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AUTOMOTIVE DIESEL MAINTENANCE, UNIT V, MAINTAINING THE LUBRICATION SYSTEM--DETROIT DIESEL ENGINE.

HUMAN ENGINEERING INSTITUTE, CLEVELAND, OHIO

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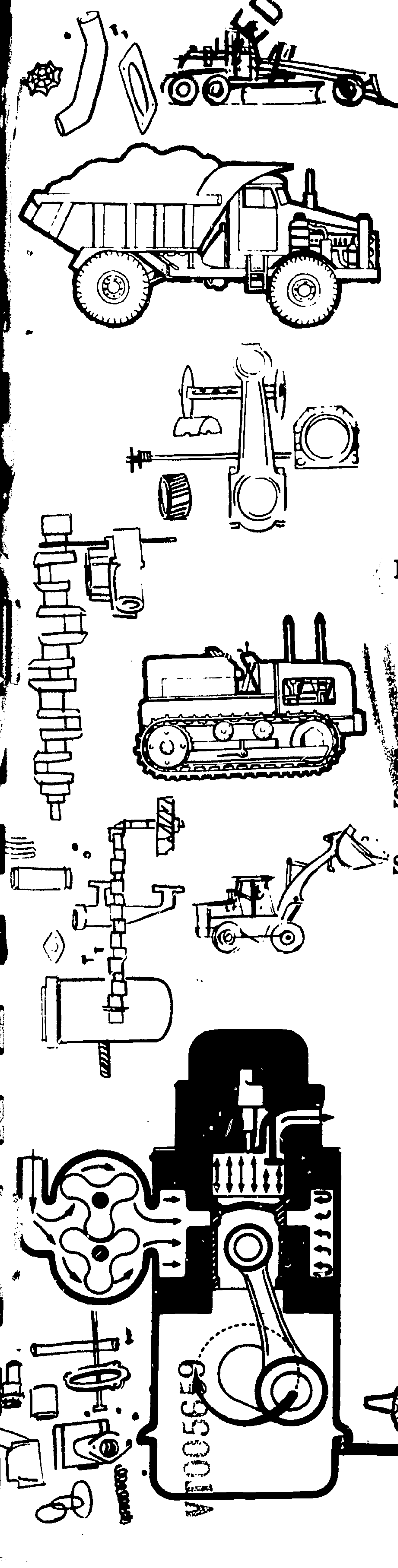
THIS MODULE OF A 30-MODULE COURSE IS DESIGNED TO DEVELOP AN UNDERSTANDING OF THE OPERATION AND MAINTENANCE OF THE DIESEL ENGINE LUBRICATION SYSTEM. TOPICS ARE LUBE OILS USED, MAINTENANCE OF THE LUBRICATION SYSTEM, AND CRANKCASE VENTILATION COMPONENTS. THE MODULE CONSISTS OF A SELF-INSTRUCTIONAL BRANCH PROGRAMED TRAINING FILM "BASIC ENGINE LUBRICANT CHARACTERISTICS" AND OTHER MATERIALS. SEE VT 005 655 FOR FURTHER INFORMATION. MODULES IN THIS SERIES ARE AVAILABLE AS VT 005 655 - VT 005 684. MODULES FOR "AUTOMOTIVE DIESEL MAINTENANCE 2" ARE AVAILABLE AS VT 005 685 - VT 005 709. THE 2-YEAR PROGRAM OUTLINE FOR "AUTOMOTIVE DIESEL MAINTENANCE 1 AND 2" IS AVAILABLE AS VT 006 006. THE TEXT MATERIAL, TRANSPARENCIES, PROGRAMED TRAINING FILM, AND THE ELECTRONIC TUTOR MAY BE RENTED (FOR $1.75 PER WEEK) OR PURCHASED FROM THE HUMAN ENGINEERING INSTITUTE, HEADQUARTERS AND DEVELOPMENT CENTER, 2341 CARNEGIE AVENUE, CLEVELAND, OHIO 44115. (HC)

STUDY AND READING MATERIALS



AUTOMOTIVE DIESEL MAINTENANCE

MAINTAINING THE LUBRICATION SYSTEM--
DETROIT DIESEL ENGINE

UNIT V

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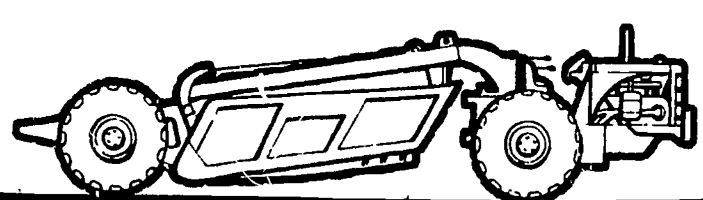


HUMAN ENGINEERING INSTITUTE

SECTION A - LUBE OILS USED

The oil flow in the lubrication system can be traced through the oil pump, the oil filter, the oil cooler, the pressure regulator, and the by-pass valve. See Figures 1 and 2.

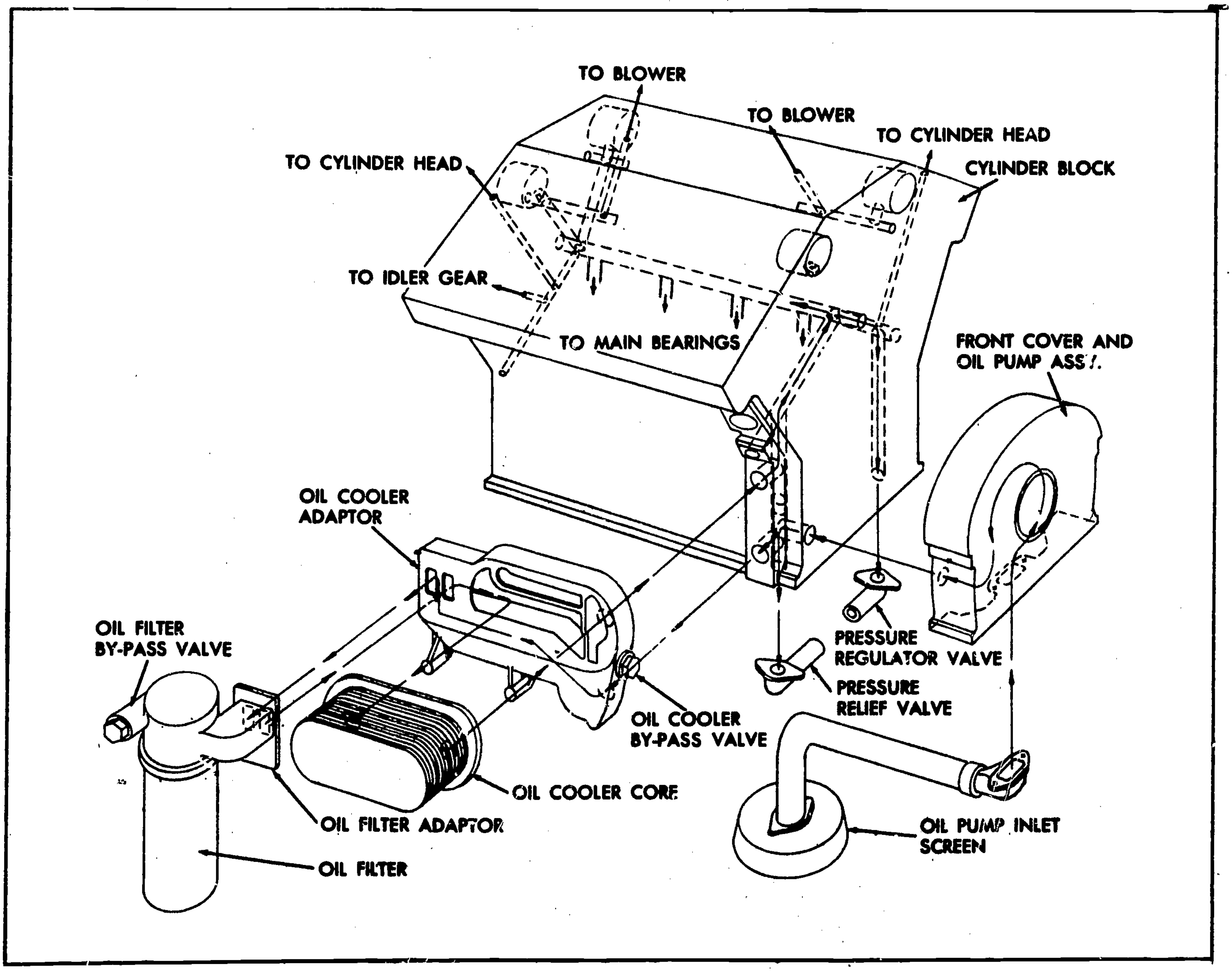


Fig. 1 Diagram of typical 6V and 8V lubrication systems.

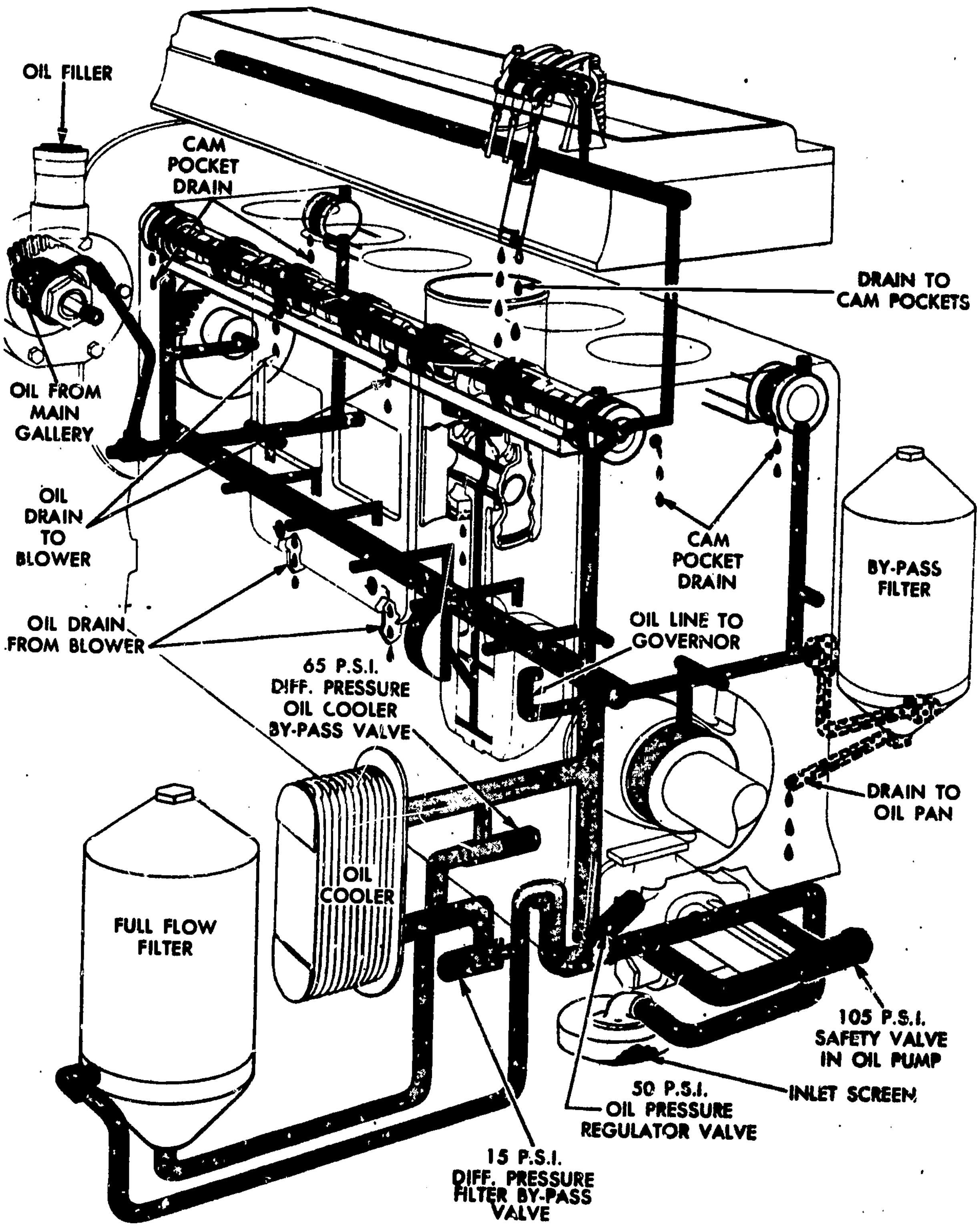


Fig. 2 Diagram of typical lubricating system (in-line).

We will not try to trace the oil flow through every passage of the engine blocks. Rather in this unit we will analyze each component part of the system and discuss some interesting points about the oil and its characteristics. In addition, some helpful tips on maintaining the lube system will be inserted throughout the text.

All diesel engines require heavy duty lubricating oils. Basic requirements of such oils are: (1) lubricating quality, (2) high heat resistance, and (3) control of contaminants.

LUBRICATING QUALITY -- The reduction of friction and wear with an oil film is a very important item. Film thickness, and therefore its ability to prevent metal-to-metal contact of moving parts, is proportional to oil viscosity; the recommended oil for GM diesel engines is SAE 30 weight. In addition, certain additive agents serve to improve "oiliness," film strength, anti-wear and extreme pressure characteristics.

HIGH HEAT RESISTANCE -- Temperature is the most important factor in determining the rate at which deterioration (oil breakdown) or oxidation of the lubricating oil will occur. Excessive temperatures in engines will breakdown the oil considerably resulting in sub-normal lubrication of the engine. Oxidation of the oil (breakdown) is prevented by various anti-oxidation agents that are added to diesel oils.

CONTROL OF CONTAMINANTS -- The piston and compression rings must ride on a film of oil to minimize wear and prevent seizure with the cylinder wall. At normal rates of consumption, oils reach a temperature zone at the upper part of the piston where rapid oxidation, polymerization (change into another compound) and carbonization can occur. Detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts. In addition, as oil circulates through the engine it is continuously contaminated by soot, acids and water originating from combustion. Until they are exhausted, detergent and dispersant additives also prevent the deposit of the sludges formed by these contaminants. But, such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insoluble deposits form, particularly on the piston in the compression ring area, early engine failure may result.

Diesels perform best and experience the longest service life with SUPPLEMENT 1 (S-1) lubricating oils. S-1 oils should always be used during run-in and prior to the initial oil change. After this period, and only under special operating conditions, other lubricating oil may be used.

"Series 3" oils have the highest concentration of additives. Furthermore, diesels do not normally require these premium-priced lubricating oils. The use of "Series 3" oils in diesels can create some serious side effects which drastically reduce engine life. Metallic ash deposits build up in two areas. The build-up can take place on the valves and valve seats until valve guttering takes place. The deposits can also collect in the top piston ring grooves, causing ring sticking, blow-by and damage to pistons and liners. These conditions have been known to result in a need for engine overhaul at less than 500 hours of operation due to the effect of the metallic ash from the lubricating oil.

Not all "Series 3" oils have the same concentration of additives, and most of the additives in "Series 3" oils are also used in SUPPLEMENT 1 (S-1) oils but in much lower concentrations. Because the additive content in "Series 3" oils is higher, the ash deposit rate is higher than with any SUPPLEMENT 1 (S-1) oil. The ash build-up rate is not only much lower, but also oil consumption tends to be lower, with SUPPLEMENT 1 (S-1) oils.

There is much research taking place in the oil industry on so-called "ashless" additives, but at the present time there is no "Series 3" oil on the market using all ashless additives.

GM diesels should be run with "Series 3" oils only under the following exceptional circumstances:

If the continued use of high sulphur fuel is unavoidable, and used oil analyses indicate exhaustion of reserve alkalinity or of detergency with a minimum practice oil drain period, use "Series 3" oil.

If light load or cold engine operation causes excessive oil sludging, and the work cycle or operating conditions cannot be adjusted to prevent sludging, use "Series 3" oil.

"Series 3" oil can be considered under these exceptional circumstances since high acid build-up from high sulphur fuels or heavy sludging are both extremely detrimental to satisfactory life. The extra additives in "Series 3" oil reduce these detrimental conditions by neutralizing more of the sulphur content and holding more of the sludge in suspension. It is to be expected, however, that these extreme conditions requiring "Series 3" oil will give shorter engine life than is to be expected with SUPPLEMENT 1 (S-1) oils under more favorable conditions. Do not use "Series 3" oil under any other circumstances.

SECTION B - MAINTENANCE OF THE LUBRICATION SYSTEM

The most important step in maintaining the lubrication system is to make sure you are using the correct type and grade of oil in the system.

CHANGING OIL -- Change the initial lubricating oil at approximately 3000 miles. The drain interval may then be increased, following the results of oil tests that are performed at scheduled intervals.

The oil level should never be allowed to drop below the LOW mark on the dipstick. Overfilling, on the other hand, may result in abnormal oil consumption, high oil temperatures, and leakage. THE OIL LEVEL SHOULD BE CHECKED DAILY.

CLEANING THE LUBRICATION SYSTEM -- A through flushing of the lubrication system is necessary at times. If the oil system becomes contaminated, the system MUST be flushed thoroughly to remove the contaminants before the engine is seriously damaged. One possible cause of such contamination-- that will damage the engine if neglected -- is a cracked oil cooler core. When this situation occurs, oil will be forced into the cooling system while the engine is running. When the engine is stopped, coolant will leak back into the oil system.

Coolant contamination of the lubricating system is especially harmful to engines during the cold seasons of the year. During this period, the cooling system is normally filled with ethylene glycol antifreeze solution. If mixed with the oil in the crankcase, this antifreeze forms a varnish which quickly binds engine parts and can cause seizure in many cases.

To remove such contaminants from the engine, both the cooling system and the lubricating system must be flushed according to the proper procedure.

MAINTAINING THE OIL PUMP -- The OIL PUMP has two spur gears. See Figure 3. As the gears revolve, a vacuum forms on the inlet side of the pump. This vacuum pulls oil from the oil pan through an inlet screen and pipe into the pump. The oil is drawn between the gears and front cover and then forced out to the other components under pressure. Oil is sent to the pressure relief valve at the same time. This valve opens at a certain pressure and sends excess oil back to the crankcase.

A REGULATOR VALVE is another component which deals with oil pressure. This valve helps to maintain a constant pressure in the system at all times. It opens at a certain pressure, and sends excess oil back to the pump.

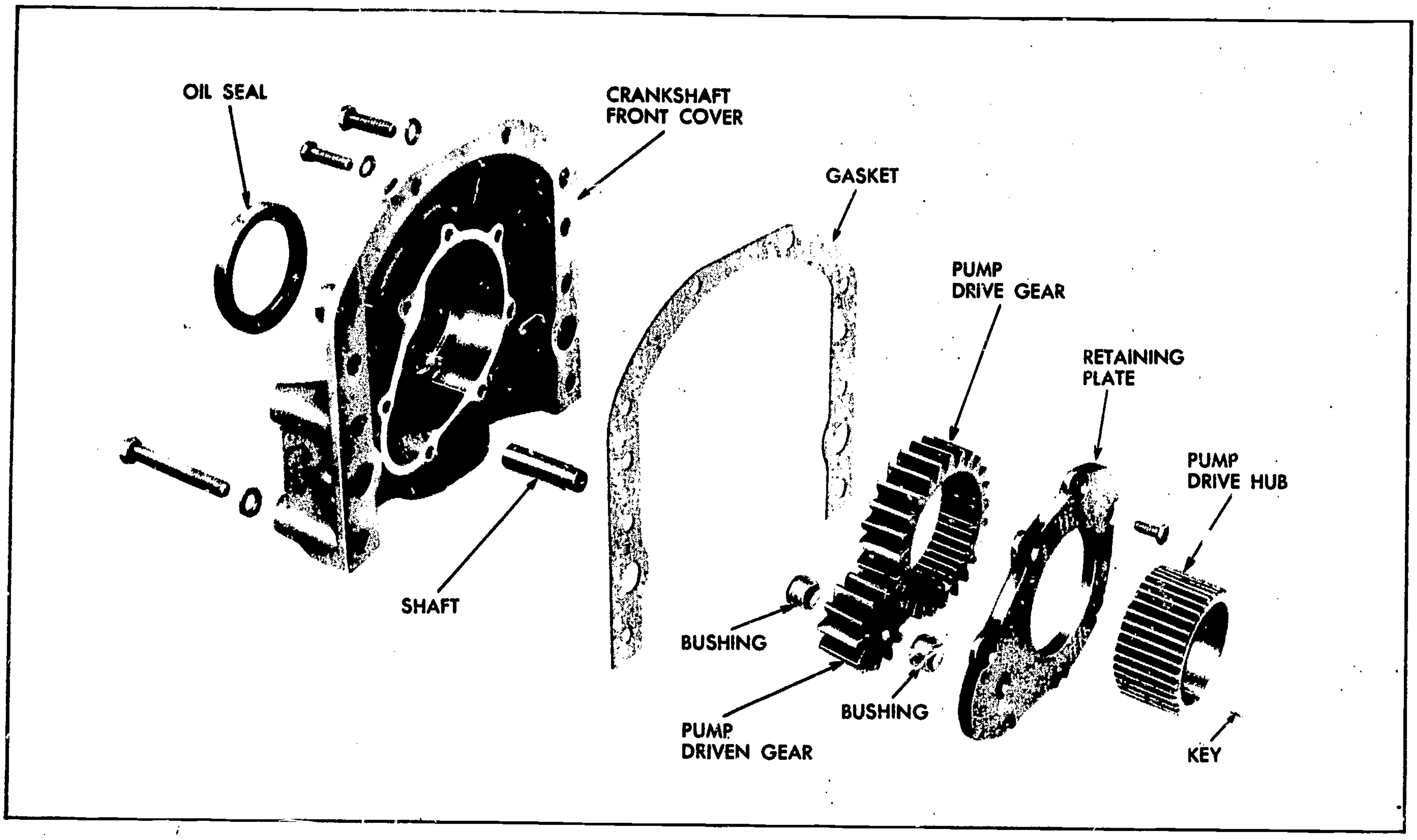


Fig. 3 Lubricating oil pump details and relative location of parts (6V or 8V engine).

When disassembling the pump, clean all the parts in fuel oil and dry them with compressed air. Then, inspect as follows:

INSPECT THE...	INSPECT IT FOR ...
Oil pump gear cavity	wear or scoring
Gear retaining plate	wear or scoring
Shaft or small gear	excessive wear or scoring
Gear teeth	wear, scoring, or chipping
Oil pump drive hub	wear, scoring, or chipping
Bushing in the small gear	wear or scoring
Oil inlet screen	dirt (clean as other components)
Oil inlet pipe	dirt (clean as other components)

Remember that the greatest amount of wear in the oil pump is imposed on the internal drive and driven gears.

MAINTAINING THE OIL PRESSURE REGULATOR VALVE -- The oil pressure regulator valve maintains stable oil pressure at all speeds and all temperatures. The valve is installed near the front of the cylinder block on the side opposite the oil cooler.

The regulator is made up of a valve body, a hollow piston-type valve, a spring, a spring seat, and a pin to hold the valve in the valve body. (See Figure 4).

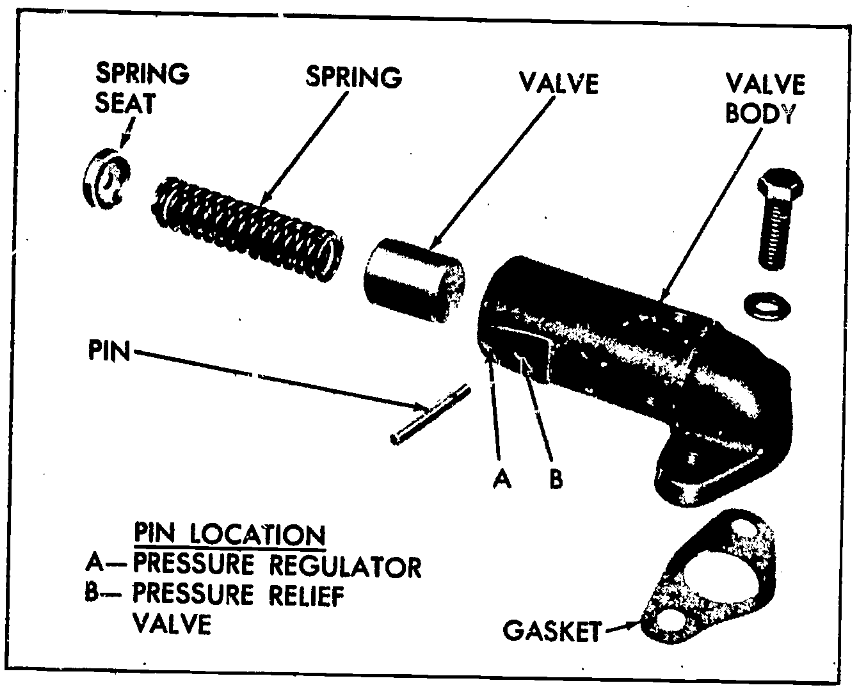


Fig. 4 Regulator valve and relief valve details and relative location of parts (6V or 8V engine).

The valve is held to its seat by a spring. This spring is compressed by a pin in back of the spring seat. The entire assembly is bolted to the lower flange of the block. It is sealed against leaks by a gasket found between the block and valve housing. When the oil pressure at the valve exceeds a set pressure, the valve is forced from the seat and oil is then by-passed to the oil pan.

Under normal conditions, the oil pressure regulator should not require much attention. If sludge has been allowed to build up in the system, however, the valve may not be able to work freely. Thus the valve will either remain open or fail to open at the proper time.

Whenever the oil pump is removed for inspection the regulator valve and spring should be gone over as well. All parts should be cleaned in fuel oil and then dried with compressed air.

During your inspection of the valve, make sure that it moves freely in the valve body. If the valve is scored so badly that it cannot be cleaned with a crocus cloth, replace it.

Check your tables or maintenance manual for the proper spring tension of the valve spring. Then check the spring, using special tool J 5237 recommended in your GM Maintenance Manual. Replace the spring when the recommended tension is no longer attained.

NOTE: The valve body used on V6 and V8 engines has two retaining pin holes. The pin for the regulator valve must be installed in the outermost hole. The inner hole is used when the regulator valve is used as a relief valve.

MAINTAINING THE OIL PRESSURE RELIEF VALVE -- Oil that leaves the pump is under pressure. It flows from the pump into the pressure relief valve housing, which contains the spring loaded pressure relief valve. When the pressure exceeds the limit set for a particular engine, the valve opens and sends excess oil back to the oil pan.

The pressure relief valve is usually found near the front of the cylinder block on the oil cooler side. On the V6 in-line series, the relief valve is found on the pump body.

The pressure relief valve is made up of the valve body, a hollow piston type valve, a spring, a spring seat, and a pin which keeps the valve assembly in the valve body. (See Figure 4).

In the V6 and V8 engines, the retaining pin is found in the inner pin hole. This gives the necessary tension to the spring.

To maintain the relief valve follow the maintenance tips given for the regulator valve.

MAINTAINING THE OIL FILTER -- The oil filter is located ahead of the oil cooler. The filter may be mounted directly to the oil cooler adaptor, or mounted on the adaptor cover and connected to the cooler by means of flexible hoses. The filter is equipped with a by-pass valve. The valve will send oil directly to the cooler if the filter should become plugged up.

The filter assembly consists of a replaceable filter element in a shell which is on a base. When the shell is on, the element is held in place by a coil spring. (See Figure 5).

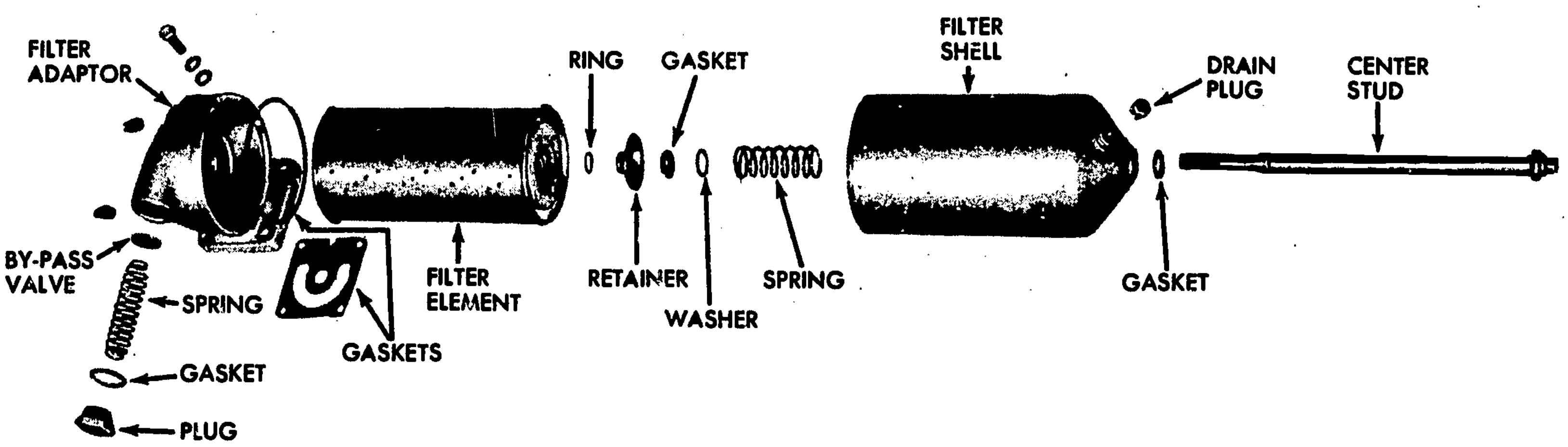


Fig. 5 Full-flow filter details and relative location of parts.

All of the oil supplied to the engine normally passes through the filter. Through pressure from the oil pump, oil is forced into the space surrounding the filter element. As the oil is forced through the filter element, all the impurities are removed. The purified oil in the center of the filter element is then forced out through another passage.

For additional filtration, a by-pass filter may be installed on the engine. (See Figure 6). This is a finer filter and works in much the same manner as the full flow filter. Oil leaving the by-pass filter does not go on to the oil cooler as in the other filter, but it is sent back to the engine crankcase.

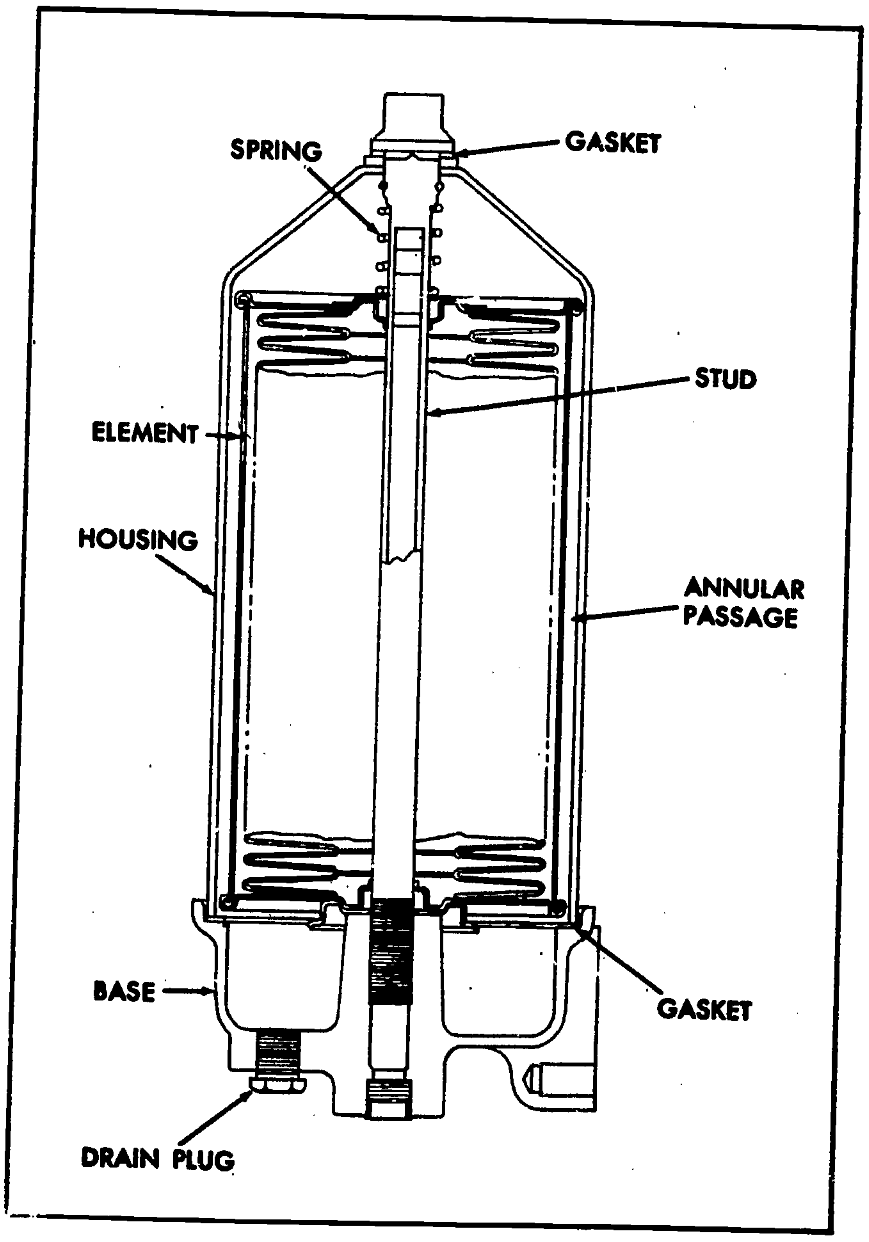


Fig. 6 Typical by-pass type oil filter.

With the use of detergent lubricating oils, we can no longer tell how clean the oil is by color. Detergent oils hold dirt in suspension and always appear dark-colored on the dipstick.

Heavy sludge deposits found on the filter element at the time the oil is changed shows that the detergency of the oil was exhausted. If this occurs, the interval between oil changes should be shortened.

Replacing the filter elements insures the removal of abrasive dust, metal particles, and carbon from the oil -- so, the oil filter elements should be changed every time the oil is changed.

When reassembling the parts of the filter, after they have been cleaned and inspected for signs of wear, be sure to use new gaskets.

When new filter elements have been installed, run the engine for a little while, and then check for leakage around the filter. The engine should then be stopped, and the oil level should be checked after it has had time to drain back to the pan. Add oil if needed.

MAINTAINING THE OIL COOLER -- While lubricating and cooling parts of the engine, the oil absorbs a lot of heat. If the oil is too hot, it cannot support bearing loads. Hot oil cannot carry away much more heat, and as a result the oil pressure will drop and the engine will need oil more often. To counter these effects of heat, we have an oil cooler.

The OIL COOLER is usually found on the side of the cylinder block at the lower front corner. (See Figure 7).

Oil is sent from the filter to the oil cooler, where it surrounds the oil cooler core. When the cooled oil is sent on, it is channeled into the oil passages or galleries in the cylinder block.

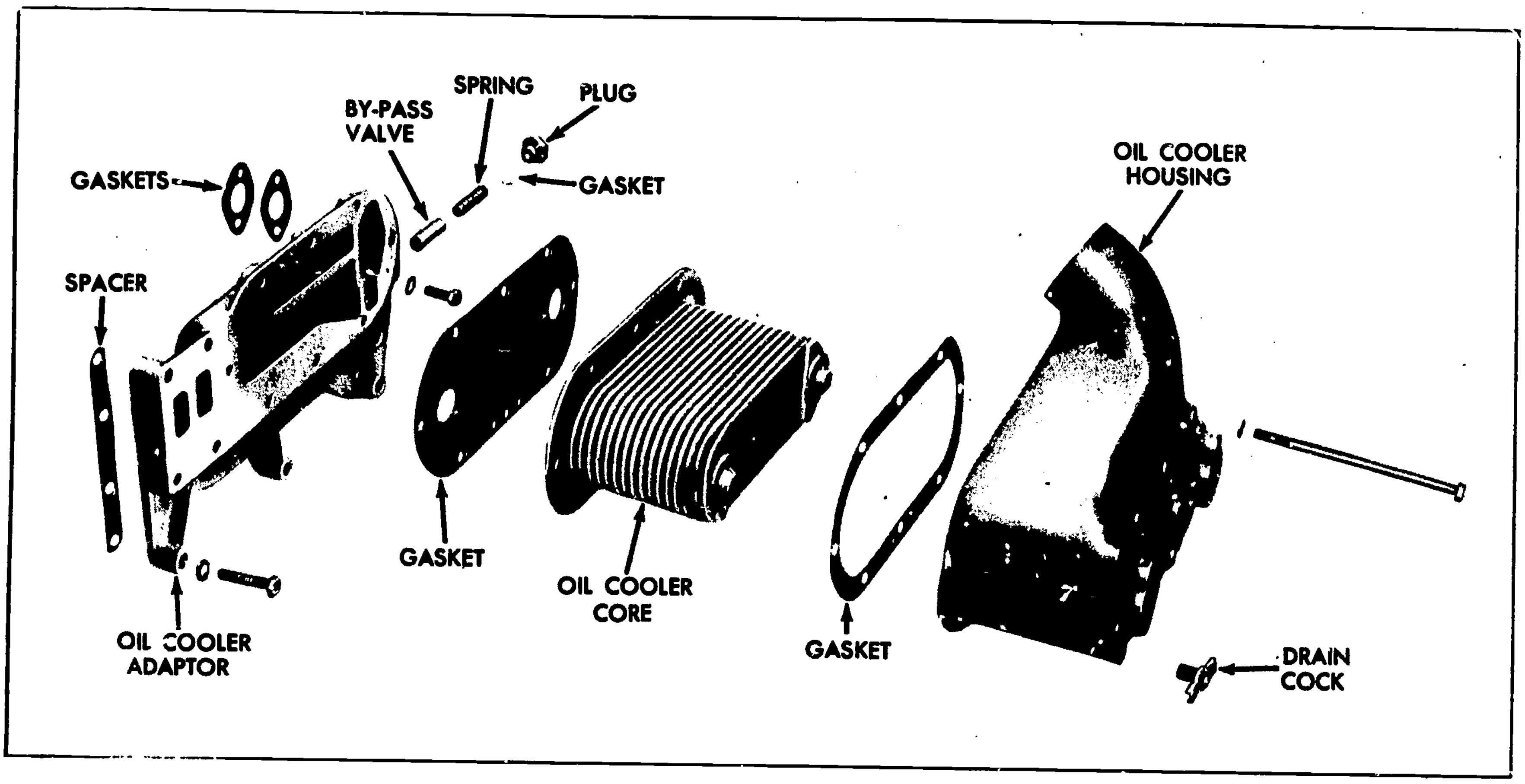


Fig. 7 Oil cooler details and relative location of parts.

The method for cleaning a particular oil cooler will be found in the manual for that particular engine. Oil coolers normally are cleaned when the entire engine must be cleaned, as in the case of contamination. They are also cleaned when engines are torn down for rebuilding. Complete coverage of cooler core cleaning will be covered later on in this course.

NOTE: Don't clean an engine cooler core when engine failure occurs in which metal particles (From worn or broken parts) are released into the oil. REPLACE THE COOLER CORE IN THIS CASE.

If the oil cooler is suspected of leaking, it may be checked by attaching an air hose to the core and submerging it in a container of water. Apply air pressure and look for leaks. If there are any, replace the cooler core.

MAINTAINING THE BY-PASS VALVE -- A by-pass valve is connected to the inlet passage of the oil cooler. (See Figure 8). This valve assures us that, even if the oil cooler becomes plugged up, the oil will still circulate through the lube system. The valve opens and allows oil to pass by the oil cooler when a certain pressure is reached.

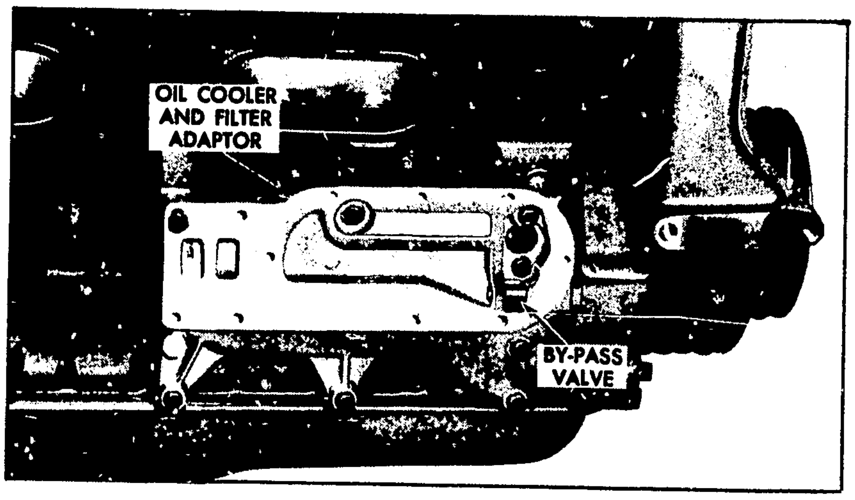


Fig. 8 Oil cooler adaptor and by-pass valve mounting.

The by-pass valve may be taken out without removing the oil cooler. The valve assembly is made up of a valve, a spring, a retaining plug, and a gasket. This assembly should be cleaned whenever the oil cooler core is removed or replaced. The by-pass valve spring is tested for tension by the GM tool J9666.

MAINTAINING THE PROPER OIL LEVEL -- The importance of maintaining the proper oil level in a diesel engine should not be taken lightly. Excessive oil in an engine is equally as dangerous as too little oil in an engine. Providing there are no leaks in the system, the indication of low oil pressure is the result of low on oil. Be sure to observe the oil pressure gauge immediately after starting the engine. If there is no oil pressure within 10 to 15 seconds, stop the engine and check the lube system. The pressure should not fall below 25 psi at 1200 rpm, or 30 pounds at 2100 rpm, and normal operating pressure should be higher.

Be sure to check the oil every day, if possible before starting the engine. Should the engine be running, shut it off and wait a few minutes until the oil distributed in the engine has had time to drain back into the oil pan.

In the V-71 series, either a one piece, or an upper and lower pan bolted together, may be used. (See Figures 9 and 10). A sectional oil pan gasket, made up of two side sections and two end sections, takes in all the necessary bolt holes. In the in-line 71 series, a one piece gasket is used on all three and four cylinder engines, and on all six cylinder engines having a stamped metal oil pan. Otherwise, the sectional gasket is used.

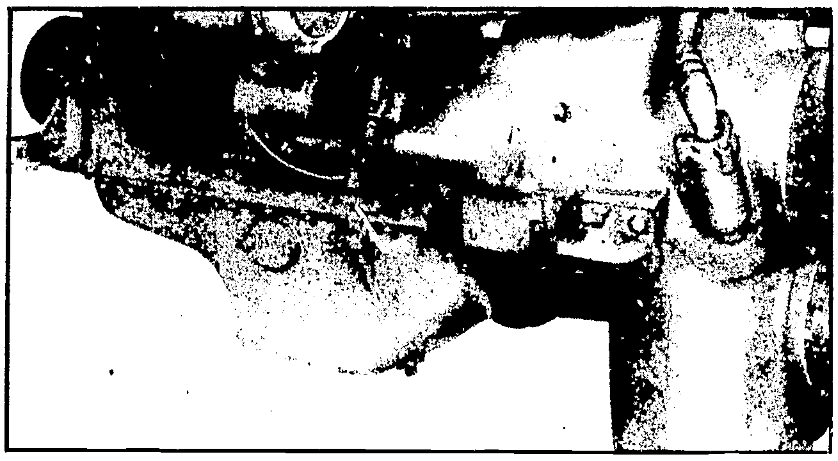


Fig. 9 Typical one piece oil pan (6V engine).

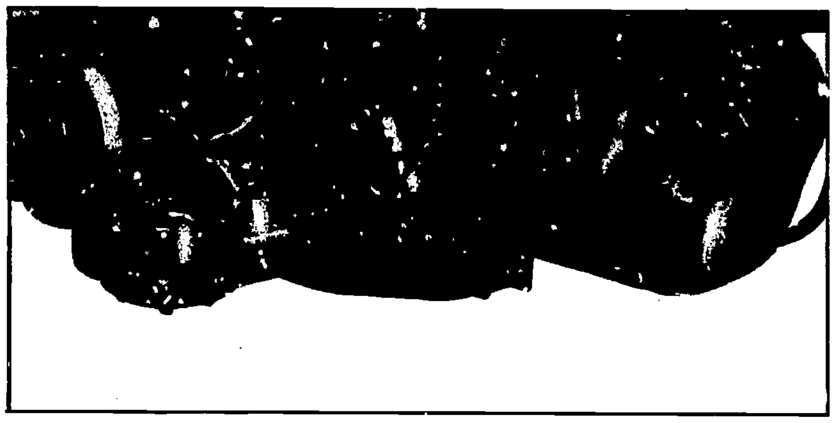


Fig. 10 Typical two piece oil pan (12V engine).

There are three points to remember when maintaining the oil pan:

1. The inside of the oil pan should be cleaned occasionally. It is important that residue is not allowed to collect in any large amount. If it is allowed to collect, it could easily work its way back into the lube system.

2. Whenever the oil pan is removed, the gasket should be replaced. Check both metal surfaces which the gasket comes in contact with to make sure that none of the old gasket remains. And DON'T use Permatex or ANY OTHER gasket sealer.

3. Be sure to note the condition of the oil pan. Make sure that there are no dents or gouges which may cause leakage in the future when the equipment is in the field.

SECTION C -- CRANKCASE VENTILATION COMPONENTS

The crankcase ventilation system through the use of pressure automatically removes harmful vapors from the crankcase, gear train, and valve compartments. The breather cavity is a large, high, cross-sectional area of the central crankcase. This location permits a large air capacity which cannot be flooded even if the engine is tilted during operation.

A breather pipe may be mounted on the top of the cylinder block or at an opening in the flywheel. (See Figure 11).

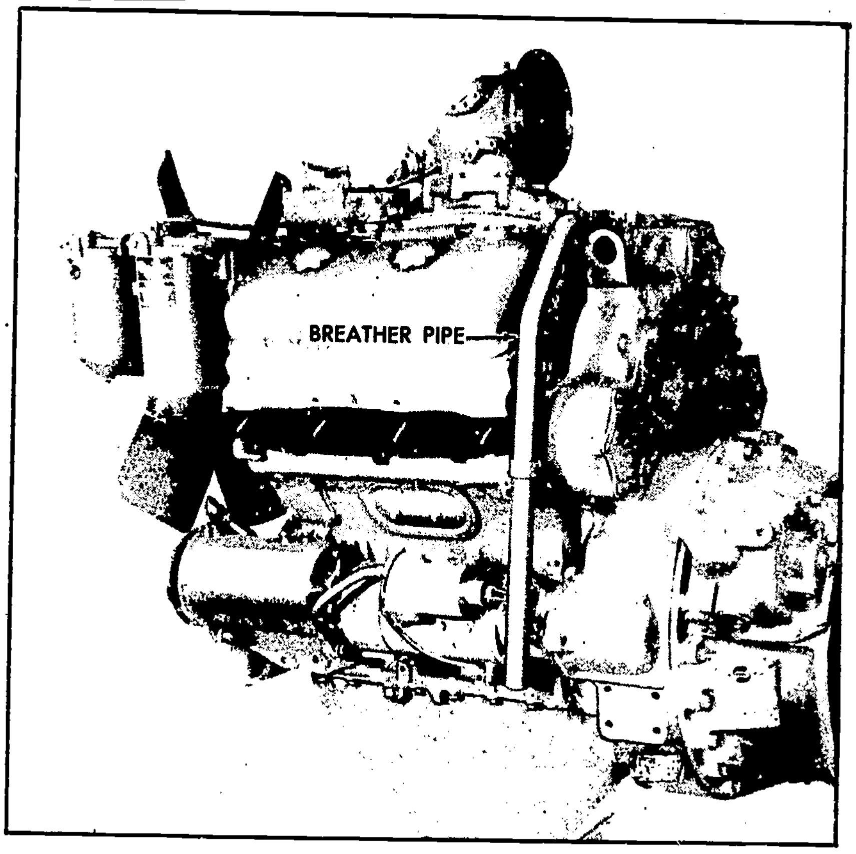


Fig. 11 Typical installation of breather pipe from top of cylinder block.

The breather assembly is made up of a wire mesh pad that filters out any oil which may be present in the vapors. This reclaimed oil is then sent back to the crankcase.

The breather pad should be cleaned about every 500 hours of operation or whenever the engine is overhauled, or when the rear cylinder block end plate is removed. Remove the breather pad, wash it in fuel oil, and dry it with compressed air. Be sure to inspect the breather pipe as well. Look for any restrictions which might affect its function.

This concludes the text on the lubrication system. Study film No. PTAM 1-5D at home. The tape covers some of the technical background of oils -- which will be helpful to you as a maintenance man.

DIDACTOR

FILM NO. PTAM 1-5D

A 0

PTAM 1-5D

BASIC ENGINE LUBRICANT CHARACTERISTICS

Human Engineering Institute

Press A — A 1

9/30/65

1

A 1

The difficulty in lubrication of diesel engines comes from the fact that the high temperatures and pressures involved cause all known lubricants to deteriorate in service.

The lubrication of small high-speed units is more difficult than that of large slow-speed engines. The same kind of changes take place in each case, but in large engines they occur at a slower rate and in a much larger body of oil.

Press A — A 2

1

A 2

The __________ temperatures and pressures in diesel engines are what cause lubricants to deteriorate in service.

A. changing — A 3
B. low — A 3
C. high — A 4

1

A 3

No. You must not be reading very carefully. Let's go over the first frame again. This time take it slow and read for facts.

Press A — A 1

1

A 4

Lubricating oils become impaired in service in two ways: (1) changes take place in the oil itself, and (2) outside sources contaminate the oil.

To advance to the next frame choose the correct answer:

It's __________ to lubricate a small high-speed diesel engine than a large low-speed one.

A. easier
B. harder — A 5
C. equally the same

1

A 5

We said there were two ways the oil deteriorates; one is through outside contamination and the other is through changes in the oil itself.

See if you can recognize one of the changes that takes place in the oil under high temperature and pressure:

A. crystallization — A 6
B. oxidation — A 7
C. evaporation — A 6

1

A 6

No, the oil neither crystallizes nor evaporates. You've never seen "crystallized" oil, have you? And you really can't say that oil evaporates like gasoline.

OXIDATION is the correct answer.

Press B — A 7

1

A 7

O. K. OXIDATION is one way oil changes. The hydrocarbons in the oil combine with oxygen in the air to produce what are called "organic acids". The organic acids with low boiling points are usually highly corrosive. The acids with high boiling points tend to form gums and lacquers.

Press C — A 8

1

DIDACTOR

FILM NO. PTAM 1-5D

A 8

When oil oxidizes, it forms organic acids. The organic acids with ________ boiling points are usually highly corrosive.

The oil oxidizes when its hydrocarbons combine with the ________ in the air.

Choose the pair of words to fill the two blanks above.

A. low, oxygen —A10
B. low, moisture —A9
C. high, moisture —A9

1

A 9

No. You've got it mixed up: the organic acids with LOW boiling points are usually highly corrosive. The oil oxidizes when its hydrocarbons combine with the OXYGEN in the air. OXIDATION means combining with oxygen.

Press C —A10

1

A 10

OK. The corrosive organic acids are the ones with LOW boiling points; the acids with HIGH boiling points tend to form gums and lacquers.

Oxidation (combining with oxygen) products are responsible for several of the problems encountered in a diesel engine's operation. If allowed to become sufficiently concentrated, the volatile organic acids attack certain bearing metals, causing pitting and failure.

Press B —A11

1

A 11

These products of oxidation also react with the remainder of the oil to form "sludges." Sludges give trouble by forming in the valve chambers, the sumps, the filters and the oil cooler.

The heavier oxidation products form hard "varnish" deposits on pistons, valve stems, and other metal parts.

Press C —A12

1

A 12

Oxidation produces organic acids that attack certain bearing metals and soft masses called ________ that deposit in valve chambers, sumps, filters, and the oil cooler.

A. sludges —A14
B. varnish —A13
C. volitants —A13

1

A 13

No, neither "varnish" nor "volitants" was the correct answer. "Varnish" is a hard deposit that you find on pistons, valve stems and other metal parts. Soft masses formed by oxidation are SLUDGES.

Press A —A14

1

A 14

OK. Oxidation of oil forms organic acids, SLUDGES, and varnish.

Varnish is a smooth, black film that develops when the oxidation products come in contact with heated metal surfaces. On valve stems, varnish may cause sticking or burning; on pistons it has a tendency to cause the rings to stick.

Press C —A15

1

A 15

Varnish is a smooth, black film that develops when the oxidation products come in contact with heated ________.

A. sludge products —A16
B. grit particles —A16
C. metal surfaces —A17

1

A 16

No. Varnish forms when oxidation products come in contact with heated METAL SURFACES.

Press A —A17

1

A 17

OK. We find varnish on valve stems and pistons; it forms on these HEATED METAL SURFACES and causes sticking.

Press B —A18

1

A 18

In the previous frames, you noted the lubrication problems which result from changes that took place in the oil itself due to its exposure to heat and air. Contamination of the oil from outside sources contributes to these problems and adds new ones. Among these contaminants are certain products of fuel combustion -- ash, soot, unburned "heavy ends" of the fuel, and water.

Press B —A19

1

A 19

We just mentioned some outside contamination sources. Among these, we mentioned certain products of______ such as ash, soot, unburned "heavy ends" of the______, and water. (Choose the correct pair of words or phrases.)

A. oil deterioration, oil —A20
B. hydrocarbon deterioration, oil —A20
C. fuel combustion, fuel —A21

1

A 20

No. We weren't talking about oil deterioration or hydrocarbon deterioration but fuel combustion. These products of fuel combustion contaminate the oil and add to the problems of oxidation that we mentioned in the beginning.

Press B —A21

1

A 21

OK. FUEL COMBUSTION produces ash, soot, water and unburned "heavy ends" of fuel.

When these mix with the lubricating oil on the cylinder walls and piston, the ash, carbon, and soot help to build up piston ring deposits. Also, the unburned fuel may crack or oxidize in the high temperature zone, making a gummy material that forms a binder for the soot or carbon particles.

Press C —A22

1

A 22

Some of the unburned fuel may find its way past the rings. When the fuel reaches the crankcase, it dilutes the lubricating oil and reduces its viscosity, or "thins" it.

For every gallon of fuel burned, about a gallon of water results as a combustion product.

Press A —A23

1

A 23

For every gallon of fuel burned, about a _________of water results as a combustion product.

A. quart —A24
B. pint —A24
C. gallon —A25

1

A 24

No. About a GALLON of water is produced as a result of the combustion of a gallon of fuel.

Press A -A25

1

A25

OK. For every gallon of fuel burned, about a GALLON of water results as a combustion product.

When unburned fuel finds its way into the crankcase, it dilutes the lubricating oil and ________ its viscosity or "thins" it.

A. increases -A26
B. decreases -A27
C. eliminates -A26

1

A26

No. When the unburned fuel gets into the crankcase it certainly doesn't INCREASE the viscosity of the oil -- and it could possibly eliminate it completely, but the answer here is the fact that it REDUCES (decreases) the viscosity.

Press B -A27

1

A27

OK. Unburned fuel in the crankcase DECREASES (reduces) the viscosity of the lubricating oil.

For every gallon of fuel burned, we just said, a gallon of water is formed. This normally passes out of the engine as vapor in the exhaust, but some of it may condense, particularly in the lower and cooler parts of the cylinder liner. This water prevents the oil from properly coating the working surfaces. Also, if hydrogen sulfide or sulfur dioxide are present, because of sulfur in the fuel, they may combine with the water and cause corrosion of the metal surfaces.

Press A -A28

1

A28

Water formed as a result of fuel combustion usually passes out of the exhaust, but some of it may condense, particularly in the ________ and ________ parts of the cylinder liner.

A. hotter, oily -A29
B. lower, cooler -A30
C. lower, hotter -A29

1

A29

No. Water condenses from a vapor when it is COOLED, and the lower parts of the cylinder liner are the cooler parts.

Press A -A30

1

A 30

OK. Water can condense in the lower, cooler parts of the cylinder liner.

This water can combine with other chemicals to ______ metal surfaces, and it also makes it ________ for the oil to properly coat working surfaces.

A. coat, easier -A31
B. corrode, harder -A32
C. corrode, easier -A31

1

A31

No. When the water combines with other chemicals it CORRODES the metal surfaces and makes it HARDER for the oil to properly coat working surfaces.

Press A -A32

DIDACTOR

FILM NO. PTAM 1-5D

A32

OK. When the water combines with other chemicals it CORRODES the metal surfaces and makes it HARDER for the oil to properly coat working surfaces.

Outside contamination -- dust and dirt -- can do damage to cylinder walls; and even the smallest particles can have a deadly grinding action.

Press A —A34

X C —A33

1

A33

You have missed one or more of the past questions in this sequence of material. To make certain you've got the material straight, let's go back and have a review.

If you answer all the questions correctly this time, you'll go on to the next section automatically.

Press B —A1

1

A34

Lubricating the diesel is a tough job -- yet it can be done successfully. How? For one thing, refineries are producing ever better lubricants. These oils are refined to have suitable physical characteristics and, even more important, the desired chemical characteristics. Modern oils are made to resist oxidation.

Press A —A35

2

A35

Modern oils have both improved physical and __________ characteristics.

A. chemical —A37
B. adherent —A36
C. Neither A or B. —A36

2

A36

No. The correct answer was "modern oils have both improved physical and CHEMICAL characteristics.

Press C —A37

2

A37

OK. Modern oils have both improved physical and CHEMICAL characteristics. One chemical characteristic is resistance to oxidation. This has been accomplished to some extent by improved refining and also by adding oxidation inhibitors in the form of special chemical compounds, called ADDITIVES.

Press A —A38

2

A38

The special chemical compounds that are added to the oil to slow down or stop oxidation are called __________.

A. detergents —A39
B. additives —A40
C. emulsions —A39

2

A39

No. Detergents ARE added to some lubricants -- and we'll talk about them soon -- but not to inhibit oxidation. Emulsions are not added to the oil; they're a product of oxidation.

Press B —A40

2

DIDACTOR

FILM NO. PTAM 1-5D

A 40

OK. ADDITIVES are put in lubricants to inhibit oxidation. Still other additives are used to produce so-called detergent oils -- that is, oils which wash the metal surfaces free of deposits and keep the carbon particles in such fine suspension in the oil that they do not deposit on the engine parts or in the filters.

Press C —A 41

2

A 41

The detergent oils wash the metal surfaces free of deposits and __________.

A. make the carbon particles heavy enough to sink out of the oil and then out of the system A 42
B. keep the carbon particles in suspension in the oil A 43
C. keep the rust and oxidation inhibitors clean so they can be used over and over again A 42

2

A 42

No. The detergent oils wash the metal surfaces free of deposits and KEEP THE CARBON PARTICLES IN SUSPENSION IN THE OIL.

Press A —A 43

2

A 43

OK. The detergent oils KEEP THE CARBON PARTICLES IN SUSPENSION IN THE OIL.

Now, let's go on to some of the characteristics of lubricants. We'll take VISCOSITY first.

Press A — B 1

XC — A 44

2

A 44

You missed at least one or two of the past few questions, so let's go back and have a review. Take it slow -- and answer your questions carefully.

Press A — A 34

2

B 1

What do we mean when we use the word VISCOSITY? VISCOSITY is a measurement. It measures the rate of FLOW of oil at certain set temperatures.

The faster the oil flows, the lower its viscosity number.

Press A — B 2

3

B 2

Therefore, VISCOSITY IS: a measurement of oil __________.

A. temperature. — B 3
B. flow. — B 4
C. thickness. — B 3

3

B 3

You aren't getting the idea.

Viscosity is simply a measurement of the rate oil flows. It measures how fast a certain amount of oil runs out a certain sized opening. Because oil thickness changes as the temperature changes, the measuring must be done at a set temperature. We must also have a set amount of time to measure the flow in.

Press A — B 4

3

DIDACTOR

FILM NO. PTAM 1-5D

B4

OK. Viscosity is a measurement of oil FLOW -- made at a certain set temperature. We also said that the faster the oil flows, the ________ its viscosity number becomes.

A. higher — B5
B. lower — B6

3

B5

Your answer is incorrect. Read about VISCOSITY again and remember what happens to the viscosity number when the oil flow increases.

Press A — B1

3

B6

Good. The faster the oil flows, the lower its viscosity number becomes, is the correct answer.

WHY do we test the viscosity of oil?

Viscosity determines what the fluid friction (the friction within the oil itself) is during operating temperature. Once we know this, we can check the oil for changes in viscosity. A change indicates contamination or oxidation is taking place in the oil.

Press A — B7

3

B7

We see that viscosity determines what the ________ is at operating temperature.

A. contamination — B8
B. oxidation — B8
C. fluid friction — B9

3

B8

Your answer is incorrect. Read the passage again and look for WHAT viscosity determines. Remember these new ideas as you read about them.

Press A — B6

3

B9

Correct. Viscosity determines what the fluid friction is at operating temperature. FLUID FRICTION is the friction ____________.

A. between the surface and oil. — B10
B. between a liquid and oil. — B10
C. in the oil itself. — B11

3

B10

Your answer is incorrect. Read the selection again and look for the answer to WHAT fluid friction is. Remember new ideas as you come across them.

Press A — B6

3

B11

Right. Fluid friction is the friction within the oil itself. We also said that we could tell, by these measurements, when a change took place in the viscosity. What did we say that these changes meant?

A. That contamination is taking place in the oil. — B13
B. That the flow rate of the oil would change accordingly. — B12
C. That as we measured and found changes, we should change the viscosity number. — B12

3

B 12

You are incorrect. Read the selection again and look for what a change in viscosity indicates. Read slowly and remember new ideas as you read.

Press A — B 6

3

B 13

Good. We find that if a change has taken place in the viscosity, it means that contamination or oxidation is taking place in the oil. That is the correct answer.

Now, how is the viscosity of the oil determined?

The unit of measure we use is time in seconds. We count the seconds that it takes a certain amount of oil to pass through a standard opening, while the oil is at a specific temperature. The two standard temperatures for recording viscosity are 100 F and 210 F.

Press A — B 14

3

B 14

We said the unit of measurement used to determine viscosity is: (Pick one)

A. Psi. — B 15
B. Time in seconds. — B 16
C. Degrees F. — B 15

3

B 15

That is an incorrect answer. We asked for the unit of measurement used to determine the viscosity. Read again how viscosity is determined. Then answer the question correctly.

Press A — B 13

3

B 16

Correct. Time in seconds is used as the unit of measurement when determining viscosity. What did we say that the standard temperatures for recording viscosity were?

A. 60 F, 120 F — B 17
B. 100 F, 210 F — B 18
C. 110 F, 260 F — B 17

3

B 17

You chose the wrong answer. Read about determining viscosity again and remember the temperatures at which it is determined.

Press A — B 13

3

B 18

That's right. The standard temperatures for recording viscosity are 100 F and 210 F.

Now, what do SAE numbers mean?

SAE numbers are used for crankcase, transmission, and rear axle lubricants to indicate their viscosity range. (The initials mean Society of Automotive Engineers.) SAE is used with the weight of the oil - such as, SAE 10W.

Press A — B 19

3

B 19

Now we can see that an oil with an SAE viscosity number of 10W will flow __________ than one with a number 30W. (Temperature being equal.)

A. faster — B 21
B. slower — B 20
C. at the same rate B 20

3

DIDACTOR

FILM NO. PTAM 1-5D

B20

You have picked an incorrect answer, and have forgotten an important idea that we mentioned earlier. Read what we have covered once more and make sure that all the ideas are clear to you.

Press A — B1

3

B21

That's right. SAE 10W will flow faster than SAE 30W oil.

Now let's take a look at carbon residue in oil. When an oil is subjected to high temperatures, its structure breaks down. The result of this breakdown is carbon residue, or deposits. This residue can cause sticking valves, gummed piston rings, and clogging of the lube system passages. Thus, we can see that it would be helpful to know how much carbon residue would remain after a particular oil had been heated. By knowing that, we could figure on how much trouble to expect.

Press A — B22

3

B22

The CONRADSON test was developed to show how much carbon residue remained after the oil has been subjected to high temperatures. It is a laboratory test in which a small amount of oil is burned. The amount of carbon left is weighed. This percentage of residue is a good indication of the carbon-forming tendency of the oil. We said that these carbon deposits could cause engine troubles, such as: (pick one)

A. clogged air filter. — B23
B. blocked radiator. — B24
C. gummed piston rings. — B25

3

B23

That is an incorrect answer.

A clogged air filter deals with the air system. We are talking about oil breakdown; thus, we are discussing a part of the lube system.

Try again.

Press A — B22

3

B24

Your answer is incorrect.

Blocking of the radiator indicates trouble with the cooling system. We have been discussing oil breakdown -- which is connected with the lube system. Try the question again.

Press A — B22

3

B25

Correct. GUMMED PISTON RINGS is one of the troubles that carbon deposits can bring about. The others we mentioned are sticking valves and a clogging of the lube system passages.

We also mentioned that there was a laboratory test to determine the percentage of residue left for a particular oil. This test is called: (pick one)

A. The Conradson Test. — B27
B. The Carlson Test. — B26
C. The Residue Test. — B26

3

B26

That is an incorrect answer. Read what we have said about the test again. The test is called the CONRADSON test.

Press A — B22

3

B27

Correct. The CONRADSON test determines the amount of carbon residue left from a sample of oil. We can tell by the results of this test what the carbon forming tendency of an oil will be.

Another test used to check the condition of the oil is called the WATER AND SEDIMENT TEST. It tells us the condition and cleanliness of oil in service. An oil sample is taken and placed in a container. Then, centrifugal force is used to separate the water and sediment from the oil.

Press A — B28

3

B 28

By finding out how much sediment and water we have in the oil, we have a good indication of how safe it is to keep that oil in use. We may find that it should be changed. We said that we separate the water and sediment from the oil by means of ____________.

A. distillation. — B 29
B. centrifugal force. — B 30
C. heating the sample. — B 29
D. gravitational pull. — B 29

3

B 29

You have picked an incorrect answer.

Read what we have said about the WATER AND SEDIMENT TEST again. Read all the details. Even though the means of performing this test is mentioned once, it is important. Read to find the important ideas.

Press A — B 27

3

B 30

Correct. We said that we separated the water and sediment from the oil by means of centrifugal force. We also said that we used the WATER AND SEDIMENT TEST to help to determine______________.

A. if the oil is good enough to buy. — B 31
B. if we should use the oil at all. — B 31
C. if we should continue using that oil. — B 32
D. if the oil will leave much carbon deposit. — B 31

3

B 31

That answer is incorrect. We asked what the WATER AND SEDIMENT TEST was used to determine. Read about the purpose of the test again and then pick the correct answer.

Press A — B 27

3

B 32

Right. We use the WATER AND SEDIMENT TEST to help determine if we should continue using that oil. We may find that the oil has too much water or sediment, and then it will have to be changed.

There is another test used to determine the amount of water in a sample of oil. This is called simply the WATER IN OIL TEST. It gives us an indication of the amount of water accumulated by the oil while in service.

Press A — B 33

3

B 33

The water in oil test is done by distillation. The oil is heated in a container and steam is formed. This steam condenses into water, which is collected in a measuring tube. Thus, the amount of water contained in a sample of oil can be found. Remember that we said this sample of oil was one which ____________.

A. had never been in service. — B 34
B. had been in service. — B 35
C. was being considered for service. — B 34

3

B 34

Your answer is incorrect. Read about the oil that we are testing again - and look for the type of oil that we are interested in testing by the WATER IN OIL TEST.

Press A — B 33

3

B 35

Right. The oil sample that we are testing is from oil that had been in service.

We also said that during the process of distillation, the oil is heated and ________ forms.

A. water — B 36
B. steam — B 37
C. air — B 36

3

B 36

You have picked an incorrect answer. Read about the distillation process again and see what happens when the oil is heated.

Press A — B 33

3

B 37

Correct. When the oil is heated, steam forms. This steam is condensed into water and measured. Thus we can tell how much water is contained in a sample of oil that is in use.

What is the name of the test used to tell how much carbon deposit an oil leaves?

A. The Conradson Test. — B 39
B. The Water and Sediment Test. — B 38
C. The Water in Oil Test. B 38

3

B38

You picked the wrong test.

The test used to determine the carbon residue of oil is the CONRADSON TEST. Read about it once again to make sure you know the difference between it and other tests.

Press A — B 22

3

B39

Correct. The CONRADSON Test determines the carbon residue in an oil sample.

Remember our discussion of viscosity? What did we say about the relation of flow to number?

A. The faster the oil flows, the higher its viscosity number. — B 40
B. The lower the viscosity number, the slower the oil flows. — B 40
C. The faster the oil flows, the lower its viscosity number. — B 41

3

B 40

That is an incorrect answer. Read about viscosity once again and remember the important ideas.

Press A — B1

3

B 41

Good. You remembered that the faster oil flows, the lower its viscosity number. You have now completed the tape. If you would like to review what you have learned about viscosity and oil tests, Press A. Otherwise,

Press REWIND.

X C — B42

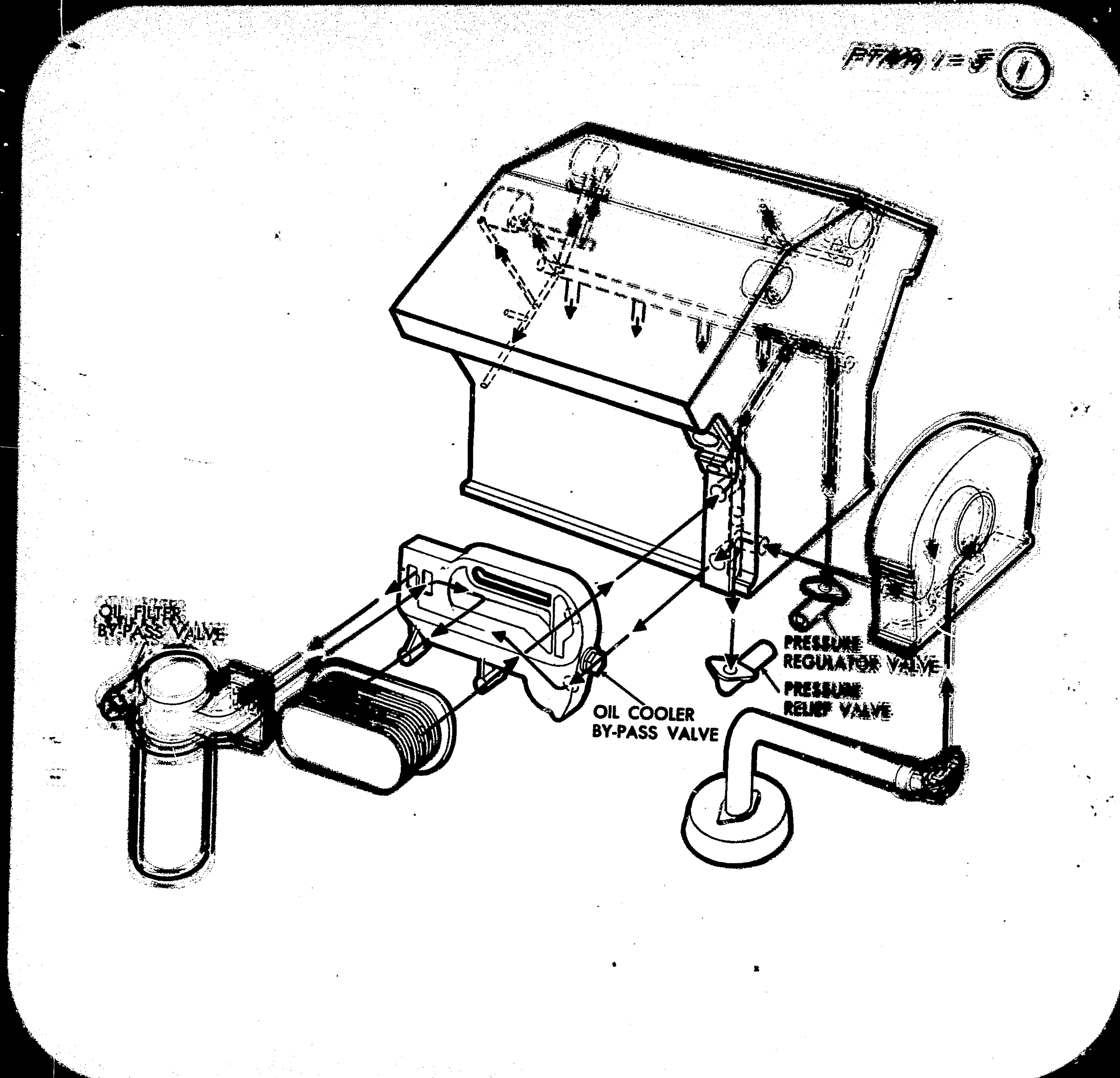
3

B 42

OK. Now we will review the section on Viscosity and Oil Tests. Read for understanding this time and try not to make any mistakes.

Press A — B1

3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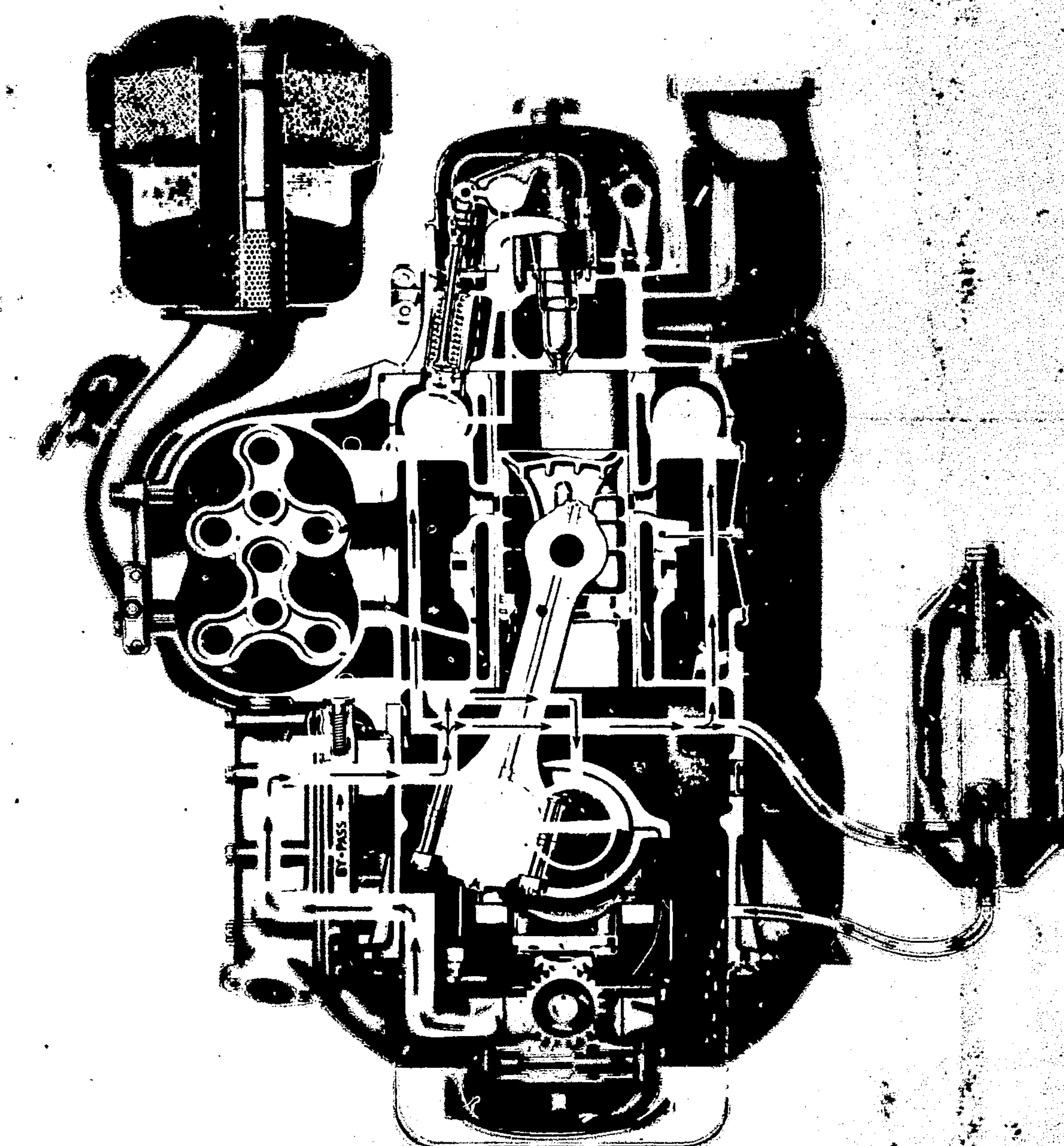
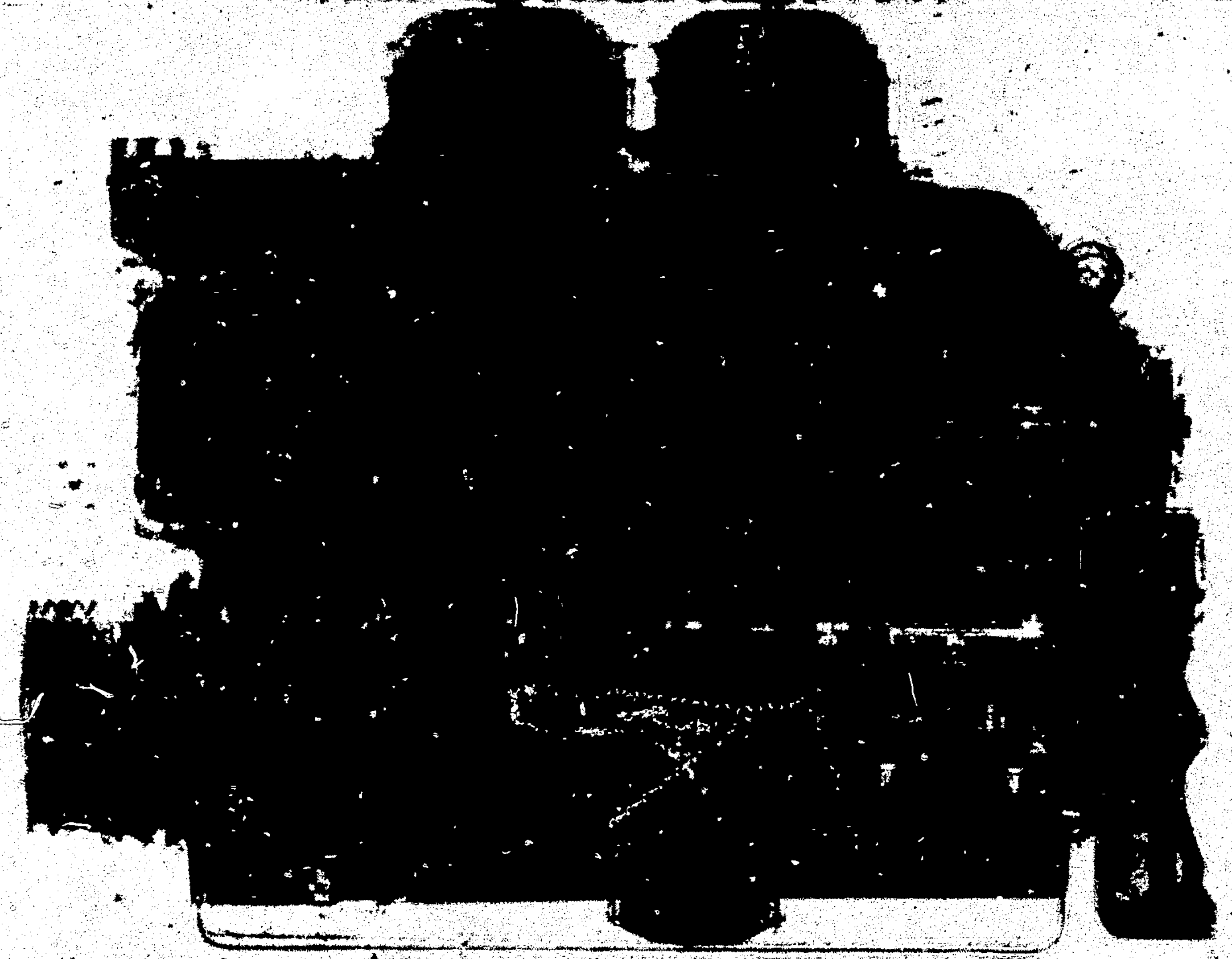
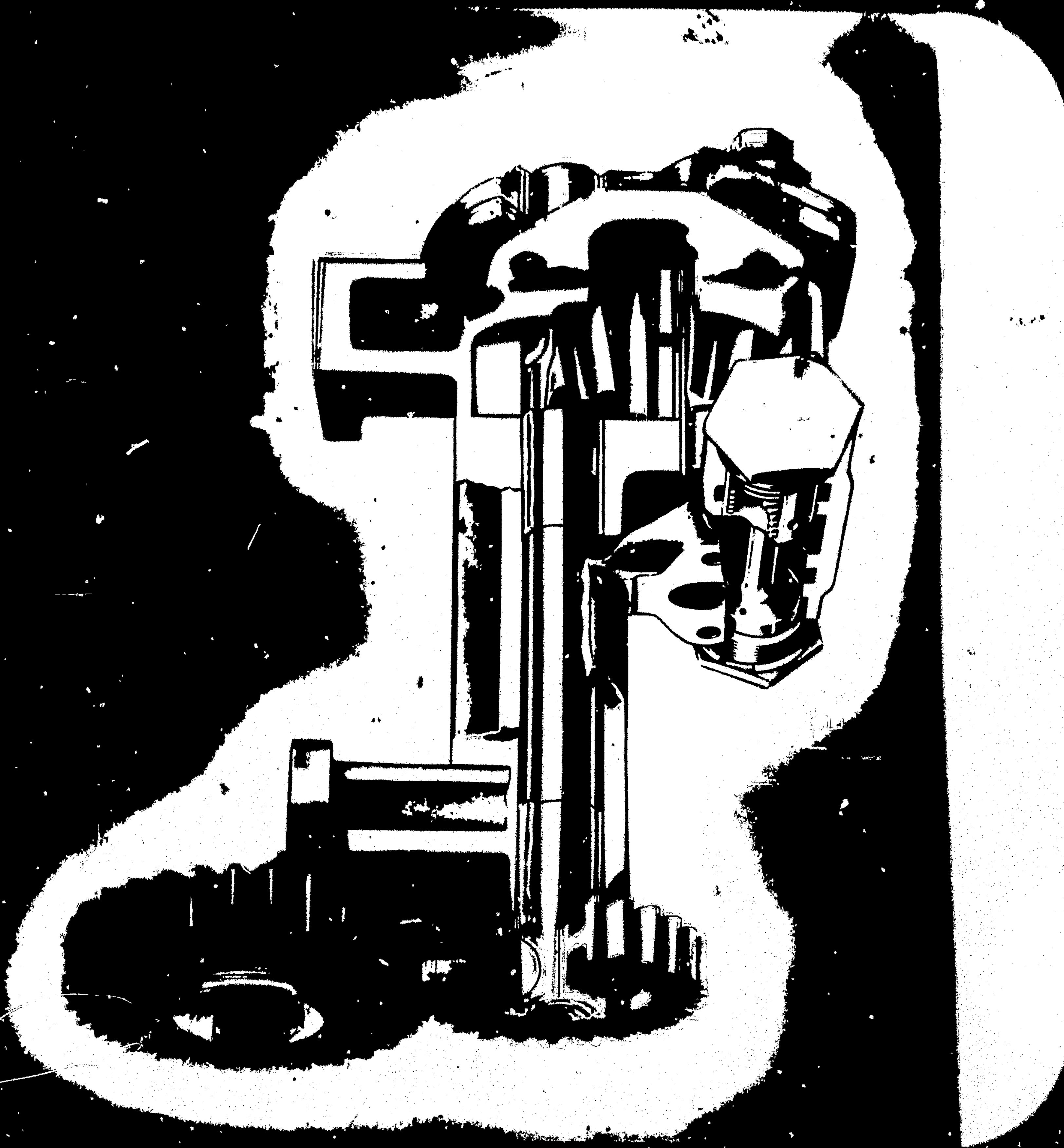
OIL COOLER BY-PASS VALVE
PRESSURE REGULATOR VALVE
PRESSURE RELIEF VALVE

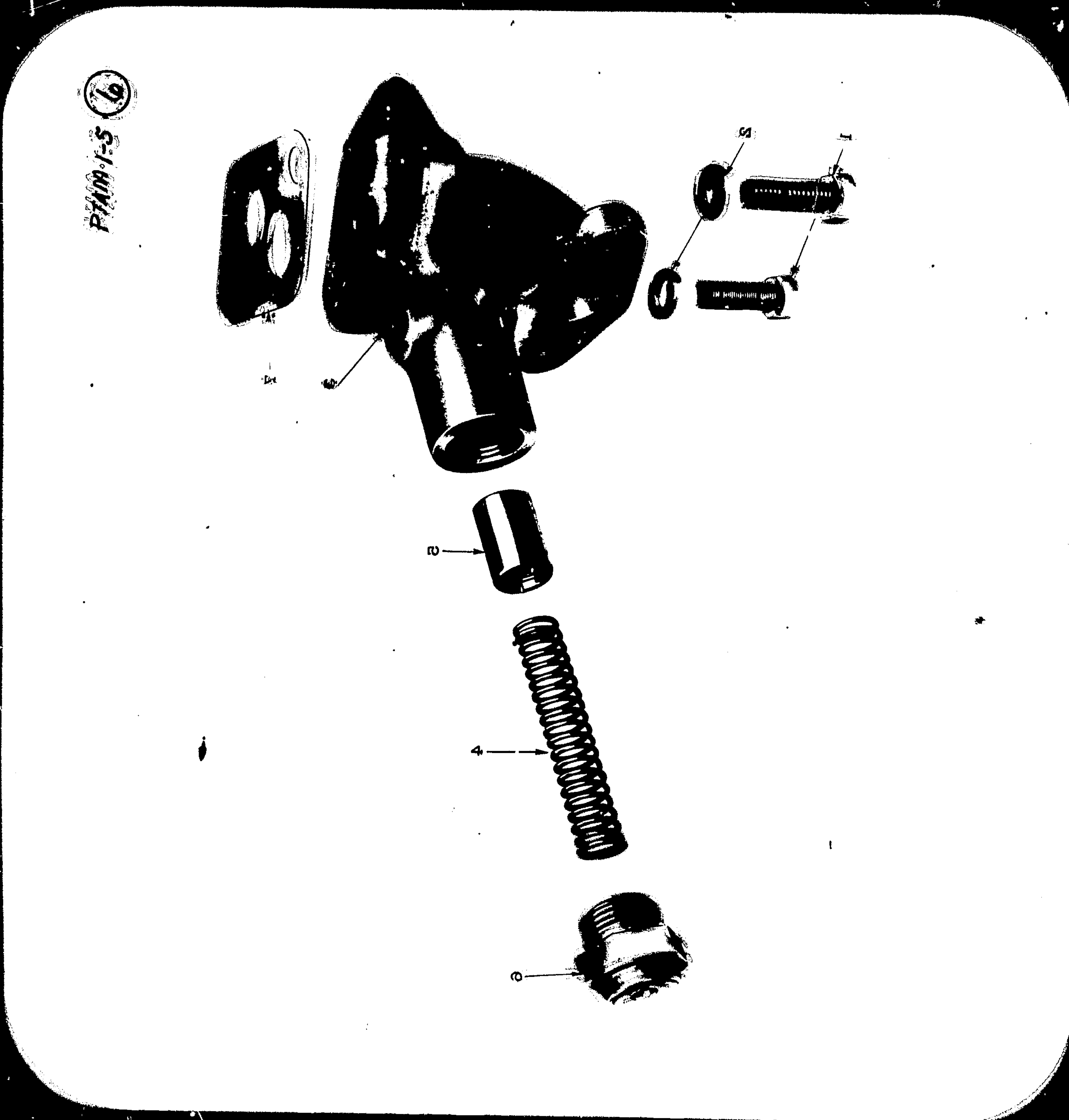
LUBRICATION DIAGRAM - EMD CROSS SECTION



LUBRICATION DIAGRAM—SIX CYLINDER
SIDE CROSS SECTION



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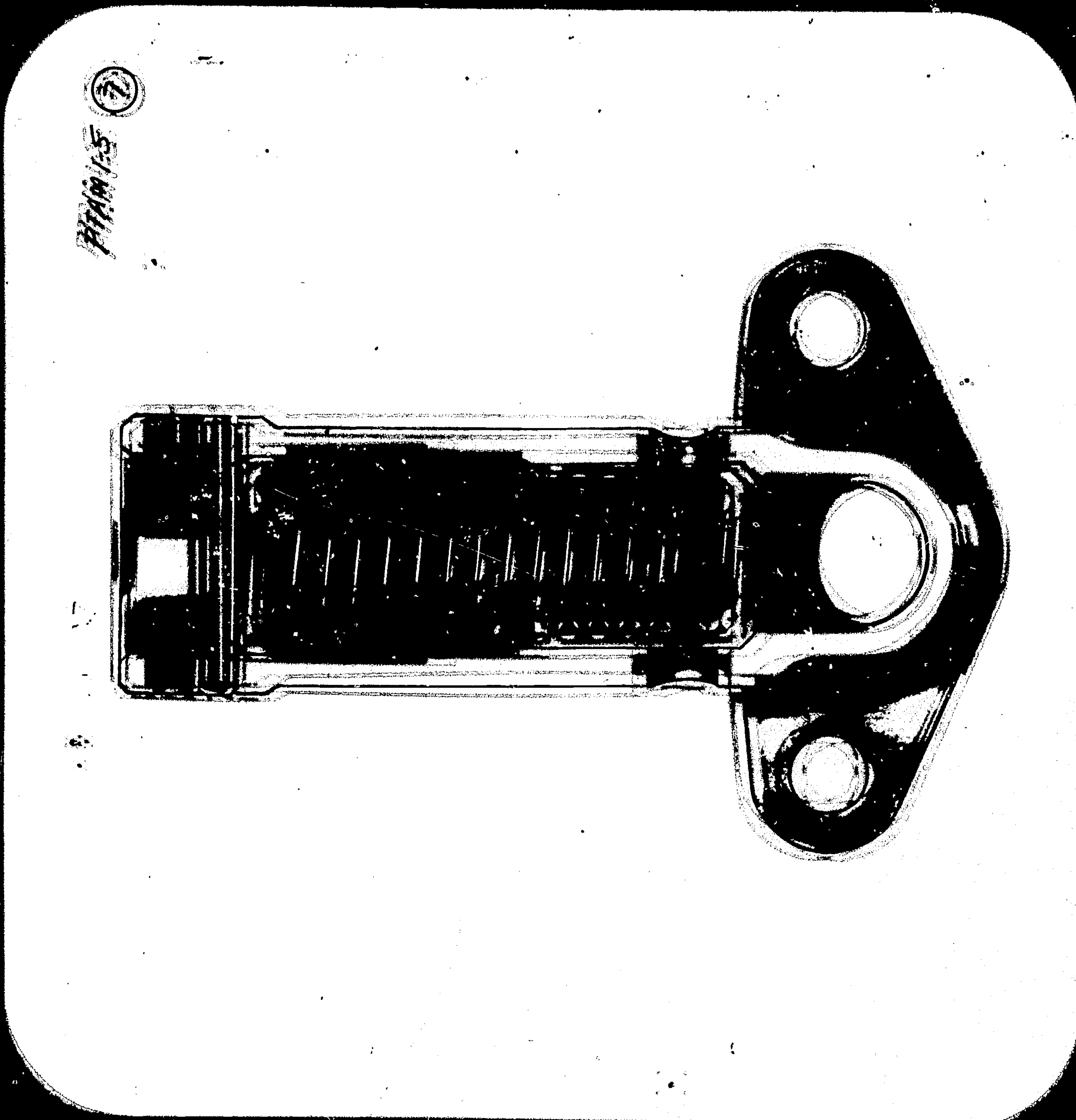

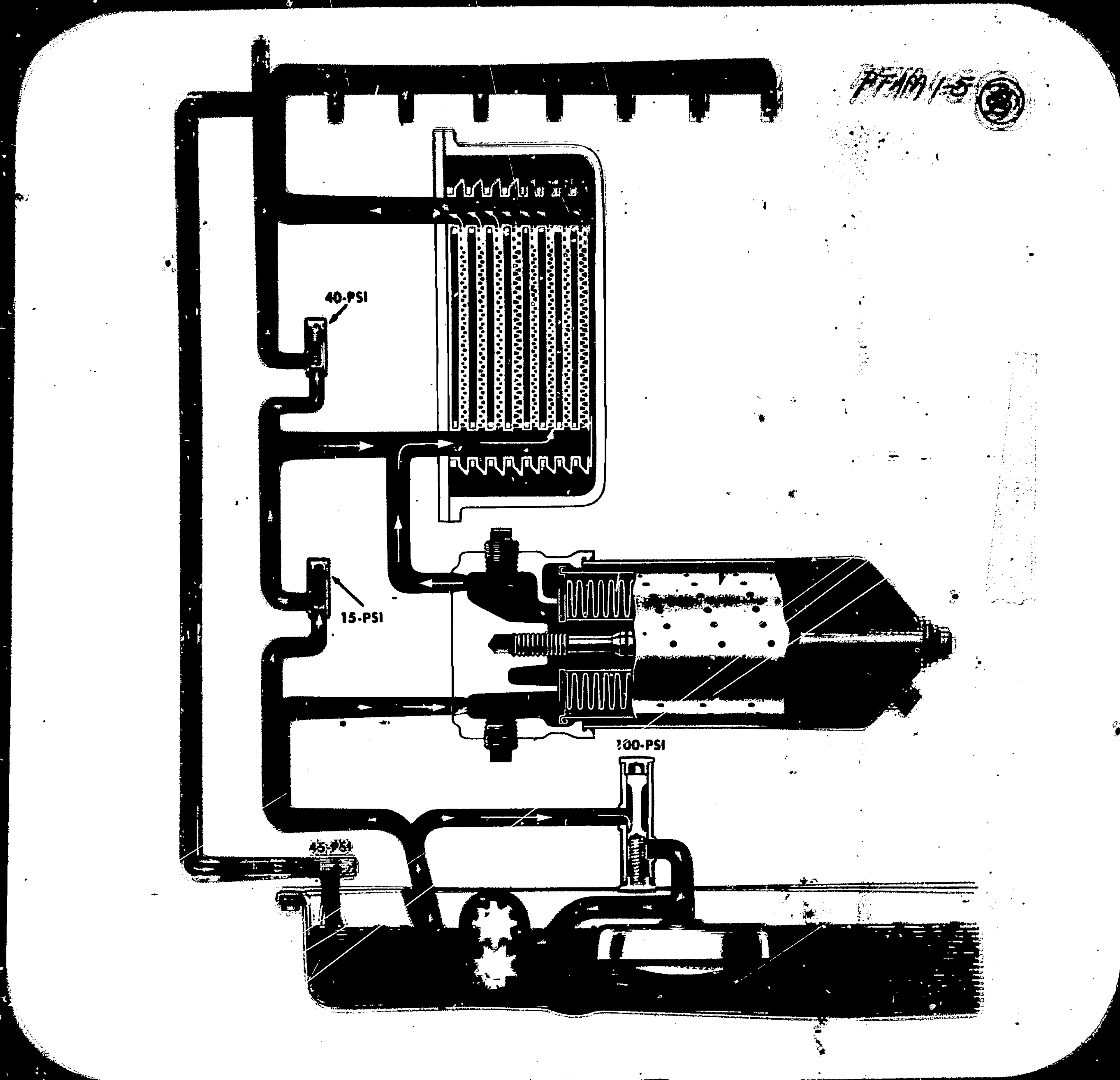
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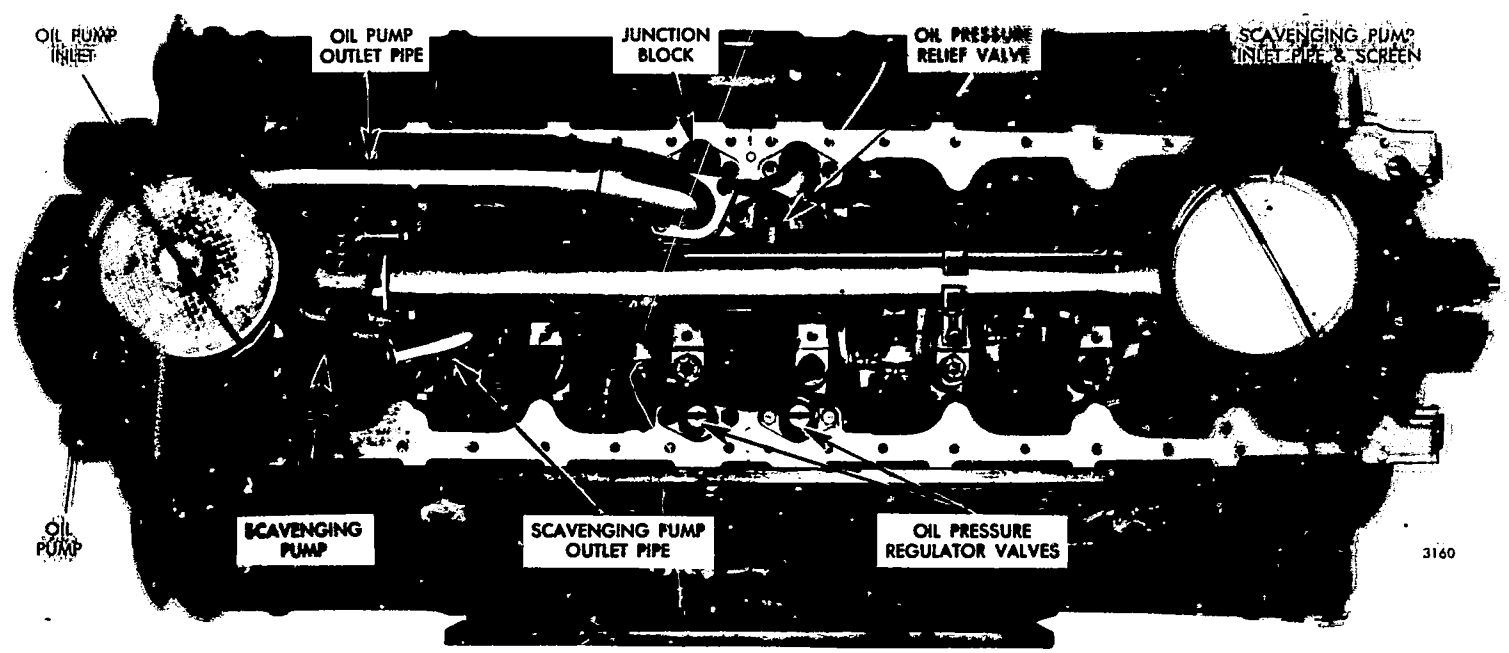
PTAM1-5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JUNCTION BLOCK
OIL PRESSURE RELIEF VALVE
SCAVENGING PUMP INLET PIPE & SCREEN
OIL PUMP
SCAVENGING PUMP
SCAVENGING PUMP OUTLET PIPE
OIL PRESSURE REGULATOR VALVES
3160

PTAM 1-5 (11)

LUBRICATING OIL PRESSURE IS AFFECTED BY

1. ENGINE SPEED
2. ENGINE WATER TEMPERATURE
3. ENGINE LOAD
4. OIL VISCOSITY
5. RESTRICTED OIL COOLER
6. WORN ENGINE PARTS

INSTRUCTOR'S GUIDE

Title of Unit: Maintaining the Lubrication System -- Detroit Diesel System

Code: PTAM 1-5
10/1/65

FIRST: Answer all student's questions on the last tape (Cooling system)

OBJECTIVES: Be sure that each student understands:

1. The construction and operation of lube system in I-71.
2. The construction and operation of lube system in V-71.
3. Operation of lubricating oil pump (V-6, V-8, and V-12) (I-71).
4. Maintenance of lubricating oil pump.
5. What the oil pressure regulator valve is and does.
6. What the oil pressure relief valve is and does.
7. What the full flow oil filter is and does.
   How to maintain it.
8. What the by-pass oil filter is and does.
   How to maintain it.
9. What the plate type oil cooler is and does.
   Cooler core checks.
   Cooler core cleaning.
   What the oil cooler by-pass valve is.
   How to inspect and lubricate it.
10. What the tube type oil cooler is and does.
    How to maintain it.
11. How to maintain the oil pan.
    Gasket replacement.
12. Why crankcase ventilation is necessary.
    How to clean the breather pad.
    How to inspect the breather pipe.

TRAINING AIDS:

Any visual aids you have available are valuable.
One visual aid may well be worth a thousand words.
Various oil pumps (cutaway), relief valves, filters, etc.
Use Detroit Diesel wall charts TA 301
TA 302 (Just show lube system).

Vue Cells:
PTAM 1-1 (9) (Function of the Lubrication System)
PTAM 1-5 (1) (V-71 Lubrication Flow)
PTAM 1-1 (10) (I-71 Lubrication Flow)
PTAM 1-5 (2) (Lubrication Diagram - End View)
PTAM 1-5 (3) (Lubrication Diagram - Side View)
PTAM 1-5 (4) (V-71 Lubrication Oil Pump)
PTAM 1-5 (5) (I-71 Lubrication Oil Pump)
PTAM 1-5 (6) (Pressure Regulator Valve)
PTAM 1-5 (7) (Pressure Relief Valve)

Training Aids cont'd.

Vue Cells cont'd.

PTAM 1-5 (8) (Lube Flow through oil filter and cooler)
PTAM 1-5 (9) (Oil Cooler Assembly)
PTAM 1-5 (10) (Lubricating oil pump mounting (V-16)
PTAM 1-5 (11) (How oil pressure is affected)

QUESTIONS:

1. What components does the oil flow through in the GM diesel engine?
2. What are three basic requirements of good oil?
3. What grade of oil does GM recommend for their engines? Why?
4. How will excessive additives in an oil, such as "Series 3" type, affect an engine?
5. When and only when would the type oil mention in 4 above, be used in an engine?
6. How can overfilling the crankcase with oil hurt an engine?
7. How can the lube system become contaminated? Is the engine running when the lube system becomes contaminated?
8. What do you look for when the oil pump is disassembled?
9. Is the oil pump of the same construction for the I-6, V-6, V-8, V-12, and V-16? Are they interchangeable?
10. Why are the lubrication system components equipped with by-pass valves?
11. What is meant by a full-flow filter? A by-pass filter?
12. How is oil cooled in the GM diesel?
13. Why is it important to watch the oil pressure after first starting the engine?
14. How is the crankcase pressurized?