be honed out to such an inside diameter as to produce a .0005" to .0025" slip fit in a cast iron block.

If excessive honing is required to remove necessary stock to bring bore within the next oversize limits, the cylinder block may first be bored, then finish honed.

Cylinder Block Bores for Various Liners

Liner O.D.	Max. Allowable Block Bore	Block Boring Dimensions
CAST IRON BLOCK		
Standard	4.628"	4.627" ± .0005"
.005" Oversize	4.633"	4.632" ± .0005"
.010" Oversize	4.638"	4.637" ± .0005"
.020" Oversize	4.648"	4.647" ± .0005"
.030" Oversize	4.658"	4.657" ± .0005"

2. Hone cylinder block bores:

a. Refer to Fig. 6 and insert hone in bore and adjust stones snugly to the narrowest section.

Fig. 6 - Honing Bore of Cylinder Block with Tool J 5902

CYLINDER HEAD

The cylinder head, Fig. 1, is a one-piece casting which can be removed from the engine as an assembly containing cam followers, cam follower guides, rocker arms, exhaust valves and injectors. The head is securely held to the top of the cylinder block with bolts, studs and nuts.

Located in the cylinder head are the exhaust valves, a fuel injector and three rocker arms for each cylinder. One rocker arm operates the injector plunger; the other two operate the exhaust valves. The rocker arms are operated by the camshaft through cam followers and push rods.

Exhaust valve inserts (valve seats), shrunk into the cylinder head, permit accurate seating of the valves under varying conditions of temperature and materially prolong the life of the cylinder head. The inserts are ground to very close limits and their freedom from warpage, under ordinary conditions, reduces valve reconditioning to a minimum. The exhaust valves and valve seat inserts are ground to a seating angle of 30°.

To ensure efficient cooling, each fuel injector is inserted into a thin-walled copper tube which passes through the water space in the cylinder head. The lower end of the injector hole copper tube is pressed into the cylinder head and flared over; the upper end is flanged and sealed with a neoprene seal.

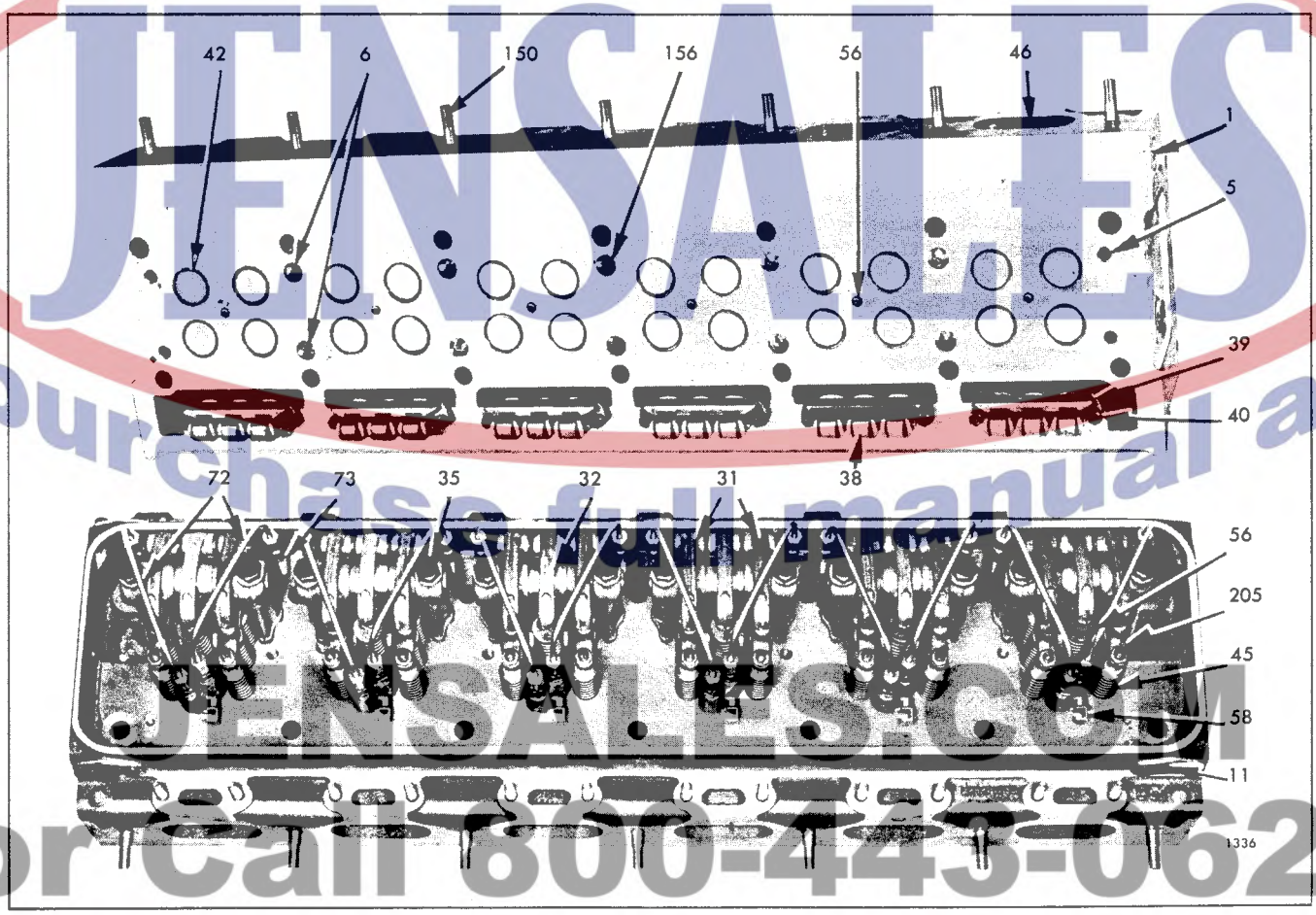


Fig. 1 - Typical Cylinder Head Assembly

1. Cylinder Head
5. Nozzle-Single Jet
6. Nozzle-Double Jet
11. Cover--Governor Hole
31. Rocker Arm--Exhaust Valve
32. Rocker Arm--Injector
35. Bolt--Rocker Shaft Bracket
38. Follower--Cam
39. Guide--Cam Follower
40. Bolt--Cam Follower Guide
42. Valve--Exhaust
45. Spring--Exhaust Valve
46. Port--Cylinder Head Exhaust
56. Injector
58. Rack--Injector
72. Pipe--Fuel
73. Connector--Fuel Pipe
150. Stud--Exhaust Manifold
156. Water Passage from Block to Head
205. Bridge--Exhaust Valve

CAMSHAFT GEARS

The camshaft gears, Fig. 1, located at the flywheel end of the engine, mesh with each other and run at the same speed as the crankshaft. Either one of the gears may be driven by the crankshaft timing gear through an idler gear, depending upon engine rotation. Viewing the engine from the gear train end, the right-hand camshaft gear has right-hand helical teeth, and the left-hand camshaft gear has left-hand helical teeth. The idler gear mates with the right-hand camshaft gear on right-hand rotation engines, and the left-hand camshaft gear on left-hand rotation engines as shown in Fig. 1 Section 1.7.

Since the two camshaft gears must be in time with each other, timing marks are stamped on the rim of both gears. Also, since these two gears as a unit, must be in time with the crankshaft, timing marks are located on the idler and crankshaft gears.

The camshaft gears are keyed to their respective shafts and held securely on the shaft by a nut, nut retainer, retainer bolts and lock washers.

The camshaft gears used on 6V engines are identical to those used on 8V engines, except that when the gears are used on 8V engines, additional balance weights are attached to the gears. Camshaft gears used on 12V engines are not interchangeable with those used on 6V or 8V engines due to the difference in the size of the integral balance weights.

Effective with engine serial number 8VA-1203, a new design balance weight with countersunk bolt holes in the outer face of the weight, has replaced the former balance weight on the 8V-71 engine. The new weight is attached to the camshaft with two 3/8"-24 flat head screws and nuts. Only the new design balance weight will be available for service.

Fig. 1 - Camshaft Gears Mounted on Engine

Fig. 2 - Removing Camshaft Gear

Remove Camshaft Gears

1. Remove camshafts from engine as outlined in Section 1.7.

2. Place one of the camshaft and gear assemblies in arbor press with gear suitably supported, as shown in Fig. 2.

3. Lay a wood block under lower end of camshaft to ensure shaft threads will not be damaged when shaft is pressed from gear.

4. Then, using a short piece of one inch O.D. brass rod between end of camshaft and ram of press, force camshaft out of camshaft gear.

   If an arbor press isn't available for removing camshaft gear, gear remover J 1902-01 may be used.

5. If necessary, remove Woodruff key from camshaft.

6. Remove gear from other camshaft in similar manner.

Inspection

Clean gears with fuel oil and dry with compressed air. Then examine gear teeth for evidence of scoring, pitting and wear. Replace gears if necessary. Also check other gears in gear train.

COLD WEATHER STARTING

When starting an internal combustion engine in cold weather, a large part of the energy of combustion is absorbed by the pistons, cylinder walls, cooling water, and in overcoming friction.

Under extremely low outside temperatures, the cold oil in the bearings and between the pistons and cylinder walls creates very high friction and the effort required to crank the engine is much greater than when the engine is warm.

In a diesel engine, the normal means of igniting the fuel sprayed into the combustion chamber is by the heat of the air compressed in the cylinder.

This temperature is high enough to ignite the fuel under ordinary conditions, but in cold weather at extremely low outside temperatures may not always ignite the fuel injected.

To assist in starting an engine under low temperature conditions a device known as the "Fluid Starting Aid" is available at the customer's option.

Fluid Starting Aid

Start Pilot

The ether starting kit consists of an ether capsule housing and pump assembly, a length of copper tubing, and air-box-cover fitting (s). The capsule housing and pump assembly is mounted in an accessible spot on the instrument panel or cab and the copper tubing is connected from the pump outlet to the air-box-cover fitting.

Multi-start capsules that hold sufficient fluid for several engine starts contain a starting fluid, upper cylinder lubricant, and an anti-detonant. The starting fluid provides quick engine starts in sub-freezing temperatures, the lubricant furnishes upper cylinder lubrication during engine starting when it is needed most, and the anti-detonant prevents the starting fluid from causing harmful engine knocking during starting.

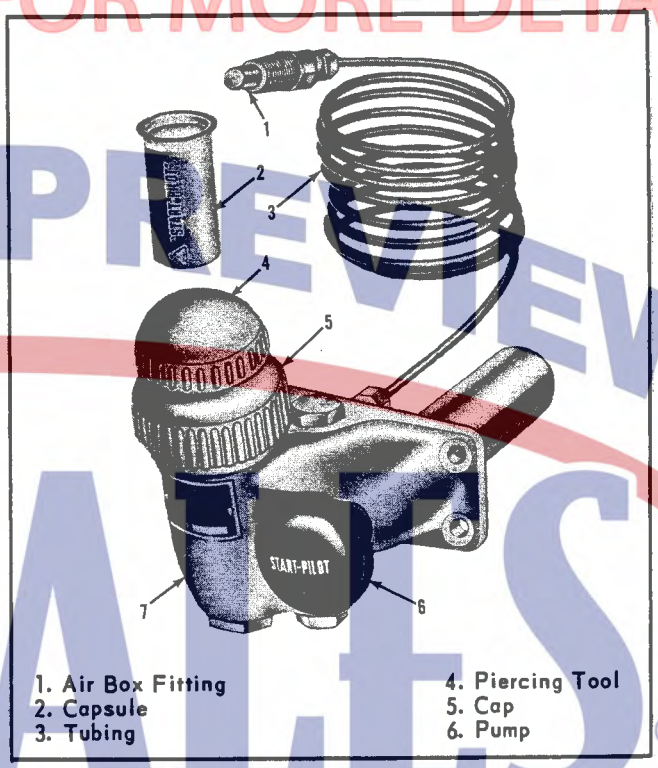
Starting Engine

To start the vehicle's engine with the aid of the ether starting kit, use the following procedure:

1. Remove cap (5) from capsule chamber and insert aluminum starting-fluid capsule (2).

2. Replace cap and tighten securely by turning right-handed against stops. Make sure that the cap "O" ring is in place to keep cover air tight.

3. Push piercing-tool plunger (4) all the way down to release starting fluid into capsule container. Starting kit is now ready for use.



1. Air Box Fitting
2. Capsule
3. Tubing
4. Piercing Tool
5. Cap
6. Pump

Fig. 2. Start Pilot Starting Kit

Engines with Electric Cranking Motors

Crank engine and operate pump plunger (6) while engine is cranking. DO NOT BEGIN PUMPING BEFORE CRANKING ENGINE. The double-acting pump forces the starting fluid-air mixture into the engine on both inward and outward strokes of the pump plunger.

After the engine starts, pumping can be continued if necessary, to keep it running smoothly during the first ignitions.

Engines with Air or Hydraulic Starters

Air and hydraulic starters turn the engine at high speed for a short period. To assure that starting fluid is in the intake manifold at the first revolution of the engine, operate the hand pump A FEW STROKES BEFORE USING STARTER.

After three or four starts, remove cap and piercing tool assembly and check capsule chamber for starting fluid. If necessary install new capsule and replace cap.

Operation

The double-acting pump plunger forces starting fluid vapor into the engine air box on both inward and outward strokes. When the pump plunger is pulled out-

VARIABLE SPEED MECHANICAL GOVERNOR AND INJECTOR CONTROL RACK ADJUSTMENT

After adjusting the exhaust valves and timing the fuel injectors, adjust variable speed mechanical governor as follows:

Adjust Governor Gap

With engine stopped, the governor gap may be set as follows:

1. Remove governor cover.
2. Place throttle control lever in the FULL SPEED position.
3. Insert a .006" feeler gauge between the spring plunger and the plunger guide as shown in Fig. 1. If required, loosen lock nut and turn adjusting screw in or out until a slight drag is noted on the feeler gauge.
4. Hold adjusting screw and tighten lock nut. Check gap. If necessary readjust.
5. Install governor cover.

Fig. 1 - Adjusting Governor Gap

Position Injector Rack Control Racks

The position of the injector control racks must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load.

Adjust No. 1L injector rack control lever first to establish a guide for adjusting the remaining injector rack control levers. The letters R or L indicate injector location in right or left cylinder bank, viewed from rear of engine. Cylinders are numbered starting at the front of the engine on each cylinder bank.

1. Disconnect any linkage attached to the throttle control lever.
2. Loosen buffer screw lock nut and back out buffer screw approximately 5/8".
3. Remove valve rocker covers.
4. Remove clevis pin between the fuel rod and the right cylinder bank injector control tube lever.
5. Loosen all inner and outer injector rack control lever adjusting screws on both cylinder heads. Be sure all injector rack control levers are free on the injector control tubes.
6. Move governor throttle control lever to the FULL SPEED position.
7. Move fuel shut-off lever to the RUN position; hold in that position with light finger pressure. Turn the inner adjusting screw of No. 1L injector rack control lever down, Fig. 2, until a slight movement of the governor cover throttle control lever is observed, or a step up in effort is noted. This will place No. 1L injector rack in the FULL FUEL position. Turn down outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws until tight.

   CAUTION: Care should be used to avoid setting rack too tight causing fuel rod to bend.

8. With the fuel shut-off lever held in the FULL FUEL position, check for a slight movement of the injector control tube lever toward the governor. This movement should not exceed .005".
9. If no movement is observed back off inner adjusting screw approximately 1/8 of a turn and tighten outer adjusting screw.

Fig. 2 - Positioning No. 1 Injector Rack Control Lever

If the movement exceeds that specified, back off outer adjusting screw approximately 1/8 of a turn and tighten inner adjusting screw.

When the setting is correct, the injector rack will be snug on the pin of the rack control lever and still maintain the movement specified in step 8.

NOTE: Performing steps 7, 8 and 9 will result in placing the governor linkage and control tube assembly in their same positions that they will obtain while the engine is running at full load. These positions are:

a. Throttle control lever is at full speed position.

b. Fuel shut-off lever is in the RUN position.

c. High speed spring plunger is within .005'' to .007'' of its seat in governor control housing.

d. Injector fuel control racks are within .005'' of maximum fuel position (measured at clevis end of injector control tube lever).

10. Remove clevis pin between the fuel rod and the left bank injector control tube lever.

11. Manually hold No. 1L injector rack in the FULL FUEL position and turn down inner adjusting screw of No. 2L injector rack control lever until the injector rack of No. 2L injector has moved into the FULL FUEL position. Turn outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws until tight.

12. Recheck No. 1L injector rack to be sure that it has remained snug on the pin of the rack control lever while positioning No. 2L injector rack. If the rack of No. 1L injector has become loose, back off slightly the inner adjusting screw on No. 2L injector rack control lever. Tighten outer adjusting screw.

    When the settings are correct, the rack of both injectors must be snug on the ball end of their respective rack control levers.

13. Position the remaining injector rack control levers as outlined in Steps 11 and 12.

14. Insert clevis pin between the fuel rod and the right cylinder bank injector control tube lever.

15. Position the right bank injector racks as outlined above for the left bank in steps 6 through 13.

16. Insert the clevis pins between the fuel rods and the injector control tube levers, both right and left cylinder banks.

17. With the governor throttle control lever held in the FULL FUEL position, check for a slight movement of both right and left bank injector control tube levers. This movement should not exceed .005''. Repeat above procedure as necessary.

Adjust Maximum No-Load Speed

The maximum no-load speed on units equipped with variable speed governors must not be less than 125 r.p.m. or more than 150 r.p.m. above the recommended full load speed.

Using an accurate hand tachometer, determine the maximum no-load speed of the engine then, make the following adjustments, if required:

1. Disconnect booster spring and retracting spring.

2. Remove two bolts and withdraw variable speed spring housing and variable speed spring plunger inside spring housing.
3. Refer to the chart below and determine the stops or shims required for the desired no-load speed.

V-71 Variable Speed Governor Adjustment

Full Load Speed*	Stops	Shims
1200 - 1750	2	Up to .325"
1750 - 2100	1	in Shims
2100 - 2300	0	Maximum

*No Load Speed is 100-140 r.p.m. above Full Load Speed.

4. Install variable speed spring housing and recheck maximum no-load speed.
5. If required add or remove shims to obtain the necessary operating speed. For each .001" shim added the operating speed will increase approximately 1 r.p.m.

   Governor shims are available in .010" and approximately .078".

Fig. 3 - Adjusting Idle Speed

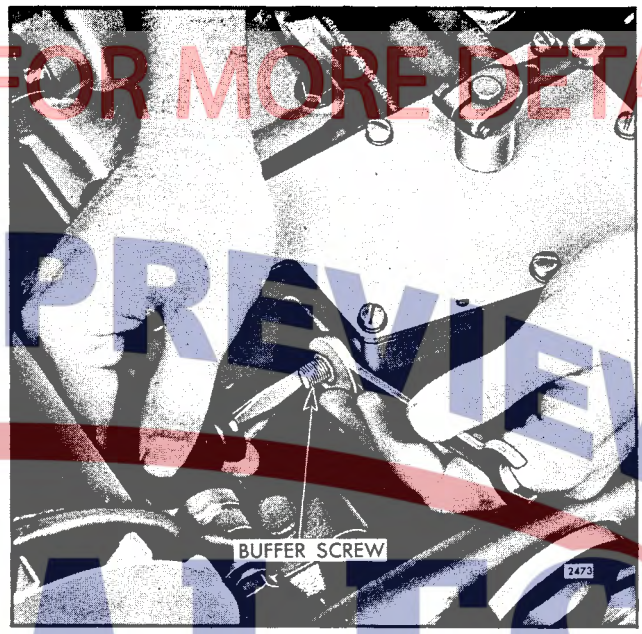


Fig. 4 - Adjusting Buffer Screw

NOTE: Governor stops are used to limit the compression of the governor spring, which determines the maximum speed of the engine.

Adjust Idle Speed

With the maximum no-load speed properly adjusted, the idle speed may be adjusted as follows:

1. Place fuel shut-off lever in the RUN position and the throttle control lever in the IDLE position.
2. With engine operating, loosen lock nut. Turn idle speed adjusting screw, Fig. 3, until engine idles at the recommended idle speed.

   The recommended idle speed is 550 r.p.m., but may vary with special engine applications.
3. Hold idle speed adjusting screw and tighten lock nut.

Adjust Buffer Screw

With idle speed properly adjusted, the buffer screw may be adjusted as follows:

1. With engine at idle speed, screw IN buffer screw, Fig. 4, so that it contacts the differential lever as lightly as possible and still eliminates the engine roll.

Cleaning The Paper Filter

Although a paper filter is used, it is entirely possible to clean it so that it can be reused. The number of times a filter can be reused depends on a few factors, among them the type of dirt on the filter, the care exercised in cleaning, and the expected life of the cleaned element. The life of a cleaned element will not be as long as a new element, and it will be less after the second cleaning than after the first, etc. Theoretically it is possible to clean a paper filter several times providing the paper does not rupture. Three methods of cleaning are possible.

1. In an emergency dust can be dislodged by tapping the cartridge on a solid surface, rotating cartridge while tapping. Care should be taken not to damage cartridge during cleaning process. Also, be sure that dirt is not allowed to fall on the clean side (outside) of the filter.

2. For more effective cleaning, direct a jet of clean compressed air against the pleats of cartridge but never use more than 100 p.s.i. The air jet should be directed in the opposite direction of normal operating air flow, or from the outside to the inside, and move the air up and down the pleats. Care should be taken not to rupture cartridge with either the nozzle or the air jet.

3. In cases where the dust cake on the filter cartridge may be difficult to clean off, the cartridges can be cleaned by washing with water. Use a good household non-sudsing detergent such as Soilax. Warm water (120°-140°) is desirable but not necessary. If a hose is used to wash or rinse the cartridge, be careful not to rupture the paper with the water jet. A maximum water line pressure of 40 p.s.i. is recommended. Flush cartridge from the outside to the inside (reverse of normal air flow), until the drain water becomes clean. Air dry element thoroughly before placing in service.

4. After cleaning filter cartridge, inspect the cartridge for damage or ruptures. To detect paper ruptures, place a bright light bulb inside the cartridge and rotate the cartridge slowly. Inspection of the element on the outside will disclose any holes where concentrated light shines through. Remember even the smallest hole will pass dust to the engine and may result in costly engine repair. Check the condition of rubber grommet in cartridge and replace worn or damaged grommet.

Connections

It is very important that the hose gaskets and elbow from the engine to the air cleaner be thoroughly checked for cracks and leaks. The flange mounting bolts and nuts should be checked for tightness to prevent leaks. Failure to correct these cracks or leaks will allow dust laden air to by-pass the air cleaners and enter directly into the engine. This will cause premature engine failure.

Recommendations

1. Under no conditions should unit be operated without a paper filter cartridge.

2. Never operate unit without the dust cup in place.

3. Carbon, soot and oil fumes are extremely injurious to the paper element. Keep the air inlet as far away from sources of these products as possible.

4. Keep replacement or cleaned filter cartridge on hand for immediate replacement in unit on an exchange basis. This will avoid unnecessary down time.

5. Use only genuine Euclid replacement cartridges. These elements have been rigorously tested and have proven to have twice the life of less expensive off brand cartridges.

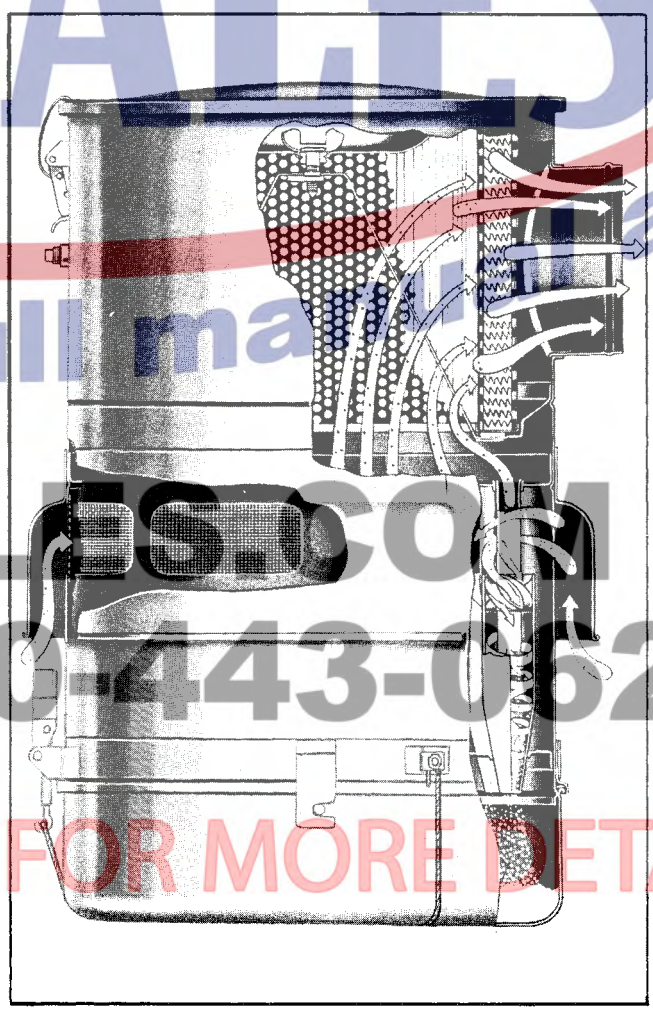


Fig. 7 - Installing Oil Pump Gear on Shaft

2. Align the pump so that teeth of pump driving gears are parallel, then secure pump to bearing caps with four nuts and lock washers. Check clearance (backlash) between gear teeth as shown in Fig. 9. Proper clearance is from .006'' to .012''.

   If shims were used between the pump mounting feet and the bearing caps on original installation, and new gears are not installed, the same shims (cleaned) or the same number of new shims of identical thickness should be installed and the number then adjusted to obtain the proper backlash between the teeth of the driving gears. However, if new gears have been installed, a larger number of shims may be required. In either case, the pump must be securely tightened on the bearing caps before the backlash between the gear teeth is measured.

   NOTE: When adjusting for gear tooth clearance by adding or deleting shims, the same number of shims must be changed under each foot so that the pump will always be level on the main bearing caps. The insertion or removal of one .005'' shim will change the gear tooth clearance by .0035''.

3. Attach new gaskets to pressure relief valve assembly and bolt valve assembly to both pump body and cooler side of cylinder block.

4. Place new gasket at end of vertical oil gallery on side of block opposite oil cooler and secure pressure regulator to block with two bolts and lock washers.

5. Using new gaskets, attach scavenger pump oil discharge and oil pump inlet pipes to pump body and secure with bolts and lock washers.

6. Attach support brackets to oil pump inlet and scavenging pump discharge pipes. Secure brackets together and to main bearing cap with bolts, lock washers, and nuts.

7. Using new gaskets, set oil inlet screen covers over oil pump inlet pipe and over pump body

Fig. 8 - Installing Oil Pump Drive-Driven Gear on Shaft