Operator's Manual

INTERNATIONAL HARVESTER

INTERNATIONAL®

UD-691

Power Unit

INTERNATIONAL HARVESTER COMPANY

180 North Michigan Ave. Chicago 1, Illinois, U.S.A.

TO THE OWNER

The purpose of this manual is to assist you in realizing the benefits you anticipated when you purchased this International Harvester product. Literally thousands of people have contributed to the design and production of this product and its delivery to you. They have an interest in its successful performance and have provided this manual to give you the benefit of the experience they have gained through years of field testing and normal usage of this and similar products.

The way you operate and the care you give this product will have much to do with its successful performance. This manual has been carefully prepared and the information arranged and illustrated to make it as easy as possible for you to find the information you wish. It will pay you to read the entire manual carefully before operating and keep it handy for future reference. Your International Construction Equipment Distributor or Dealer will be glad to answer any further questions you may have on the operation or care of this product.

It is the policy of International Harvester Company to improve its products whenever it is possible and practical to do so. We reserve the right to make changes or add improvements at any time without incurring any obligation to make such changes on products sold previously.

CONTENTS

INTRODUCTION

The UD-691 power unit is a six-cylinder-in-line, valve-in-head, four-cycle full diesel engine.

Instructions on operation, lubrication and maintenance of the basic unit and attachments are covered in the manual. Disregard any instructions that are not applicable to your unit.

Throughout this manual of the use of the terms "left" and "right," and "front" and "rear," must be understood to avoid confusion when following instructions. "Left" and "right" indicate the left and right sides of the power unit when facing the unit from the flywheel end. The "front" of the power unit is the fan drive pulley end. The "rear" is the flywheel end.

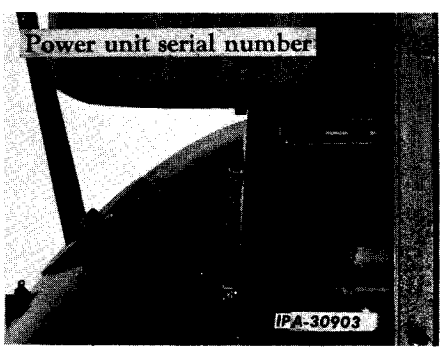
When in need of parts, always specify the power unit and engine serial numbers. Refer to Illust. 1 and 2. Write these serial numbers in the spaces provided.

Power Unit Serial No.

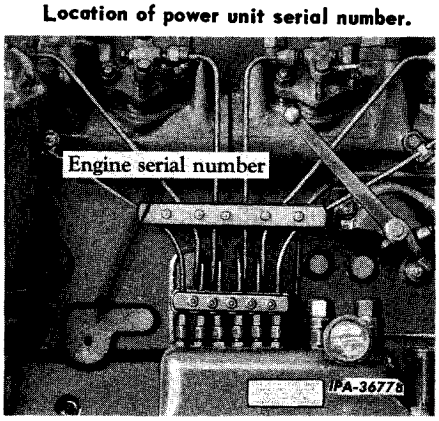
UD-691 - _____

Engine Serial No.

UD-691-M - _____



Illust. 1
Location of power unit serial number.



Illust. 2
Location of engine serial number.

SUGGESTED POWER UNIT AND FUEL SUPPLY TANK INSTALLATION

For a suggested arrangement when you wish to install a fuel supply tank:

Keep within the minimum and maximum limits when purchasing pipes and equipment.

The suggested minimum size for the main fuel supply tank is approximately 50 U.S. gallons.

All piping must slope down from the engine to avoid high pockets in the line which might interfere with the flow of fuel.

The suction pipe must preferably be 3/8 inch iron pipe with a suitable brass check valve installed in the line at the tank.

The overflow or return line from the air trap mounted on the right side of the engine to the main supply tank should be 1/2 inch pipe.

Use only clean (strained) fuel in the supply tank.

Anchor the power unit securely to a solid foundation.

Mount the power unit or driven machine so that the belts may be removed or tightened. The slide rail and belt tightening attachments are ideal for this.

Install flexible fuel lines between pipes to fuel tank and engine. Also install flexible exhaust piping so that belting may be adjusted without disconnecting these pipes or lines.

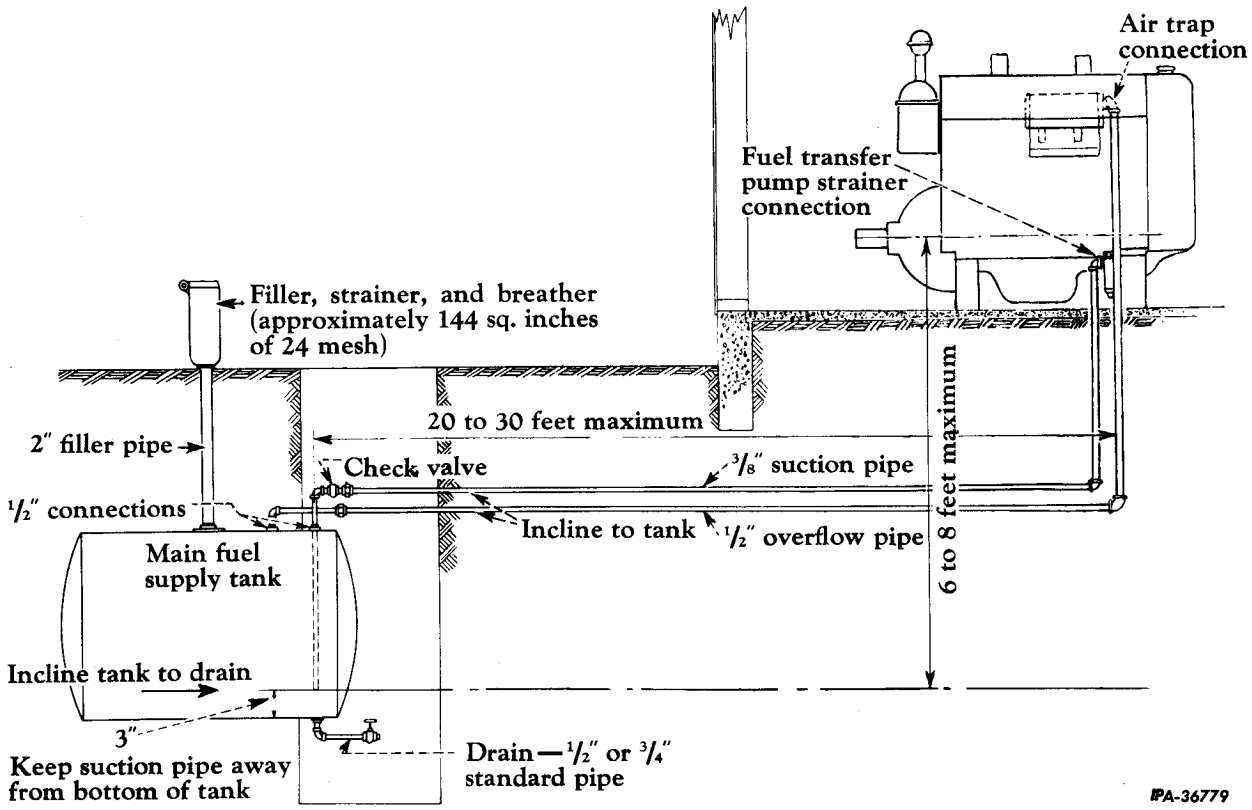
When the main supply tank is installed above the ground, the highest level of the fuel must be less than six feet above the fuel transfer pump. If the tank is installed below the ground, the lowest level of fuel must be no greater than eight feet below the fuel transfer pump (Illust. 3).

Do not support long exhaust pipes on the exhaust manifolds; use flexible pipes at the engine, and support rigid pipes from ceiling or floor.

Use long sweep elbows in exhaust pipes.

For every 12 feet of exhaust pipe, enlarge diameter of pipe one standard pipe size.

Diesel fuel return pipe must always be larger than the supply pipe.



Illust. 3
Suggested power unit fuel tank installation.

VENTILATION FOR POWER UNITS INSTALLED INSIDE OF BUILDING

Power units installed inside buildings, sheds or cabs must be the open type; that is, with the engine hood and back panel removed to permit free circulation of fresh air around the engine, radiator, etc. Steps must be taken to carry the waste heat to the outside, or to change the air in the engine room rapidly.

The exhaust pipes should be arranged to provide the shortest possible length within the engine room. The parts of these exhaust pipes inside the building should be surrounded with a light steel tube sufficiently large to permit a two to four inch air space all around. This space should be ventilated to the outside. Another method of installation is to cover the exhaust pipe completely with at least two inches of air cell asbestos.

Ventilate the engine room thoroughly and install the power unit so that air can flow freely through the radiator. An opening to the outside, in front of the radiator, is extremely desirable. Ducts must be provided between the radiator and the wall openings. On some installations, it may be necessary to provide a reverse-flow fan to blow the heated air out of the building.

Where the door or window area is restricted, galvanized ducts extending from the ceiling above the engine to the top of the building are recommended to carry off the hot air. Not less than two ducts, 24 x 24 inches in cross section, must be installed. At the same time, as many openings in the sides of the engine room as possible must be provided to let in cool outside air. Openings to the north or to a shaded side of the building are preferred.

The exhaust manifolds are provided with one or more drain holes. Plugs are furnished for closing the holes to prevent the escape of the exhaust gas. Be sure to use these plugs when the power unit is to be operated inside of a building.

DESCRIPTION

SPECIFICATIONS AND CAPACITIES

The capacities which appear throughout this manual are specifically for this engine and its special attachments.

Capacities (U.S. Measure)(Approximate)

Gasoline tank (starting)	1 gallon
Cooling system	25 gallons
Crankcase oil pan	26 quarts
Air cleaner oil cup	6 pints
Air trap	7 pints
Fuel injection pump	1 pint

Specifications

Engine (Diesel, 4-cycle)

Cylinders	6
Bore	4-3/4 in.
Stroke	6-1/2 in.
Spark plug gap	.023 in.
Distributor point clearance	.020 in.
Magneto point clearance	.020 in.
Valve clearance (intake and exhaust) (engine hot)	.018 in.
Valve clearance (intake and exhaust) (engine cold)	.020 in.
Distributor	IH model K
Carburetor	IH 1-1/4 in.

Engine Speeds

Full load	1600 ± 10 rpm
High idle	1745 ± 30 rpm
Low idle	500 ± 50 rpm

Power Take-off Clutch

Double plate over-center (Twin-Disc)	14 in.
Single plate over-center (Rockford)	17 in.

Dimensions (Approximate)(Over-all)

Length (with power take-off)	7 ft. 11-7/8 in.
Width	2 ft. 11-7/8 in.
Height (to top of air cleaner cap)	4 ft. 11-3/4 in.

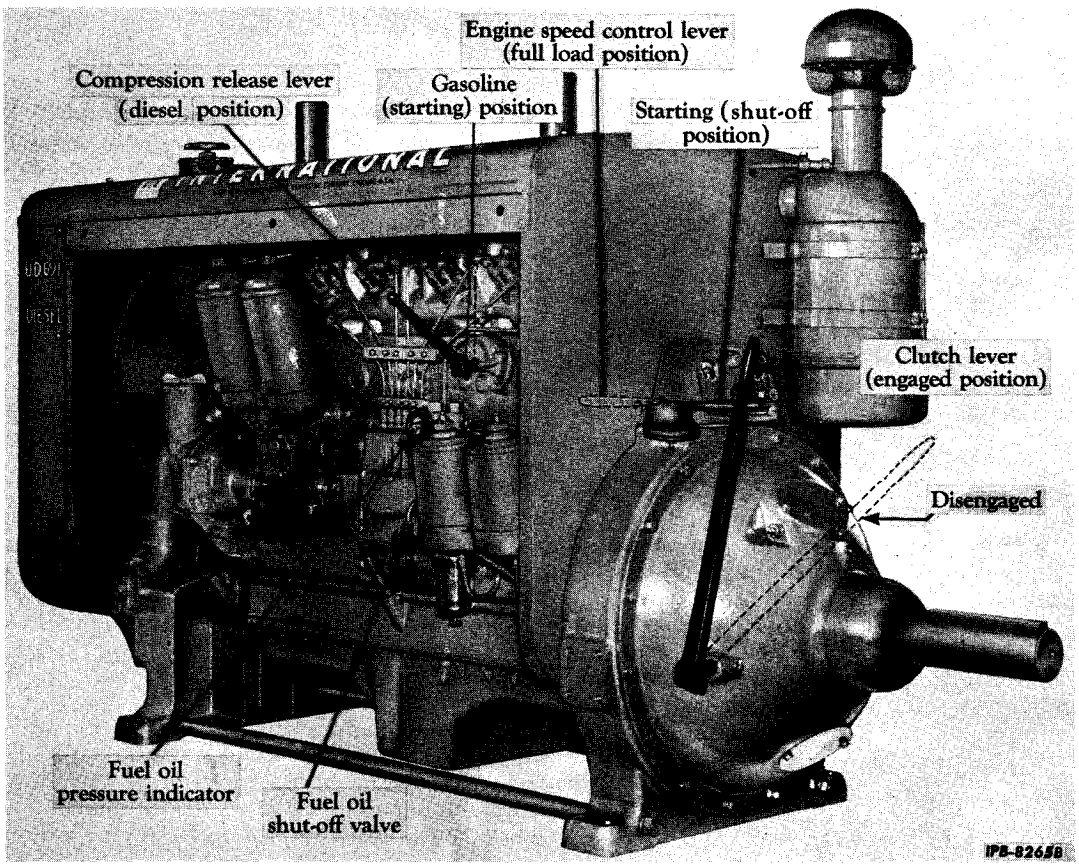
Specifications are subject to change without notice.

DIESEL FUEL SPECIFICATIONS

Consult your International Construction Equipment distributor or dealer or fuel supplier for the diesel fuels which will give the most satisfactory performance in your International engine.

INSTRUMENTS AND CONTROLS
(Refer to Illusts. 4 and 6)

The operator of this power unit must thoroughly familiarize himself with the instruments



Illust. 4
Principal instruments and controls.

and controls provided for operation. There are important differences between various engines; therefore, regardless of previous experience with other machines, the operator must fully understand what each control is for, and how to use it, before operating this power unit.

Controls

Engine Speed Control Lever

This lever controls the speed of the engine. When set in a given position, it maintains a uniform engine speed under variable loads. Pull the lever clockwise to increase the speed.

Compression Release Lever

With this lever all the way forward, the engine will operate on the diesel cycle. With the lever all the way back, the engine will be in the gasoline cycle.

Clutch Lever

This lever is used to engage or disengage the engine from the load.

Starting Primer

The starting primer is used in cold weather. Operating the primer plunger, sprays raw gasoline directly into the intake manifold.

Mechanical Safety Shut-off Reset Lever

This lever is located in the side of the safety control box which is mounted on the left, rear side of the unit.

When starting the engine, raise the reset lever. The lever will remain in a raised position until tripped by the control.

Radiator Shutter Control Crank

Turning this crank to the right opens the shutter and to the left closes the shutter.

Choke Lever

The choke aids in starting the engine when it is cold.

Move the lever (Illust. 5) upward to close the choke and downward to open the choke.

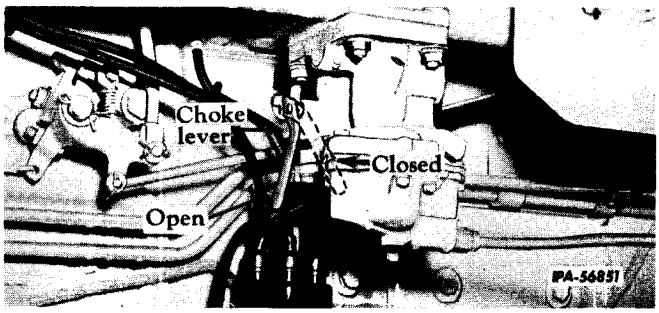
Instruments

Ignition Switch

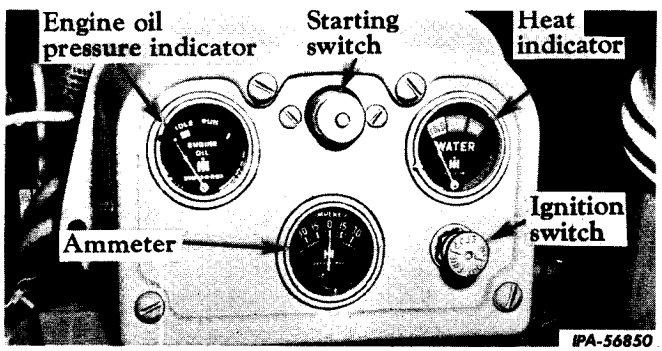
This is a "push-pull" type switch having two positions, "OFF" and "ON."

Starting Switch

Pressing the button completes the electrical circuit between the batteries and cranking motor to crank the engine.



Illust. 5
Choke lever.



Illust. 6
Instrument panel.

Ammeter

This instrument indicates if the batteries are being charged by the generator, or if the batteries are discharging.

Heat Indicator

This instrument shows the temperature of the water circulating through the engine.

Engine Oil Pressure Indicator

This instrument registers the pressure in the engine lubrication system.

Fuel Oil Pressure Indicator

This indicator, located on the injection pump, registers the pressure of the fuel from the primary pump through the final fuel filter to the injection pump.

Service Meter

With a service meter a check can be kept on the number of hours that the power unit has been operating.

BEFORE STARTING A NEW POWER UNIT

The power unit has been given pre-delivery and delivery service by your distributor or dealer and is ready for operation. As an added precaution, check the oil levels in the different compartments and check that the coolant in the radiator is up to the proper level.

Operate a new power unit with a light load for the first 30 to 36 hours at the rated governed speed.

PRECAUTIONS

CAUTION: Because of fire hazards and insurance regulations, we do not recommend the use of gasoline for cleaning parts, especially when service is performed inside buildings. A less flammable fluid, such as a solvent meeting these requirements or kerosene, must be used.

Never attempt to clean or oil the engine while it is operating.

CAUTION: When hand-cranking the engine, stand in a position that will eliminate any possibility of being struck by the starting crank, if there is a reversal of the direction of the engine. Crank the engine by using quick upstrokes; do not spin it.

Never pour cold water into the radiator if the engine is very hot unless conditions make it absolutely necessary. Under such conditions start the engine and let it idle while slowly pouring the water into the radiator.

PREPARING FOR EACH DAY'S WORK

Fuel System

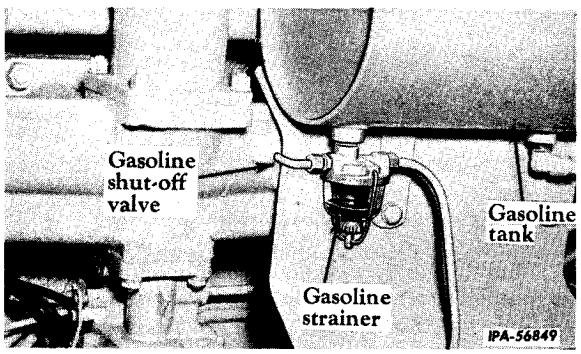
Fill the main fuel tank and the gasoline tank, if necessary. For capacities, refer to page 4. Strain the diesel fuel to be sure it is free from foreign substances. Do not use dirty fuel. Always fill the fuel tank at the end of each day to reduce condensation. Drain the water trap daily.

CAUTION: Never fill the gasoline tank when near an open flame or when the engine is operating. Keep the funnel and container or hose nozzle used for pouring in the fuel, in contact with the metal of the tank to avoid the possibility of an electric spark igniting the gas. Do not light matches near gasoline as the air within a radius of several feet is permeated with a highly explosive vapor. (Illust. 7.)

The gasoline supply tank has a filler cap with air vents. Keep these vents open to assure the proper flow of the gasoline.

Illust. 7
Method of filling gasoline tank.

Illust. 8
Filler cap vent holes.



Illust. 9
Gasoline shut-off valve.

Open the diesel fuel shut-off valve and the gasoline shut-off valve (Illust. 9).

Lubrication

Be sure that the oil level in the crankcase is up to the "FULL" mark on the crankcase oil level gauge. Refer to the "LUBRICATION GUIDE" for complete lubrication requirements. Check for leakage from all lubricant compartments.

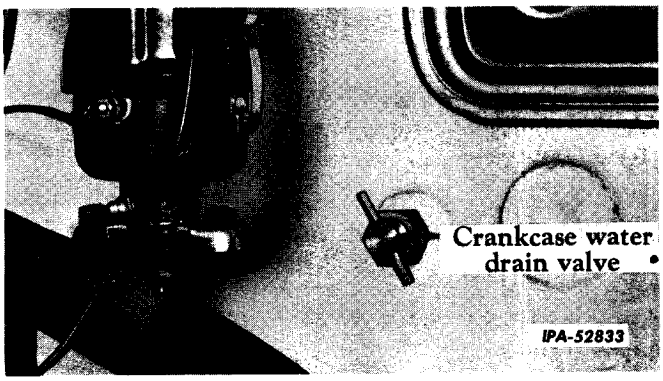
Cooling System

Be sure the water drain valves on the right side of the crankcase (Illust. 10) and on the bottom of the radiator are closed.

NOTE: Do not start the engine until the cooling system is filled with coolant.

Remove the radiator cap clamp and remove the radiator filler cap and see if the water comes up to the level of the baffle. Add water if necessary.

Install the filler cap and tighten it securely with the cap clamp.



Illust. 10
Crankcase water drain valve.

Batteries

Inspect the batteries to see that the water is at the correct level.

OPERATING THE POWER UNIT

Starting the Engine on Gasoline

1. In cold weather, close the radiator shutter all the way.

2. Open the diesel fuel shut-off valve and the gasoline shut-off valve (Illust. 9). To assure against leakage or seepage from the valve when open, be sure to screw the needle stem (shut-off valve) out until the seat of the stem is tight against the stop.

3. Place the clutch lever in the disengaged position (lever all the way back).

4. Pull the compression release lever all the way back into the gasoline (starting) position.

5. Place the engine speed control lever in the starting (shut-off) position by moving the lever counterclockwise as far as it will go.

6. Set the choke lever (Illust. 5) half way open. (In cold weather, pull the lever all the way up.) If equipped with primer, use as many strokes as required for the prevailing air temperature.

7. Pull out the ignition switch.

8. Depress the starter button and raise the reset lever located on the safety control box.

NOTE: Do not operate the cranking motor for more than 30 seconds at one time. Shut off the ignition and allow the cranking motor to cool two or thre minutes before repeating the starting operation. If the engine will not start on gasoline in cold or damp weather, the spark plugs should be removed and any condensation wiped off. Check the spark plug gap. Refer to page 4.

9. As soon as the engine starts, the choke should be adjusted to where the engine operates steadily. As the engine warms up, set the choke all the way open.

10. Check both the engine and fuel oil pressure indicators. If the indicator pointer does not move into the "RUN" or "OPERATING" range of the individual indicator, stop the engine and inspect the oil and fuel systems to find the cause of failure. If unable to find the cause, consult your International Construction Equipment distributor or dealer before operating the engine.

Changing to Diesel Operation

1. Allow the engine to operate on gasoline for about one minute (two or three minutes in cold weather) before switching over to diesel operation.

2. Push the compression release lever forward to the diesel position, then immediately advance the engine speed control lever enough to prevent the engine from stalling.

3. The engine will now run properly as a diesel unit unless there is air in the fuel injection system. Refer to "VENTING THE DIESEL FUEL SYSTEM" following.

Venting the Diesel Fuel System

The fuel system will have to be vented if:

The fuel filters have been drained.

The fuel pipes have been disconnected.

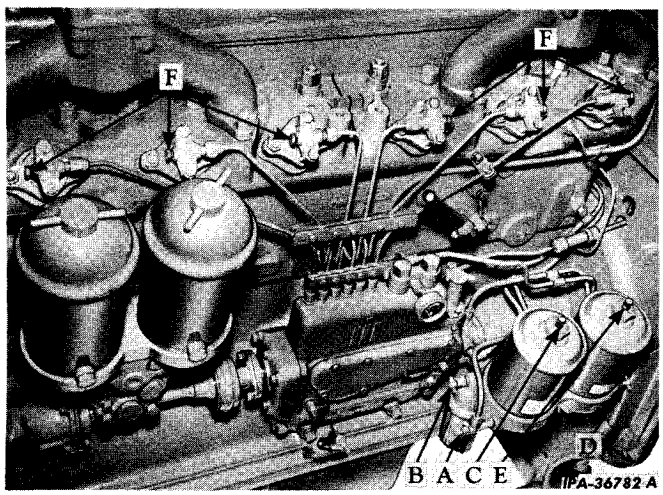
The engine, in operation, has run out of fuel.

A new engine is being started for the first time.

1. Be sure there is a supply of fuel in the diesel fuel tank.

2. Check to see that the transfer pump is filled with fuel. Loosen either fuel line connection on top of transfer pump. If no fuel appears, remove the connection, and pour in fuel to fill the pump; then reconnect the fuel line.

(Continued on next page.)



Illust. 11
Venting air from the fuel system.

3. Open the water trap drain valve "B" (Illust. 11) and the auxiliary filter vent valve "C," and be certain that the fuel shut-off valve "A" is open.

4. Remove the filler plug in the top of the air trap, and pour fuel into the air trap until fuel, free of air, appears at the water trap pouring until fuel flows free of air from vent "C." Close "C." Continue to fill the air trap to within one inch of the top. and install the filter plug.

NOTE: The fuel shut-off valve "A" (Illust. 11) is to remain open for normal operation.

5. Be sure that the final fuel filter drain valve "D" is closed.

6. Start the engine, and, while operating in the gasoline cycle, advance the engine speed control lever slightly. Do not move the compression release lever.

7. Open final filter air vent valve "E." When fuel flows free of air at this point, close "E."

8. Open each nozzle air vent "F" individually, and, as fuel flows free of air from each, close the vent.

9. Move the engine speed control lever to the gasoline (shut-off) position. The fuel system should now be completely vented of air.

Operating the Power Unit

Read and observe "PRECAUTIONS" on page 6.

Do not operate the engine under load until it is thoroughly warmed up. Never operate the engine at more than the regular governed speed. Excessive speeds are harmful.

Advance the engine speed control lever to a position where the engine will operate best for the load to be handled.

Engage the clutch gradually by pushing the lever forward until positive over-center action is felt.

As the engine warms up, open the radiator shutter enough to keep the heat indicator in the "RUN" range.

The ammeter should show "CHARGE" whenever the engine is operating at a speed faster than low idle speed. If it shows "DISCHARGE" continuously while the engine is operating at this speed, the cause must be investigated immediately.

NOTE: Engines equipped with either mechanical or electrically operated automatic safety shut-off: If the engine has been automatically shut off because of lack of oil pressure or high water temperature, check the engine oil and coolant levels. If this is not the cause, consult your International Construction Equipment distributor or dealer.

Vent the diesel fuel system of air as described on pages 7 and 8, before attempting to restart the engine.

1. Be sure that the gasoline supply shut-off valve is open.

2. Place the engine speed control lever in the starting (SHUT-OFF) position, and at the same time place the compression release lever in the gasoling (STARTING) position. (Illust. 4.)

3. Allow the engine to operate on gasoline until the exhaust is clear, then stop the engine by placing the compression release lever in the diesel position (do not move the engine speed control lever).

4. After the engine stops, leave the compression release lever in the diesel position to permit the starting valves to cool on their seats and to prevent warping.

5. Turn off the ignition switch. Refer to NOTE.

6. Close the gasoline shut-off valve. Refer to NOTE.

CAUTION: Starting valves are subject to warpage if the operator does not follow the preceding procedures when stopping the engine.

NOTE: Steps 5 and 6 are recommended when the engine is to be shut down for a long period or as a precaution when the operator leaves the unit unattended.

PREVENTIVE MAINTENANCE

Preventive maintenance is a systematic series of inspections performed periodically in order to maintain high efficiency in the operation of the power unit. The importance of preventive maintenance cannot be over-emphasized, and must be practiced by every power unit owner.

Preventive maintenance inspections must be performed at the intervals given, and as outlined in "PERIODIC INSPECTIONS." The prompt detection and correction of minor irregularities will help keep the power unit operating at the fullest efficiency at all times.

PERIODIC INSPECTIONS

After Every 10 Hours of Operation

Point of Inspection	Remarks
Diesel fuel water trap	Drain off water and sediment. Refer to page 32.
Extended shaft and outboard bearing	Apply several strokes of (CL) chassis lubricant.
Lubrication points	Refer to "LUBRICATION GUIDE" on pages 12 and 13.

After Every 50 Hours of Operation

Fan belts	Check tension; replace when necessary. Refer to page 16.
Fuel transfer pump strainer	Remove screen and clean. Refer to page 32.
Flexible rubber connections between air cleaner and intake manifold	Inspect for loose fit or damage.
Radiator core	Clean spaces. Refer to page 16.
Lubrication points	Refer to "LUBRICATION GUIDE," pages 12 and 13.

After Every 100 Hours of Operation

Air cleaner (tray assembly)	Remove and clean. Refer to pages 17 and 18.
Batteries	Check liquid level.*
Lubrication points	Refer to "LUBRICATION GUIDE," pages 12 and 13.

After Every 250 Hours of Operation

Crankcase breather pipe	Remove and clean. Refer to page 20.
Gasoline strainer and sediment bowl	Take apart and clean. Refer to page 31.
Spark plugs	Remove and clean; check gap. Refer to page 21.
Distributor chamber and breaker points	Clean chamber and check gap. Refer to page 22.
Lubrication points	Refer to "LUBRICATION GUIDE" on pages 12 and 13.

After Every 500 Hours of Operation

Carburetor strainer screen	Remove and clean. Refer to page 30
Cooling system	Clean. Refer to page 16.
Engine valves	Check for clearance. Refer to pages 19 and 20.
Diesel fuel water trap	Remove and clean. Refer to page 32.
Lubrication points	Refer to "LUBRICATION GUIDE" on pages 12 and 13.

After Every 1000 Hours of Operation

Air cleaner, complete	Remove and clean. Refer to pages 17 and 18.
Lubrication points	Refer to "LUBRICATION GUIDE" on pages 12 and 13.

*When the ambient temperature is continuously 90° F or higher, the liquid level must be checked every 50 hours.

Periodically

Point of Inspection	Remarks
Battery terminals	Check for tightness and clean. Refer to pages 7 and 14.
Generator and cranking motor commutators	Clean. Refer to page 20.
Distributor cap	Remove and clean. Refer to page 22.
Oil pump screen	Clean whenever the oil pan is removed.
Oil filler strainer	Remove the strainer from the crankcase oil filler and clean.
Power take-off	Check for correct engagement. Refer to pages 35 and 36.
Wiring	Check for worn, cracked or frayed insulation, broken wires, loose or corroded connections.

LUBRICATION

The life and performance of a machine depend on the care that it is given and proper lubrication is the most important maintenance service for your power unit.

Thorough lubrication service performed at definite intervals and according to an established routine will aid greatly in prolonging the life of the power unit and in reducing operating expense. In the "LUBRICATION GUIDE" on pages 12 and 13 the recommended intervals between lubrication periods are approximate, being based on average operating conditions.

However, the type of work being done, load and weather conditions are all factors to consider in frequency of lubrication. It may be necessary to lubricate after shorter working periods under severe operating conditions such as extremely dusty conditions, low engine temperatures, intermittent operation, excessively heavy loads with high oil temperatures, or when diesel fuel with a high sulphur content is used.

Lubricant Specifications

Engine Oil

Engine oil (EO) (for use in crankcase, air cleaner and injection pump) should be well refined petroleum oil, free from water and sediment.

"Heavy duty" is the term used for engine oil possessing the oxidation stabilizing, anti-corrosive and anti-sludging properties necessary to make it generally suitable for high speed diesel engines. This is additive-type oil. The term "heavy duty" as used here does not pertain to the viscosity rating or "weight" of the oil.

Heavy duty crankcase oils provide the most satisfactory engine lubrication and must be used in International diesel engines with present day diesel fuels. The quality of the base oil and the amount and type of additives used in these oils determine their suitability for use in high speed diesel engines under severe operating conditions, and also determine the degree of their suitability for use with diesel fuels containing sulphur or other injurious products.

The requirements of diesel engine crankcase oils vary greatly with service severity and fuel composition. In order to give a better idea of the proper additive level oil to be used in the engine, three types of service are defined. The type of oil required for each type of service is specified as follows:

NORMAL SERVICE:

Diesel engine service is considered normal when operating temperatures are normal, fuel sulphur content does not exceed 0.4% and the engine operates at the specified horsepower rating for continuous operation or is intermittently loaded to maximum horsepower.

Oil represented by the oil supplier as meeting all of the requirements of U.S. Military Specification MIL-L-2104A and/or British Ministry of Defence Specification DEF/2101A are a minimum requirement for this type of service.

SERVICE MORE SEVERE THAN NORMAL:

Operation as described for normal service plus any of the following conditions;

Fuel having 0.4% to 0.9% sulphur content.

Long stand-by periods.

Low atmospheric or engine coolant temperatures.

High atmospheric or engine coolant temperatures.

Oils generally known in the trade as "Supplement List No. 1" or "Sup. 1" lubricating oils are considered suitable for use in engines running under more severe conditions than normal. These oils are represented by the oil supplier as meeting conditions somewhat more severe than the conditions under which oils for normal service have been represented.

VERY SEVERE SERVICE:

Conditions which describe more severe service are as follows:

Operation with fuel having sulphur content above 0.9%.

Unusually high or low atmospheric temperatures.

Continuous operation at maximum load or overload.

Oils which are known generally in the trade as "Supplement List No. 2" or "Sup. 2" represent the highest detergency level of heavy duty diesel engine oils and are considered suitable for use in engines running under very severe conditions.

It is not the policy of the International Harvester Company to publish approved lists of lubricants or to guarantee oil performance in service. The responsibility for the quality of the lubricant its performance under conditions of operation, and its compatibility with the diesel fuels used must remain with the supplier of the lubricant. High speed diesel fuels and lubricants should be procured from a reliable source. When in doubt, consult your International Construction Equipment distributor or dealer for information given in the latest service bulletin on crankcase lubricating oils.

No special procedure is required when heavy duty oils are used other than to have the engine thoroughly run-in.

Other Lubricants

The proper grade of lubricant for prevailing air temperatures must be used. Lubricants of high quality and recognized manufacture are recommended for your protection.

Chassis lubricant (CL) is used as pressure gun or lubricator grease at all temperatures.

High temperature melting point grease (HTG) is used for the distributor, ignition cut-out switch, generator idler pulley, clutch camshaft, lever shaft and bearings.

Engine Lubrication

Selecting the Proper Engine Oil

During cold weather, base the selection of crankcase lubricating oils on the lowest anticipated temperature for the day to make starting easier. For hot weather operation, base the selection on the highest anticipated temperature. Refer to the "LUBRICATION GUIDE."

Changes in Temperature

It is not necessary to change crankcase oil during operation when the atmospheric temperature rises or falls into another temperature range as specified in the "LUBRICATION GUIDE." For example: Grade 30 can be used instead of Grade 10W in temperatures below +32° F if no starting problems are experienced; or Grade 10W can be used in temperatures as high as +40° F, except when operating under continuously heavy loads.

Thinning the Crankcase Oil

When using lighter grades of lubricating oils, there may be a tendency for the oil in the crankcase, to gradually become thicker; in this case it is desirable in cold weather to add one quart of kerosene to the crankcase between specified oil changes to maintain easy cranking.

Precautions

After changing oil, the engine must not be operated at high speed or under load until the new oil has had ample time to reach all bearings.

LUBRICATION GUIDE

KEY

EO (Engine Oil)—According to anticipated air temperature. Refer to instructions under "Lubricant Specifications" on pages 10 and 11.

HTG (High temperature grease)—MIL-L-3545.

CL (Pressure-gun grease)—All temperatures.

APPLICATION	KEY	CAPACITY	ANTICIPATED AIR TEMPERATURE		
			Above +32°F.	+32°F. to −10°F.	Below −10°F.
Crankcase	EO	26 quarts	Grade 30*	Grade 10W	* *
Air cleaner	EO	6 pints	Grade 30*	Grade 10W	Grade 10W
Fuel injection pump	EO	1 pint	Grade 30*	Grade 10W	Grade 10W

*Above +90°F. SAE-40 may be used if desired.

**Grade-10W diluted with 6 quarts of kerosene. Below −25°F. use only MIL-L-10295A oil.

Point of Lubrication — Lubricant — Hours

Air cleaner . . . . . EO 10

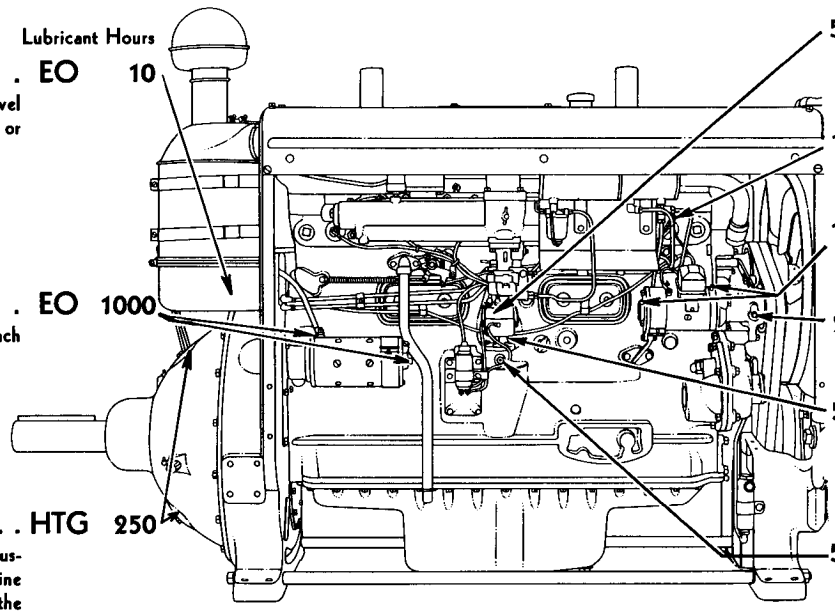
Clean the oil cup and refill it to the oil level bead when ¼-inch of dirt has accumulated or when oil will not flow freely.

Cranking motor . . . . . EO 1000

Occasionally put a few drops of oil in each of two oil cups.

Clutch camshaft (Rockford only) . . HTG 250

Remove either the upper or lower clutch housing handhole cover; then crank the engine until the lubrication fittings are opposite the opening. Apply two or three strokes of the lubricator to each of three fittings.



Hours Lubricant — Point of Lubrication

500 HTG — Distributor breaker arm

Remove the distributor cap and pack a small quantity of grease back of the breaker arm rubbing block and in the breaker arm recess.

1000 HTG — Ignition cut-out switch

Remove manifold end cover, apply a trace of grease to the contact points.

125 EO — Generator

Apply 8 to 10 drops of oil to each of two oil cups.

250 HTG — Generator idler pulley

Remove the plug and fill to the level of the plug opening.

500 HTG — Distributor rotor shaft

Apply lubricant to the fitting in the distributor housing, until a small quantity comes out of the relief hole opposite the fitting.

500 EO — Breaker cam washer

Remove the distributor cap and apply one or two drops of light engine oil to the felt washer at the end of the breaker cam.

Lubrication Points on Right Side

IPB-8266C

Always use clean containers. Keep lubricators clean. Wipe dirt from fittings before applying lubricators.

Point of Lubrication — Lubricant Hours

Recommended Intervals of Time for Lubrication Service

10 hours of operation or daily service.
50 hours of operation or weekly service.
125 hours of operation or bi-weekly service.
250 hours of operation or monthly service.
500 hours of operation or bi-monthly service.
1000 hours of operation or seasonal service.

Note—Intervals of time between lubrication services are based on average operating conditions. Under unusually severe conditions of operation, reduce the interval of time between services.

Lubricating oil filters . . . . . EO 500

Change the filter elements to coincide with every other crankcase oil change. Drain the filters at the filter base drain plug and the filter case drain plugs. Drain while the oil is warm. When replacing drained oil, add one quart to each filter case as part of the total amount of oil specified for the crankcase. It may be necessary to change the oil after shorter working periods under severe operating conditions such as extremely dusty conditions, low engine temperatures, intermittent operation, excessively heavy loads with high oil temperatures, or when diesel fuel with high sulphur content is used.

Water pump housing . . . . . CL 250

Keep filled with lubricant to level of plug hole. **Do not overlubricate.** Use of military specification grease MIL-G-10924A is suggested when extremely cold temperatures are anticipated.

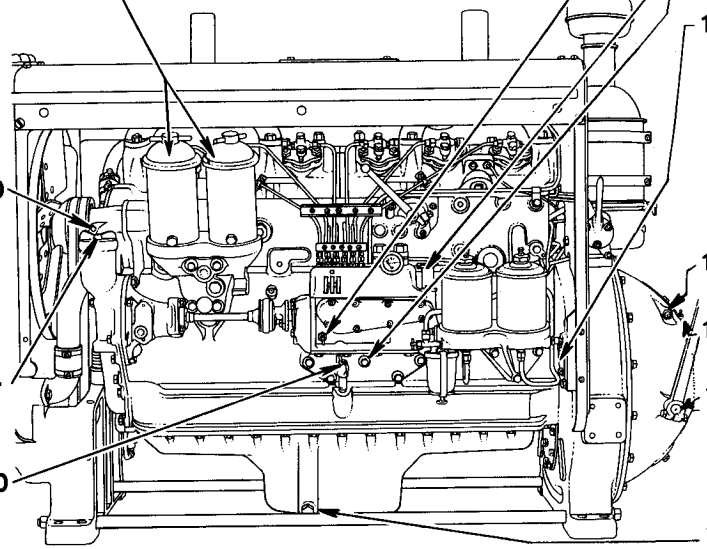
Crankcase oil filler . . . . . EO . .

Unscrew the cap. Fill the crankcase to the "FULL" mark on the crankcase oil level gauge.

Crankcase oil level gauge 10

Readings on both sides of the gauge show the crankcase oil level when the engine is operating and when it is stopped. For an accurate check with the engine stopped, wait for the oil to drain into the crankcase pan. If the oil level is to be checked with the engine running remove the cap from the oil filler to relieve crankcase pressure and assure an accurate reading.

1. Unscrew the wing nut, remove the gauge, and wipe it clean.
2. Insert the gauge until the wing nut rests on the top of the gauge sleeve threads. Do not screw the nut onto the sleeve.
3. Remove the gauge and check the oil level.



Lubrication Points on Left Side

Occasionally apply a few drops of engine oil to the engine speed control, compression release, and other engine control linkage.

Hours Lubricant — Point of Lubrication

FUEL INJECTION PUMP

10 . . **Oil level valve**

Open oil level valve to check oil level. If oil does not appear, add oil through the oil filler until oil appears at the valve opening.

. . EO **Oil filler**

250 . . **Oil drain plug**

Remove the drain plug and drain the pump each time the crankcase oil is changed. Refill at the filler until oil appears at the level valve opening.

125 HTG **Clutch pilot bearing**

Rockford only:

Remove the plate on the flywheel housing; then crank the engine until the lubrication fitting is opposite the opening. Apply three or four strokes of the lubricator.

Twin-disc only: Apply three or four strokes of the lubricator to the fitting in the end of the power take-off shaft.

10 HTG **Clutch throwout bearing**

Apply two or three strokes of the lubricator.

125 HTG **Clutch shaft outer bearing**

Apply two or three strokes of the lubricator.

125 HTG **Clutch lever shaft**

Rockford only: (One fitting on each side.) Apply two or three strokes of the lubricator

Two-Disc only: Apply five or six drops of oil in the oil cup on each side.

250 . . **Crankcase oil drain plugs**

(2 drain plugs provide for either side or bottom draining.) Remove the plug and drain the oil while the engine is warm. Drain the oil filters at the filter base drain plug and the filter case drain plugs. When replacing drain oil, add one quart to each filter case as part of the total amount of oil specified for the crankcase. It may be necessary to change the oil after shorter working periods under severe operating conditions such as extremely dusty conditions, low engine temperatures, intermittent operation, excessively heavy loads with high oil temperatures, or when diesel fuel with high sulphur content is used. *IPB-8267B*

MAINTENANCE

PREPARING FOR COLD WEATHER

In order to operate the power unit in temperatures of 32° F or lower, observe the following instructions:

Fuel System

Use only a high test, winter grade gasoline for starting. Keep the supply in a closed container to prevent the more volatile portion of the gasoline from evaporating. Fill the gasoline tank and the diesel fuel tank at the end of each day's run to prevent moisture from collecting in the tanks.

Lubrication

Lubricate the power unit completely with winter-grade lubricants as outlined in the "LUBRICATION GUIDE."

Engine oils for use in the crankcase and air cleaner must be based on the lowest anticipated temperature for the day in order to make starting easier.

Cooling System

When the temperature is likely to be +32° F or lower, there is danger of the water freezing in the cooling system. To prevent this, either drain the water from the cooling system at the end of each day's run, or use a recommended anti-freeze solution.

Before putting anti-freeze into the cooling system, drain and clean the system as described on pages 15 and 17. Refill with water and check the radiator, water pump, all gaskets and hose connections for leaks and drain the system.

Fill the cooling system as described on page 15.

Anti-freeze Solutions

NOTE: Use only one type of anti-freeze solution. Do not mix solutions as this would make it difficult to determine the amount of protection given to the cooling system.

Do not use alcohol as an anti-freeze if other solutions are available, as denatured alcohol boils at 173° F. However, if it is necessary to use alcohol, the use of a low-boiling-point thermostat is recommended. Check the solution frequently to be sure that the cooling system is adequately protected against freezing.

The following table shows the percentage of anti-freeze solution required for various temperatures.

Freezing Point (Fahrenheit)	USE IN COOLING SYSTEM		
	Ethylene Glycol	Distilled Glycerine	Denatured Alcohol
10°	25%	33-1/3%	30%
0°	33-1/3%	40%	37%
-10°	40%	47%	43%
-20°	45%	53%	50%
-30°	50%	59%	57%
-40°	54%	-	65%
-50°	58%	-	72%
-60°	62%	-	78%
-70°	65%	-	-

If anti-freeze is not available, drain the cooling system completely after operation. The cooling system must be filled completely before starting the engine. Special attention must be given to insure that there are no air locks in the system.

CAUTION: Operating the engine without coolant will cause cylinder head failure and overheat the piston rings.

Batteries

The efficiency of batteries decreases sharply with lowering temperatures and it becomes practically nil at minus (-) at 40° F. Do not attempt to start the engine, if the batteries have been chilled to -20° F, unless the batteries have been heated. Immersion in warm water to within an inch or two of the top of the battery case is a satisfactory means of warming a battery. Check the specific gravity of the battery electrolyte at frequent intervals, and keep the batteries as fully charged as possible.

It is especially important to keep the batteries at full charge for cold weather operation. Add water to the batteries in freezing temperatures only when the engine is to operate for several hours, to thoroughly mix the water and the electrolyte, or damage to the battery will result from the water freezing.

PREPARING FOR HOT WEATHER

Lubrication

Follow closely the lubrication instructions as outlined in the "LUBRICATION GUIDE."

Engine oils for use in the crankcase and air cleaner must be based on the highest anticipated temperature.

Fuel System

Keep the gasoline tank and the diesel fuel tank full to prevent condensation of moisture

in the tanks. Be sure that the vents in the gasoline tank filler cap are open.

Batteries

Inspect the batteries frequently to see that the water is at the correct level.

Cooling System

To prevent overheating in hot weather, make the following checks:

Check the tension of the fan belts at frequent intervals.

Check the coolant level frequently, and be sure the radiator filler cap is on tight.

Clean and flush the internal parts of the cooling system frequently.

Keep the external parts of the radiator clean of bugs and dirt. Refer to "Cleaning the Radiator Core" on page 16.

COOLING SYSTEM

The pressure-cooled system will not operate properly unless the cooling system is tight. The filler cap must be properly tightened. The cap gaskets must be in good condition. The system must not have loose connections or leaks. Unless these instructions are followed, pressure will not be maintained and loss of coolant and consequent overheating will result.

Care of the Cooling System

Add a rust inhibitor for summer operation, as required, in the proportions recommended by the manufacturer.

Rust and sludge, if allowed to accumulate in the cooling system, will impair circulation and cause the engine to overheat. Drain and flush out the system before adding anti-freeze to the water and again when removing it.

The appearance of rust in the radiator or in the coolant is an indication that the inhibitor has become weakened, and it is possible that some sludge has accumulated in the system. When this condition exists, the coolant must be drained immediately after stopping the engine, when complete circulation has been established and while most of the sediment is in suspension.

Removing the Radiator Cap

A regulating pressure valve, in the radiator cap, is designed to open at a pressure of approximately four pounds per square inch.

Unscrew the cap handle and remove the handle with clamp. Remove the cap from the radiator.

NOTE: Do not attempt to repair or replace any of the regulating valve parts. If the valve is faulty, replace it with a new valve of the same type.

Draining the Cooling System

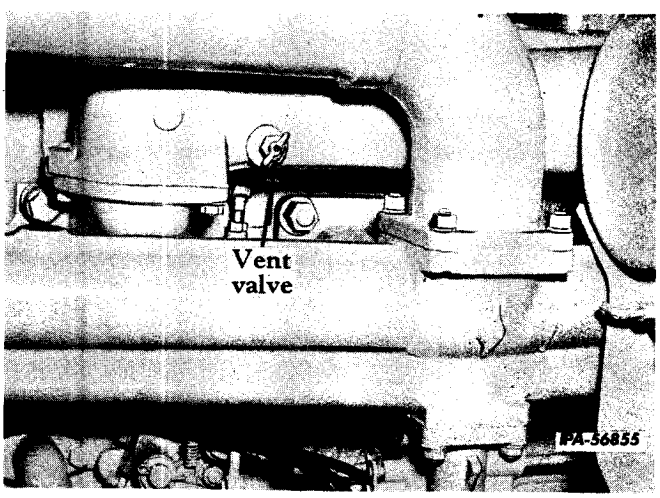
Remove the radiator cap, open the radiator drain and the crankcase water drain valve. Allow the system to drain completely and be sure that the drain outlets do not plug up during the draining. Close the drain outlets.

Filling the Cooling System

Be sure the drain valves are tightly closed.

Open the vent valve on the water outlet manifold (Illust. 12). Pour or run water slowly into the radiator until partly full. Add a rust inhibitor for hot weather operation or an anti-freeze for temperatures below +32° F. Refer to page 14. Continue to fill until a continuous flow of water is noted at the vent valve on the water manifold. Close the valve and continue to fill until water reaches the baffle. Wait a few minutes to allow for air to escape, then add water as needed.

Install the radiator cap, clamp and handle. Start and run the engine until operating temperature is reached. Stop the engine, remove the cap handle and cap and recheck level, adding water as needed and install cap and clamp with handle.



Illust. 12
Vent valve on water manifold.

Cleaning the Cooling System

The system must be drained and thoroughly flushed twice a year or more often if necessary.

There are cleaning solutions available which successfully remove the accumulation of rust, scale, sludge and grease. Each solution must be used according to the manufacturers' recommendation.

After the cooling system has been flushed, close the drains and refill the cooling system.

Adding Water to an Over-heated Cooling System

Do not pour cold water into the radiator if the engine is very hot unless conditions make it absolutely necessary; in this case, start the engine and let it idle; then slowly pour the water into the radiator.

Cleaning the Radiator Core

Engine overheating often is caused by bent or clogged radiator fins. Blow insects and dirt from the radiator core air passages, using air or water under pressure. Apply the air or water hose to the rear of the radiator. When straightening bent fins, be careful not to injure the tubes or to break the bond between the fins and tubes.

Fan Belts

Fan Belt Tension

The tension is correct when the belts can be depressed without effort by the thumb, approximately 3/4 to 1 inch midway between the idler pulley and the crankshaft pulley. If the belts are too tight or too loose, adjust.

Adjusting the Fan Belts

1. Loosen the nut "A" on the idler brace (Illust. 13).

2. Loosen the nuts "B" on the idler and generator mounting bolts.

3. Push the generator and idler assembly in to loosen the belts or out to tighten the belts.

4. After the correct tension is obtained, tighten the three nuts.

NOTE: Having the belts too loose, or too tight, will result in rapid wear.

Removing the Fan Belts

1. If equipped with fan guards, they must be removed.

2. Decrease the fan belt tension as outlined previously.

3. Working one belt at a time, remove the belts from the idler and crankshaft pulleys.

4. Turn the fan by hand and work the belts over the fan blades until they can be removed.

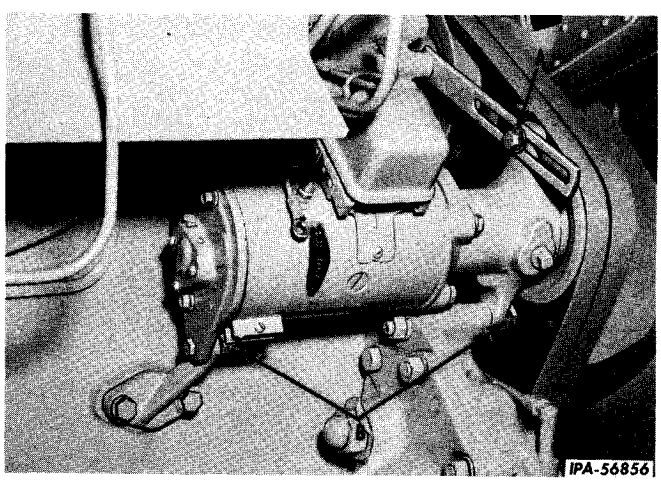
Replacing the Fan Belts

1. The fan belts should be replaced when they become soaked with grease or so badly worn that they do not drive the fan at the proper speed.

2. When old belts become worn, replace both belts at the same time with a new pair.

3. When installing belts, reverse the procedure outlined for removing the belts.

4. Adjust the belt tension as described on this page.



Illust. 13
Generator and idler mounting belts.

Removing the Thermostats

1. Remove the engine hood (if equipped).

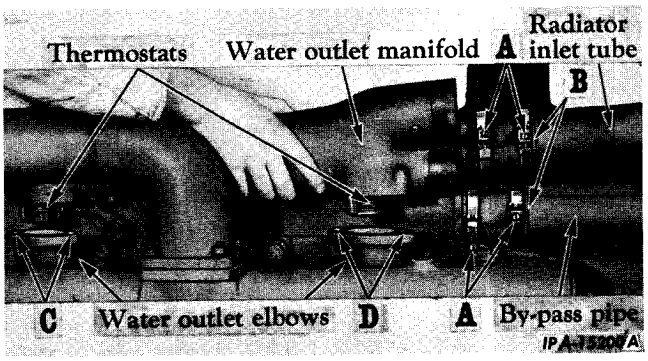
2. Drain the cooling system.

3. Loosen four clamps "A" (Illust. 14).

4. Pry the hoses "B" loose and move them forward onto pipes.

5. Remove two cap screws from "C" and "D."

6. Lift off the water outlet manifold with gaskets and remove the thermostats.



Illust. 14
Removing the thermostats.

Installing the Thermostat

Check that the hose connections and the thermostat seals are in good condition.

Replace the water outlet elbow gaskets.

Reverse the procedure for removing the thermostats.

When filling the cooling system refer to page 15.

AIR CLEANER

Cleaning the Oil Cup

Before removing or installing the oil cup, clean or wipe the oil or grit from the top bead of the oil cup, oil cup retaining clamp, and the surface under the clamp.

Loosen the retaining clamp and pull the oil cup from the air cleaner body.

Pour out the old oil and thoroughly clean the inside of the oil cup. Fill the oil cup to oil level bead (refer to "SPECIFICATIONS AND CAPACITIES" on page 4) with the grade required for the prevailing air temperature. Refer to the "LUBRICATION GUIDE" on pages 12 and 13.

Cleaning the Tray Assembly

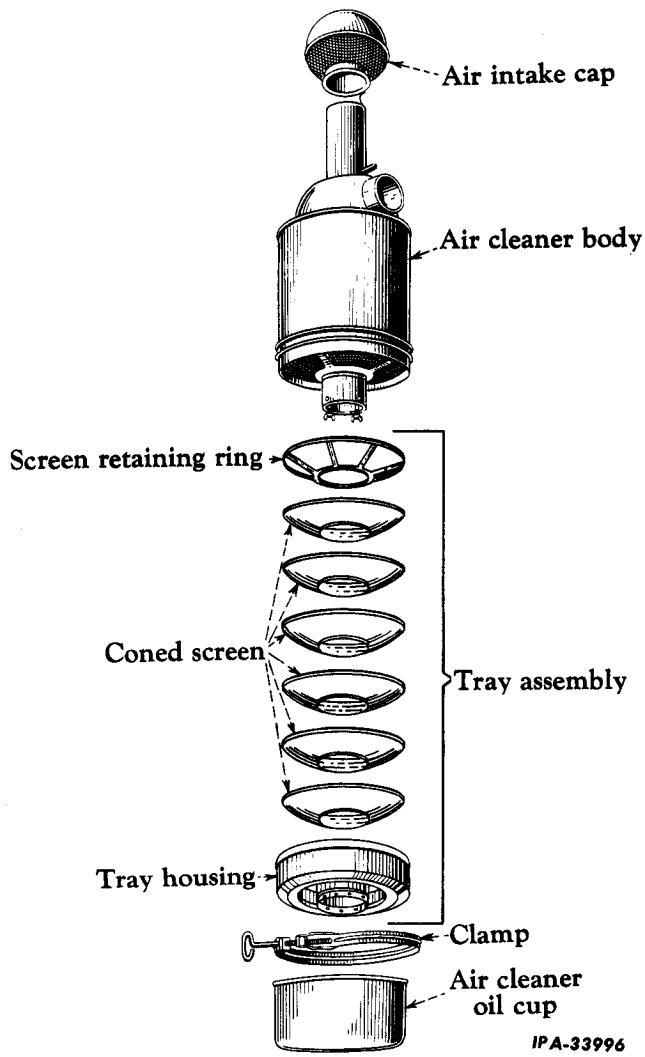
The air cleaner is provided with a removable tray held in place by wing nuts which, when loosened will allow the tray to be turned (right or left) to release the tray locks for dropping the tray. For cleaning, take out the four wing bolts and screen retaining ring to remove the six screens, nested within the tray housing. Clean the tray and housing with diesel fuel, dry-cleaning solvent or kerosene.

Install the six screens in the tray housing. Insert the retaining ring and tighten the four wing bolts. Install the tray assembly on the air cleaner body, turning the tray assembly slightly and tightening the air cleaner body wing nuts. Fill the oil cup as described under "Cleaning the Oil Cup."

Cleaning the Air Cleaner

Remove the air cleaner from the power unit and disassemble it. Wash the parts thoroughly in kerosene or dry-cleaning solvent. Be sure to clean out the air intake pipe and the inside of the main body.

After the parts have been cleaned thoroughly, install the air cleaner body on the power unit. Be sure that all the joints are air-tight; then replace the air intake cap. Fill the oil cup to the proper level with the specified grade of oil and install it on the air cleaner. Be sure it is held securely in place by the cup clamp.



Illust. 15
Air cleaner disassembled.

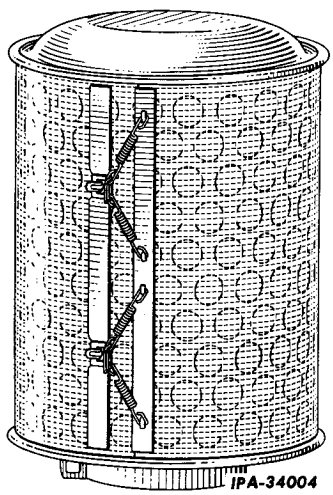
Air Intake Cap

The dome of the air intake cap serves as a rain shield, and the screen prevents chaff and other coarse dirt from getting into the air cleaner. Keep this screen free from all foreign matter. Clogged holes in the screen will reduce the power of the engine by restricting the flow of air.

General Precautions

As an added precaution against dirt getting into the engine, frequently inspect the flexible rubber hose connections between the intake manifold and the air cleaner. If they show any sign of deterioration, replace them. To eliminate strain on the rubber hose connections, be sure that the pipes line up.

All joints between the air cleaner and the intake manifold and between the manifold and the cylinders of the engine should be tight. All gaskets must be in good condition, and bolts should be drawn up tight.

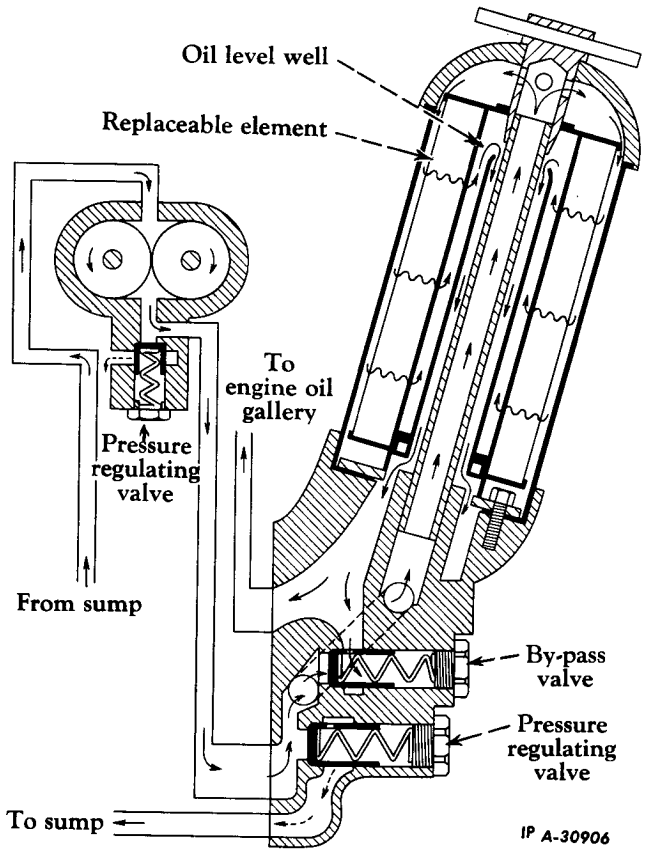


Illust. 16
Pre-Screener.

Remove and clean the screen frequently. To remove the screen from the body assembly, unhook the screen locks. Remove and inspect the body regularly. When the body becomes dirty or oily, wash the entire pre-screener in kerosene.

LUBRICATING OIL FILTERS

The full-flow lubricating oil system of this engine includes a "no-drain-back" feature, which eliminates the necessity of pumping the oil up into the filters when starting the engine.



Illust. 17
Cross-section of filter.

Changing Filter Elements

1. Stop the engine.

2. Remove the crankcase oil pan drain plug and drain while the oil is still warm.

3. Remove the filter base drain plug and drain. (Illust. 18.)

4. Remove the filter case drain plugs (one for each case) and allow the cases to drain completely. (Illust. 18.)

5. Clean off the filter case covers to prevent dirt from falling into the cases.

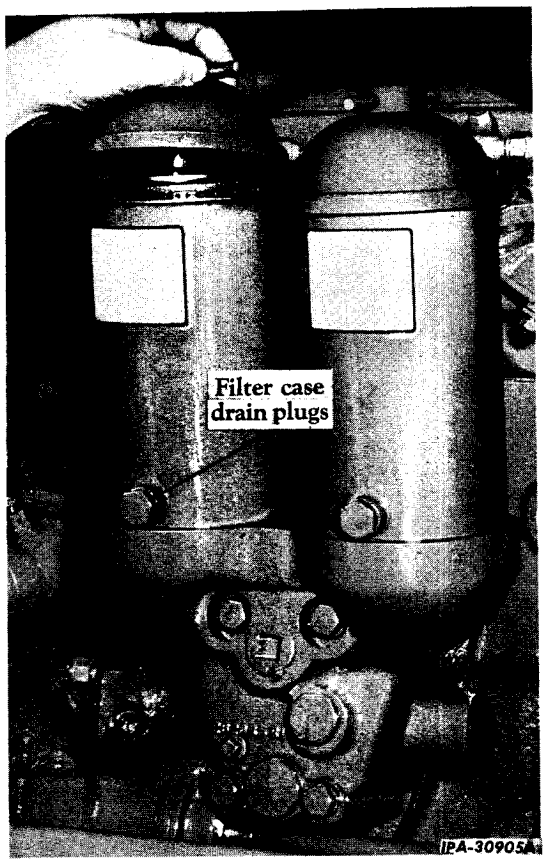
6. Unscrew the retaining nuts and remove the case covers.

7. Remove the old elements.

8. Clean the inside of the filter cases with a rag dampened in kerosene.

9. Install the new filter elements.

10. Be sure all four drain plugs are replaced.



Illust. 18
Lifting cover to change element.

11. Refill the crankcase and filters as follows (crankcase capacity 26 quarts):

a. Fill the crankcase with 24 quarts of oil (viscosity specified in the "LUBRICATION GUIDE" for the prevailing temperature).

b. Fill the filter cases (one quart of oil for each filter case). Adding oil to each filter speeds up lubrication to the bearings, oil pump drive gears, and other vital engine parts, thus eliminating the time required by the pump to fill the filter cases.

12. Install the case covers, being sure the surface of rubber seal seated in the cover groove is clean. Tighten the covers hand tight.

13. Start the engine and see that the engine oil pressure indicator is registering pressure.

NOTE: To avoid delays, always carry extra elements on hand for replacement at the proper time. CLEANING THE OLD ELEMENTS IS NOT SATISFACTORY.

VALVE CLEARANCE ADJUSTMENT

For valve clearances, refer to "SPECIFICATIONS AND CAPACITIES" on page 4.

1. Before checking the valve clearance, cut out the distributor by disconnecting the ignition cut-out switch cable from the terminal on the ignition coil. This will prevent accidental starting.

2. Set the compression release lever in the gasoline (STARTING) position.

3. Remove the hood sheet.

4. Remove the valve cover and gasket.

5. Remove the cover plate from the flywheel housing to expose the timing pointer and timing mark on the flywheel. (Illust. 23.)

6. Remove the spark plug from No. 1 cylinder (the cylinder next to the radiator). Place your thumb over the spark plug opening and slowly crank the engine until an outward pressure can be felt. Pressure indicates that the No. 1 piston is moving toward top-dead-center of the compression stroke. Continue cranking slowly until the "DC 1-6" mark on the flywheel is in line with the pointer. Both intake and exhaust valves are now closed on the compression stroke of No. 1 cylinder.

7. Check the clearance of the No. 1 valves and adjust if necessary as follows. Be accurate; use a feeler gauge.

8. Loosen the adjusting screw lock nut on both the No. 1 intake and exhaust valve levers. Insert the feeler gauge between the valve lever and valve stem. Turn the adjusting screw in or out as necessary to hold the feeler gauge snugly. When the correct clearance is secure, hold the adjusting screw in place with a screwdriver and tighten the lock nut. Adjust both the intake and exhaust valve levers in the same way.

9. Crank the engine one third revolution at a time and check the clearance of the valves for each cylinder. Adjust if necessary. Do this on each set of cylinder valves in succession according to the firing order of the engine, which is 1, 5, 3, 6, 2, 4. (Illust. 25.)

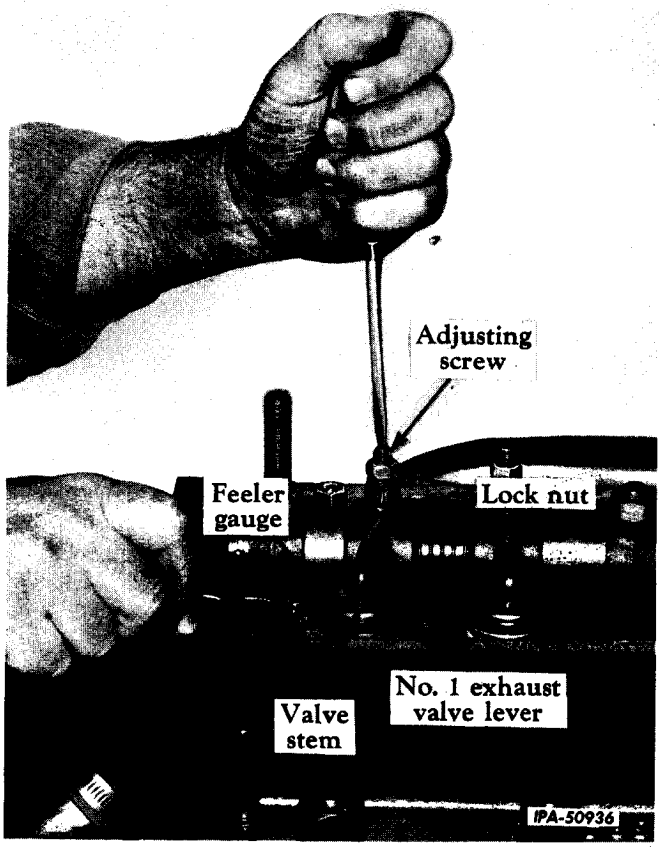
10. Install the valve cover and gasket. Be sure the gasket makes an oil-tight seal with the cylinder head. Use a new gasket if necessary.

11. Connect the ignition cut-out switch cable to the ignition coil.

(Continued on next page.)

12. Install the hood sheet.

13. Install the timing cover on the flywheel housing and be sure all spark plug connections have been properly made.



Illust. 19
Adjusting valve clearance.

CRANKCASE BREATHER PIPE

The crankcase breather pipe is flanged to the crankcase above the rear push rod chamber on the right side of the crankcase. A smoky exhaust and/or excessive oil consumption may be an indication that the breather pipe is clogged. Detach the pipe by removing the two cap screws from the flange, and clean out the pipe. Replace gasket if damaged.

ELECTRICAL SYSTEM

General Precautions

Before working on any part of the electrical system, disconnect the battery ground cable. Do not reconnect the battery ground cable until all electrical work has been completed. This will avoid shorting and causing damage to any of the electrical units.

Be sure that all terminals are clean and securely fastened, and that there are no broken wires anywhere in the electrical circuit.

CAUTION: The generator will burn out if operated with the battery cables or battery charging circuit cables disconnected or broken. To operate the generator without the battery, remove the connection from the "F" terminal on the generator frame.

Do not paint the instruments or electrical connections.

Generator and Regulator

The voltage regulator is mounted on the generator which is hinge-mounted on the right side of the engine crankcase.

The generator charging rate is controlled by a voltage regulator which controls the generator output, thereby maintaining a satisfactory charging rate, and prevents the battery from overcharging under varying temperatures and operating conditions. It should not require adjustment or attention. If the regulator fails to operate correctly, replace it with a new one or see your International Construction Equipment distributor or dealer.

Polarizing the Generator

If the generator or regulator has been removed or the leads disconnected, the generator must be repolarized. After the leads have been connected, but before the engine is started, proceed as follows:

After being certain that the grounded battery terminal is the positive (+) one, place one end of the jumper lead on the "BAT" terminal of the regulator and with the other end wipe across (flash) the "GEN" terminal of the regulator. This allows a momentary surge of current to flow through the generator, which correctly polarizes it. Reversed polarity may result in vibration, arcing and burning of the regulator contact points.

CAUTION: Do not at any time place a jumper lead between the battery terminal and the field terminal on the regulator. Serious damage to the regulator may result.

CAUTION: Do not touch the jumper lead to the "F" terminal on the generator as this will damage the regulator.

Cleaning the Generator and Cranking Motor Commutators

Periodically remove the cover band from the generator and the cranking motor to inspect the commutator of each unit.

If the commutators are greasy, dirty, or slightly burred, they can be polished with No. 00 sandpaper. Never use emery cloth. After the polishing operation, all dust must be blown from the commutator. If a commutator is very rough or out-of-round, refer to your International Construction Equipment distributor or dealer.

Before polishing the cranking motor commutator, remove the spark plugs to relieve the cylinder compression, also disconnect the coil cable at the cut-out switch terminal on the manifold front cover. With the starting switch depressed and the cranking motor turning, place the piece of No. 00 sandpaper over the commutator.

To polish the generator commutator, place a piece of No. 00 sandpaper between a brush and the commutator while the armature is revolving.

Spark Plugs

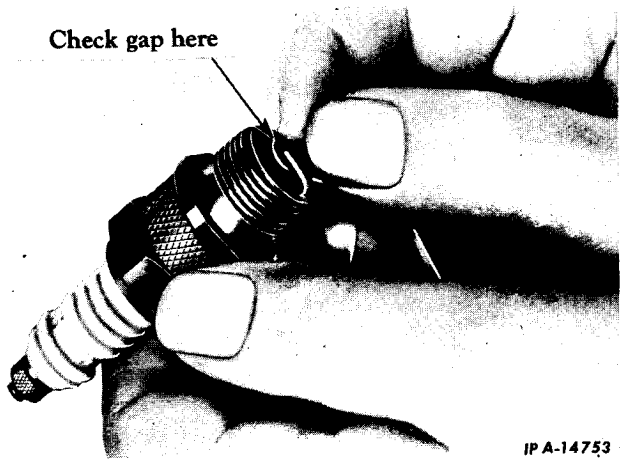
For recommended spark plugs, consult your International Construction Equipment distributor or dealer.

CAUTION: Remove all dirt from the base of a spark plug before removing the spark plug.

1. Always use a spark plug wrench when removing or replacing plugs to prevent cracking the porcelain.

2. Sand blasting is the recommended method of cleaning spark plugs. Never scrape or clean the insulator with anything which will scratch the porcelain. Scratched porcelain allows carbon and dirt to accumulate much faster. Replace defective plugs.

3. When adjusting spark plug gap, (refer to "SPECIFICATIONS AND CAPACITIES" on page 4) always bend the outer electrode. Never bend the center electrode as this will damage the insulator. If the gap between the electrodes is too great, due to improper setting or burning off the ends, the engine will misfire and will be hard to start.



Illust. 20
Checking spark plug gap.

Spark Plug Cables

If the spark plug cables are removed for any reason, note the position of each cable on the distributor. The correct positions of the cables are shown in Illust. 25.

A minimum clearance of 1/4 inch between the spark plug cables and the cylinder head is recommended. By maintaining this clearance, shorting out the spark plugs will be prevented and the cable will be away from the heat of the cylinder head. If the cable touches the cylinder head, the heat will soon cause the rubber to become soft and will ruin the cable.

Storage Batteries

A registration card is furnished with the batteries. The purchaser of new batteries should take the card to the nearest authorized battery service station for registration.

Complete instructions for a dry-charged battery (used for export) are included with the battery.

Cleaning and Servicing the Battery

If the top of the battery is dirty, it may be cleaned with a brush dipped in ammonia or soda solution. The vent plugs must be tightened to prevent any solution from getting into the battery cells. After foaming stops, flush off the battery with clean water. Brighten the terminal contact surfaces with steel wool or a steel brush. If brass terminals are used, a light coating of lubricant (preferably vaseline) may be applied.

Battery cable terminals must be kept clean and tight. Be sure the battery is fastened securely in the battery frame to avoid vibration.

CAUTION: If tightened excessively, the battery case could warp or break.

Check that the vent holes in the filler caps are not clogged. Replace unserviceable cables.

The electrolyte in each cell must be at the proper level at all times to prevent battery failure. Check the level of the electrolyte. When the electrolyte is below this level, pure distilled water must be added. Never use hydrant water or any water which has been in a

(Continued on next page.)

metal container. Acid or electrolyte must never be added except by a skilled batteryman. Under no circumstances add any special battery "dopes," solutions, or powders.

Ignition Coil

The ignition coil does not require special service other than to keep all terminals and connections clean and tight.

DISTRIBUTOR

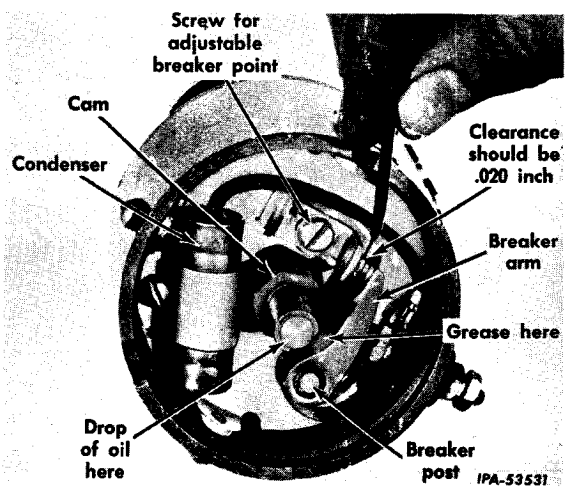
Distributor Cap

Whenever the distributor cap is removed, examine the inside. If any dust, moisture or oil deposits are present, thoroughly clean and wipe dry. Also see that the distributor rotor is kept clean.

If the terminal nipples are removed, be sure the distributor cap terminals and coil terminal are clean and dry. The distributor is equipped with these nipples to prevent any external electrical leakage when operating under adverse conditions.

Checking the Points

It is important that the breaker chamber be kept clean because oil on the breaker points will cause rapid burning. Remove the distributor cap, distributor rotor, the breaker cover and felt washer for breaker chamber inspection (Illust. 22). Care must be taken, when removing the breaker cover, to prevent dirt from entering the breaker chamber. Be sure the chamber is clean and that the breaker points are in good condition and have the proper opening.



Illust. 21
Adjusting the breaker points

Check the condition of the breaker points for build-up or lip formation. If present, the points must be dressed before the point opening can be checked or set. Check the opening between the breaker points with a feeler gauge when the rubbing block is on the high part of the cam, (Illust. 21). Rever to "SPECIFICATIONS AND CAPACITIES" on page 4. If the gap is not correct, adjust it by loosening the screw holding the adjustable point. Then move the point toward or away from the point on the breaker arm until the gauge slips snugly into the opening. After the adjustment has been made, tighten the screw.

NEVER USE EMERY CLOTH OR SANDPAPER TO CLEAN THE POINTS. If the points are worn excessively, replace both points.

Removing the Distributor (Illust. 22)

If it is necessary to remove the distributor for any reason, without disturbing the spark plug cable hook-up to the distributor cap, proceed as follows:

1. Unsnap the two outer spring clips and remove the distributor cap.

2. Disconnect the "distributor to coil" cable (primary) from the terminal on the side of the distributor housing.

3. Scribe a mark on the distributor housing and bracket in line with the rotor in order to retain this same position when the distributor is being installed.

4. Remove the cap screws and hold-down clamps and lift the distributor out of the bracket.

5. To remove the distributor bracket, give the lock nut on the bracket set screw in the crankcase one-half turn.

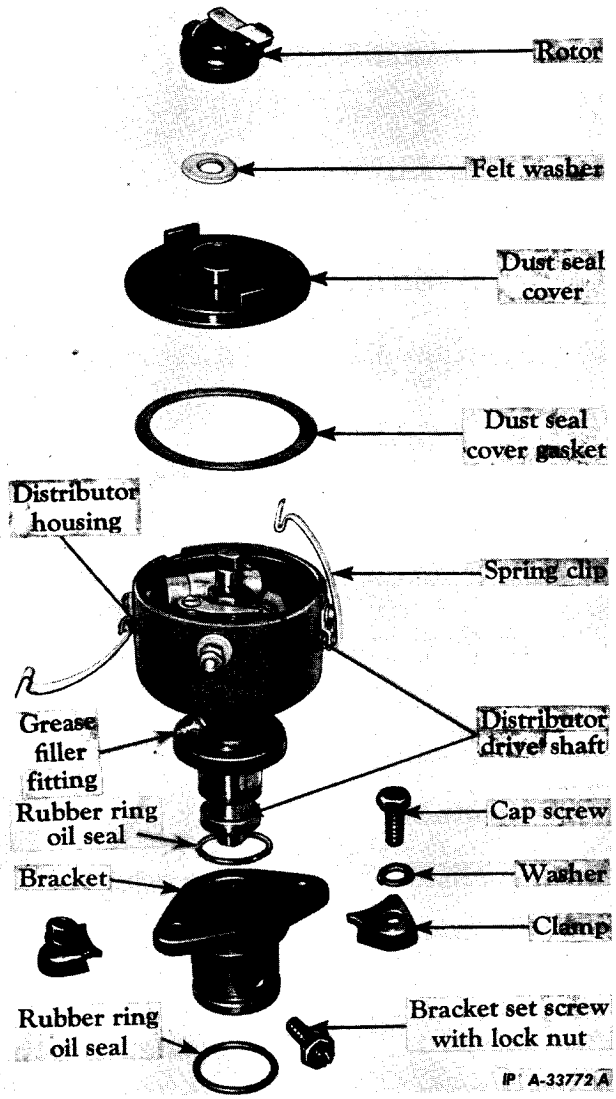
6. Remove the set screw and lift out the bracket.

Installing and Timing

A. Installing Complete Distributor Assembly on Engine. Crankshaft Position Known.

NOTE: The following instructions will apply only if the engine crankshaft has not been rotated since the distributor was removed. If for any reason the engine has been rotated, refer to instructions under step B.

1. If the distributor bracket was removed, inspect the condition of the rubber ring oil seals in the base of the bracket. Replace the seals if worn or broken.



Illust. 22
Distributor partially disassembled for servicing.

2. Apply a light coating of grease to the seals and install the bracket and tighten the set screw and lock nut.

3. Place the rotor on the distributor shaft and carefully press it into position.

4. Rotate the rotor so the top is in alignment with the scribe mark made on the housing during removal.

5. Slide the distributor into the bracket and line up the scribe marks of the bracket and distributor housing.

6. Install the hold-down clamps, washers and cap screws and tighten enough to prevent the distributor from turning freely.

NOTE: If the spark plug cables have been removed from the distributor cap, they must be inserted consecutively in counterclockwise rotation. The cylinder firing order is 1-5-3-6-2-4. (Illust. 24 and 25.)

7. Install the cap to the distributor housing and secure with the two outer spring clips.

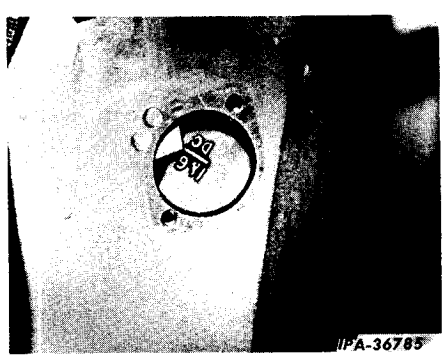
CAUTION: If the cap is incorrectly positioned on the housing, it will result in a broken rotor when attempting to start the engine.

8. Connect the "distributor to coil" cable (primary) to the terminal on the side of the distributor housing.

9. Start the engine and set the timing as described under "Ignition Timing" on page 24.

B. Installing Distributor on Engine When Crankshaft Position is Unknown.

1. With the engine on the gasoline cycle, remove the No. 1 spark plug, crank the engine and hold thumb over the spark plug hole until you feel pressure. Slowly continue cranking the engine until the "DC/1-6" mark on the flywheel is in line with the pointer on the flywheel housing.



Illust. 23
Timing mark on flywheel.

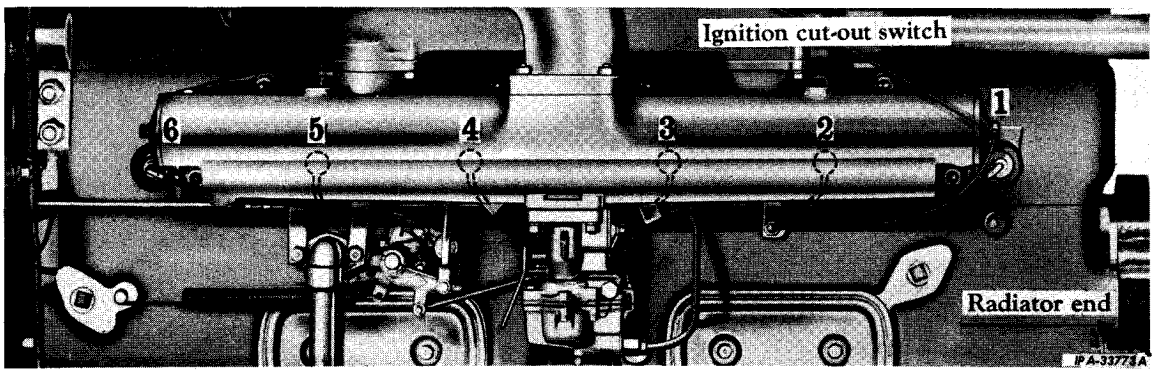
NOTE: The timing hole cover on the flywheel housing must be removed. (Illust. 23.)

2. If the distributor bracket was removed, inspect the condition of the rubber ring oil seals in the base of the bracket. Replace the seals if worn or broken.

3. Apply a light coating of grease to the seals and install the bracket and tighten the set screw and lock nut.

4. Install the rotor by carefully pressing it into position on the end of the distributor shaft. While holding the cap in approximately the correct position (spring clips approximately parallel to the center line of the engine), rotate the distributor rotor so that the rotor top will point in the direction of the No. 1 terminal on the distributor cap. (Illust. 25.) Slide the distributor into the bracket.

Continued on next page.



Illust. 24
Cylinder firing order. Firing order is 1-5-3-6-2-4.

NOTE: It may be necessary to move the rotor slightly until the tang on the drive shaft engages the slot in the drive coupling, but the rotor will line up with the No. 1 terminal post when the distributor is down in place.

5. Install the hold-down clamps, washers and cap screws and tighten enough to prevent the distributor from turning freely.

NOTE: If the spark plug cables have been removed from the distributor cap, they must be inserted consecutively in counterclockwise rotation. The cylinder firing order is 1-5-3-6-2-4. (Illust. 24 and 25.)

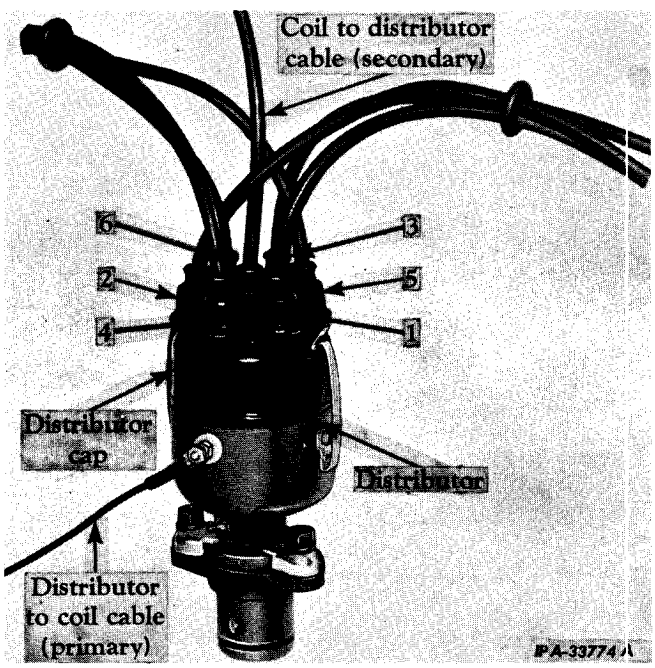
6. Install the cap to the distributor housing and secure with two outer spring clips.

CAUTION: If the cap is incorrectly positioned on the housing, it will result in a broken rotor when attempting to start the engine.

7. Connect the "distributor to coil" cable (primary) to the terminal on the side of the distributor housing.

8. To recheck the timing, pull out the ignition switch button and slowly crank the engine until the No. 1 piston is again coming up on the compression stroke. Hold the plug end of the No. 1 spark plug cable 1/4 inch from the cylinder head and continue to turn the engine very slowly until a spark occurs. At this point, the "DC/1-6" mark on the flywheel should be in line with the pointer. If it is not, the distributor must be reset. If the "DC/1-6" mark is below the pointer, turn the distributor counterclockwise to retard the spark. If the "DC/1-6" mark is above the pointer, turn the distributor clockwise to advance the spark.

9. Set the timing as described under "Ignition Timing" which follows.



Illust. 25
Spark plug cables.

Ignition Timing

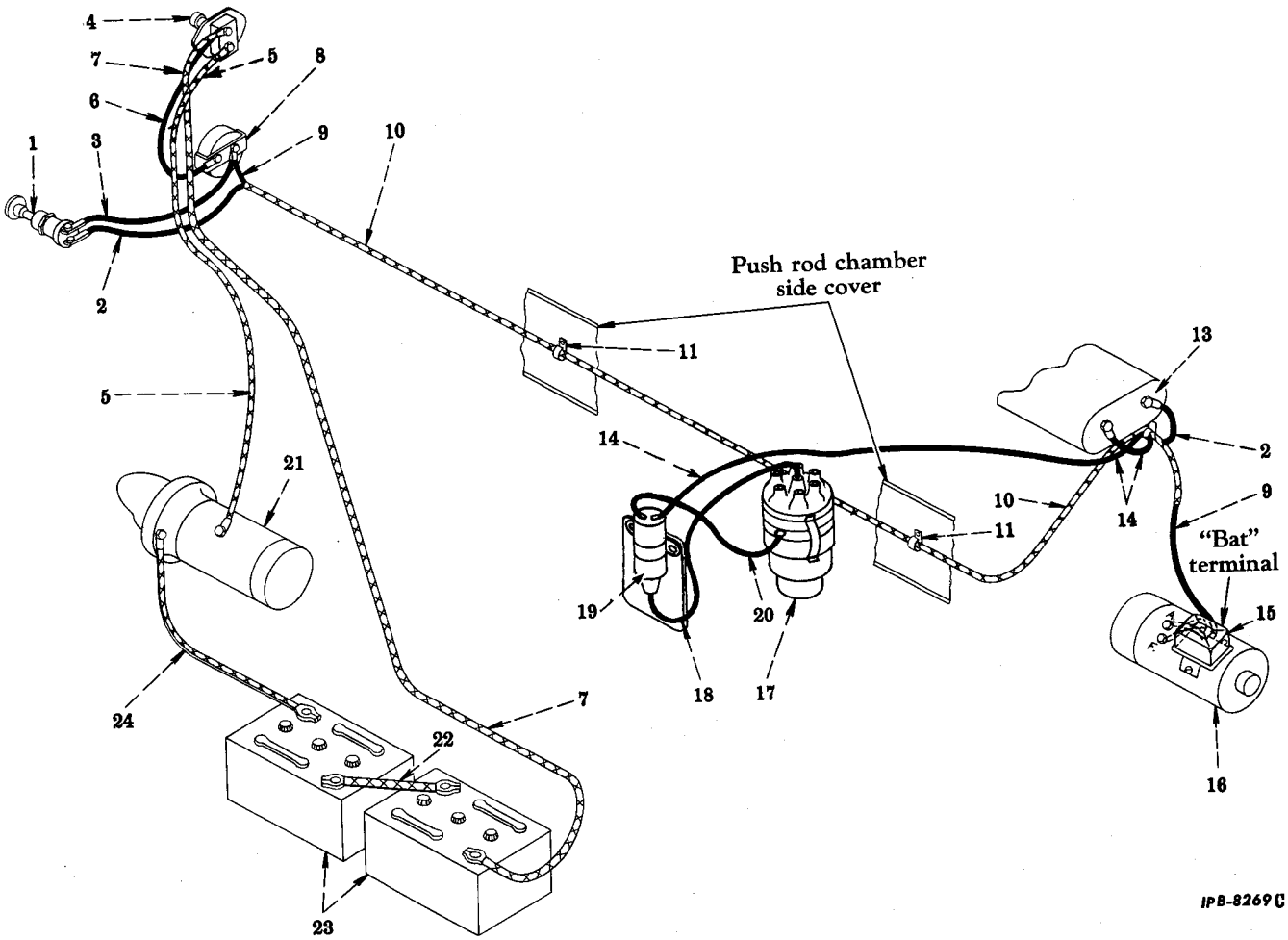
1. Start and operate the engine on the gasoline cycle. Allow the engine to warm up for a short period of time.

2. Loosen the distributor hold-down clamps.

3. Rotate the distributor to the left or right until the best performance is obtained.

NOTE: Rotating the distributor to the right (clockwise) advances the spark; to the left (counterclockwise) will retard the spark.

4. Tighten the hold-down clamps to secure the distributor in position.



Illust. 26
Wiring diagram for battery ignition with electric starting.

Ref. No.	Description	Ref. No.	Description
1.	Ignition switch.	12.	Cable clip (rubber covered) for 1/2-inch bolt (intake manifold front end).
2.	Cable, ignition switch to ignition cut-out switch (black).	13.	Ignition cut-out switch (intake manifold front end cover).
3.	Cable, ignition switch to ammeter.	14.	Cable, coil to ignition cut-out switch.
4.	Starting switch.	15.	Voltage regulator.
5.	Cable, starting switch to cranking motor.	16.	Generator.
6.	Cable, ammeter to starting switch.	17.	Distributor.
7.	Cable, starting switch to battery.	18.	Cable distributor to coil (secondary).
8.	Ammeter.	19.	Coil.
9.	Cable, ammeter to "BAT" of voltage regulator (green).	20.	Cable coil to distributor (primary).
10.	Cable, harness (includes refs. 2 and 9).	21.	Cranking motor.
11.	Cable clip (part of push rod chamber side cover) (two required).	22.	Cable, battery to battery.
		23.	Batteries.
		24.	Cable, battery to ground.

MAGNETO

Description

The magneto is mounted on the right side of the crankcase and is built in accordance with the latest ignition practices.

The magneto is permanently engaged, but the spark is eliminated during diesel operation by means of the ignition cut-out switch which is operated automatically when the compression release lever is placed in the diesel position.

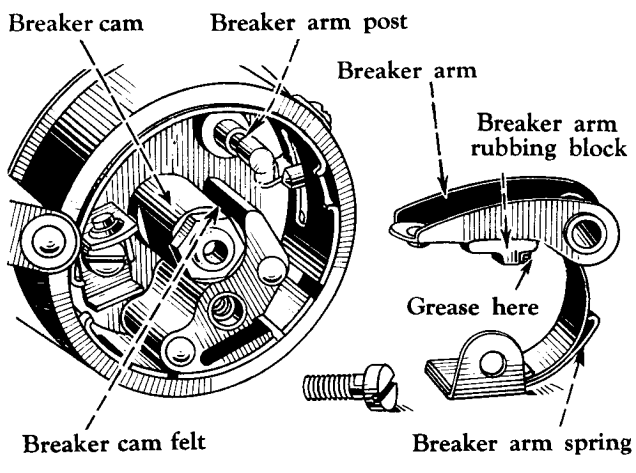
Lubrication

After every 50 hours of operation, oil the impulse coupling oil cup (Illust. 34) liberally with a light engine oil (Grade 10W). Use a kerosene when the temperature is below -10°F.

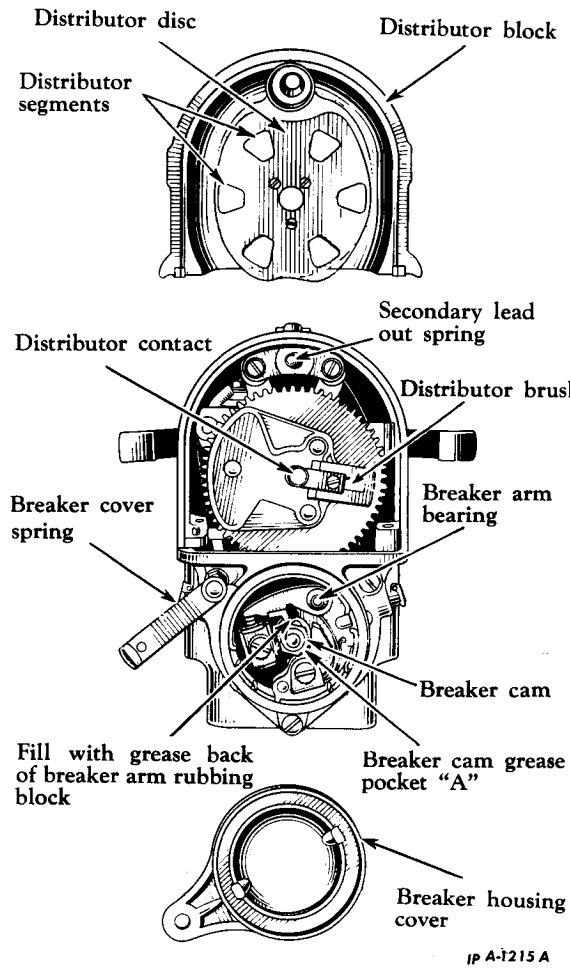
After every 250 hours of operation, remove the distributor block and clean the inside of the distributor block and the face of the distributor disc with a clean cloth moistened with kerosene; then wipe dry. Moisten a cloth with engine oil and apply a light coating on the surface of the distributor disc.

NOTE: Be careful not to damage the carbon brush.

After every 500 hours of operation, take off the breaker housing cover and remove the circuit breaker assembly. Wipe all parts clean of old grease. Apply a thin film of magneto grease on the cam surface and pack a small quantity on the breaker arm post, in the pocket "A" (Illust. 28) of the breaker cam, and on the breaker arm rubbing block. Wipe the breaker arm spring with a cloth dampened with engine oil to prevent rust.



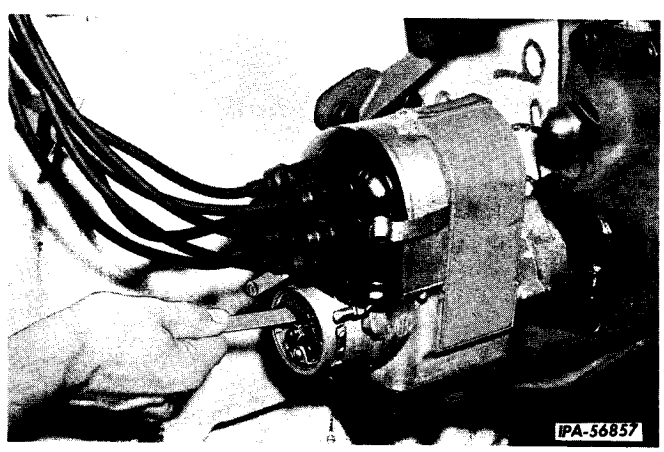
Illust. 27
Circuit breaker.



Illust. 28
Details of magneto distributor and breaker mechanism.

Breaker Points

The magneto requires little attention. It is important to keep the breaker point chamber clean, as oil on the breaker points will cause rapid point wear.



Illust. 29
Checking breaker point gap.

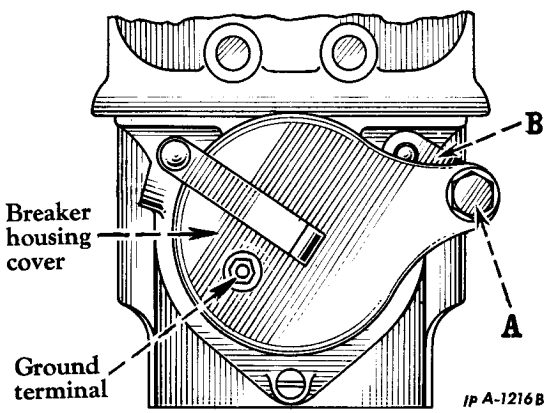
The breaker points must be inspected after every 250 hours of operation for adjustment and general conditioning. The point opening (refer to "SPECIFICATIONS AND CAPACITIES" on page 4) must be checked when the rubbing block is on the high point of the cam.

Adjusting the Breaker Points

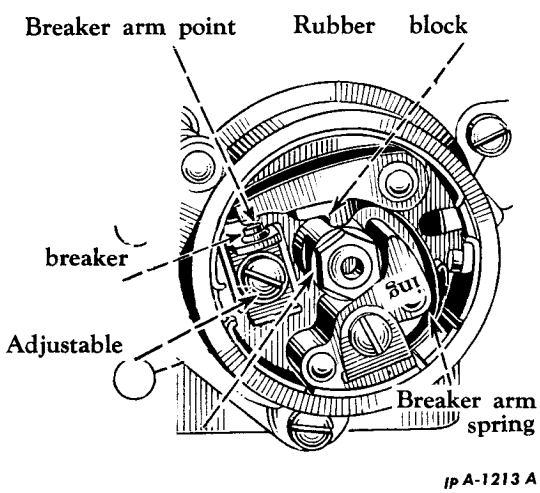
1. Take out nut "A" (Illust. 30) to disconnect breaker cover from link "B" (Illust. 30).

2. Fully retard the spark by rotating the link end of the breaker housing cover counterclockwise as high as it will go.

3. Lift up the breaker cover spring and remove the breaker housing cover carefully, to avoid moving the breaker assembly.



Illust. 30
Breaker housing cover and timing links.



Illust. 31
Breaker mechanism.

4. Crank the engine until the rubbing block is on the high point of the cam.

5. Insert a feeler gauge between breaker points (Illust. 29). If the points are too wide or too close, loosen the point support screws slightly. Adjust so that a gauge will slip snugly into the opening. Tighten screw and recheck the opening. Use a screwdriver as a pry to move the point support.

Dressing Breaker Points

If the points are rough or pitted, remove both points and dress them with a sharp point file. If they are worn excessively, replace both points with new ones and adjust them as described previously.

Removing the Magneto

1. Crank the engine until the No. 1 piston (the piston nearest to the radiator) is on the top-dead-center of the compression stroke. (The compression stroke can be determined by removing the No. 1 spark plug, placing a thumb over the opening, and having the engine cranked until an outward pressure is felt by the thumb.) Continue cranking until the "DC/1-6" mark on the flywheel is in line with the pointer on the flywheel housing. (Illust. 23.)

2. Remove the bolt in the magneto drive cover. Take off the cut-out switch cable by removing the fillister-head screw and lock washer attaching the cable to the magneto terminal.

3. Pull the spark plug cables from the sockets in the distributor cap.

4. Remove the cap screws and washers holding the magneto to the bracket. Remove the magneto assembly from the bracket.

Installing and Timing the Magneto to the Engine

1. Pull the compression release lever into the gasoline (STARTING) position.

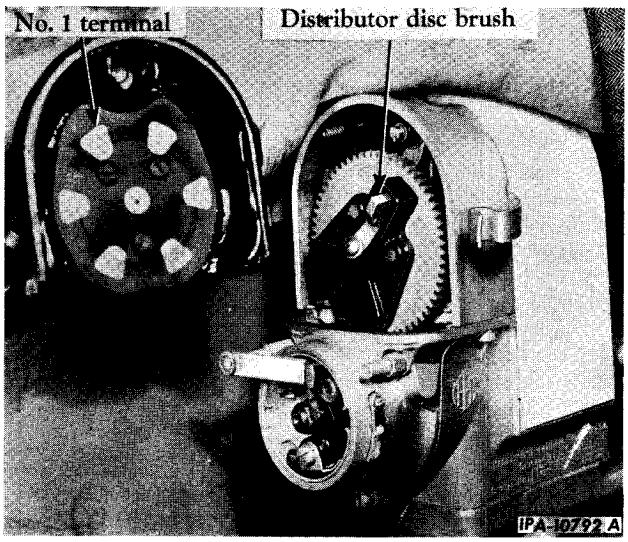
2. Remove the spark plug from No. 1 cylinder (the cylinder next to the radiator). Place your thumb over the spark plug opening and slowly crank the engine until an outward pressure can be felt. Pressure indicates that the No. 1 piston is moving toward top-dead-center of the compression stroke. Continue cranking slowly until the "DC/1-6" mark on the flywheel is in line with the pointer.

3. Remove the distributor cap from the magneto and hold it close to the magneto. Rotate the magneto half of the coupling counterclockwise as viewed from the coupling end until the brush in the distributor disc is under the distributor cap terminal marked No. 1 (Illust. 32).

(Continued on next page.)

4. Place the magneto into position on the magneto bracket, engaging the lugs on the magneto coupling block with the slots in the coupling block spacer. Secure the magneto with the base cap screws and lock washers.

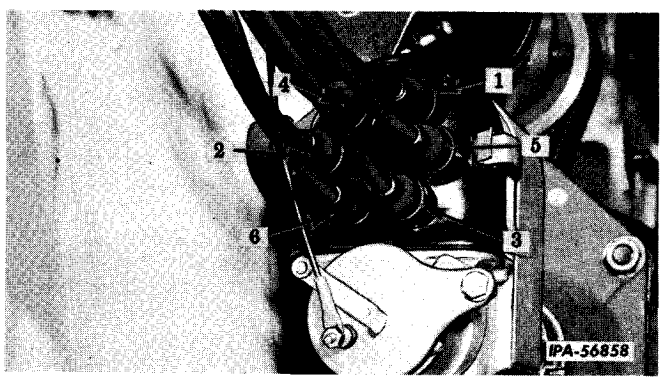
NOTE: Do not use screws which are longer than the originals, as they will damage the magneto.



Illust. 32
Showing position of distributor disc brush.

5. Install the distributor cap on the magneto and insert the spark plug cables into the cap according to the firing order of the engine, 1-5-3-6-2-4 as shown in Illust. 33.

6. Secure the magneto drive cover with the bolt.



Illust. 33
Spark plug cables in position.

NOTE: The cover must always be assembled so the hold is on the bottom to facilitate drainage in damp or rainy weather. When operating under extremely dusty conditions, the flap over the hole in the cover must be partially closed to prevent the entrance of excessive amounts of dust.

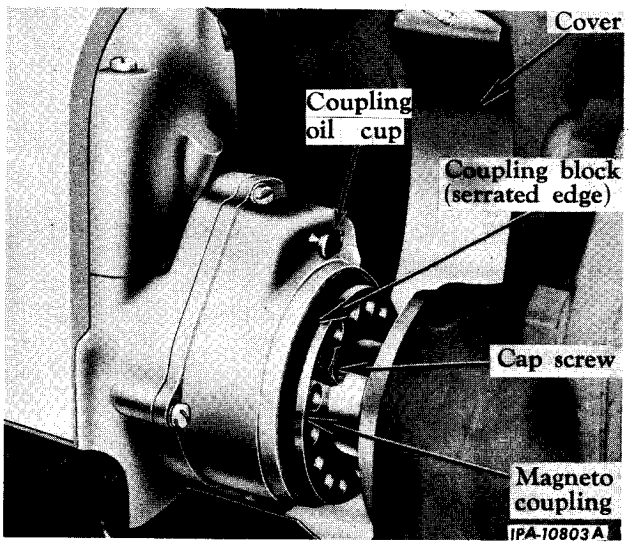
7. Connect the ignition cut-out switch cable to the ground terminal with the screw and washer (Illust. 30).

8. Refer to "Checking the Timing of the Magneto" which follows.

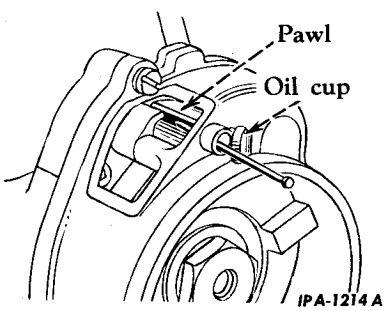
Checking the Timing at the magneto

1. Crank the engine slowly until the No. 1 piston is on the upper dead-center of the compression stroke and the impulse coupling just trips.

2. If timing is correct, the timing pointer on the flywheel housing will be between the "DC/1-6" or "MAG" mark on the flywheel. The timing pointer must never be before the "DC/1-6" mark when the impulse coupling just trips. If the timing is not correct, magneto must be retimed to engine as follows:



Illust. 34
Magneto drive and timing coupling.



Illust. 35
Disengaging the coupling.

3. Remove the magneto drive cover (Illust. 34).

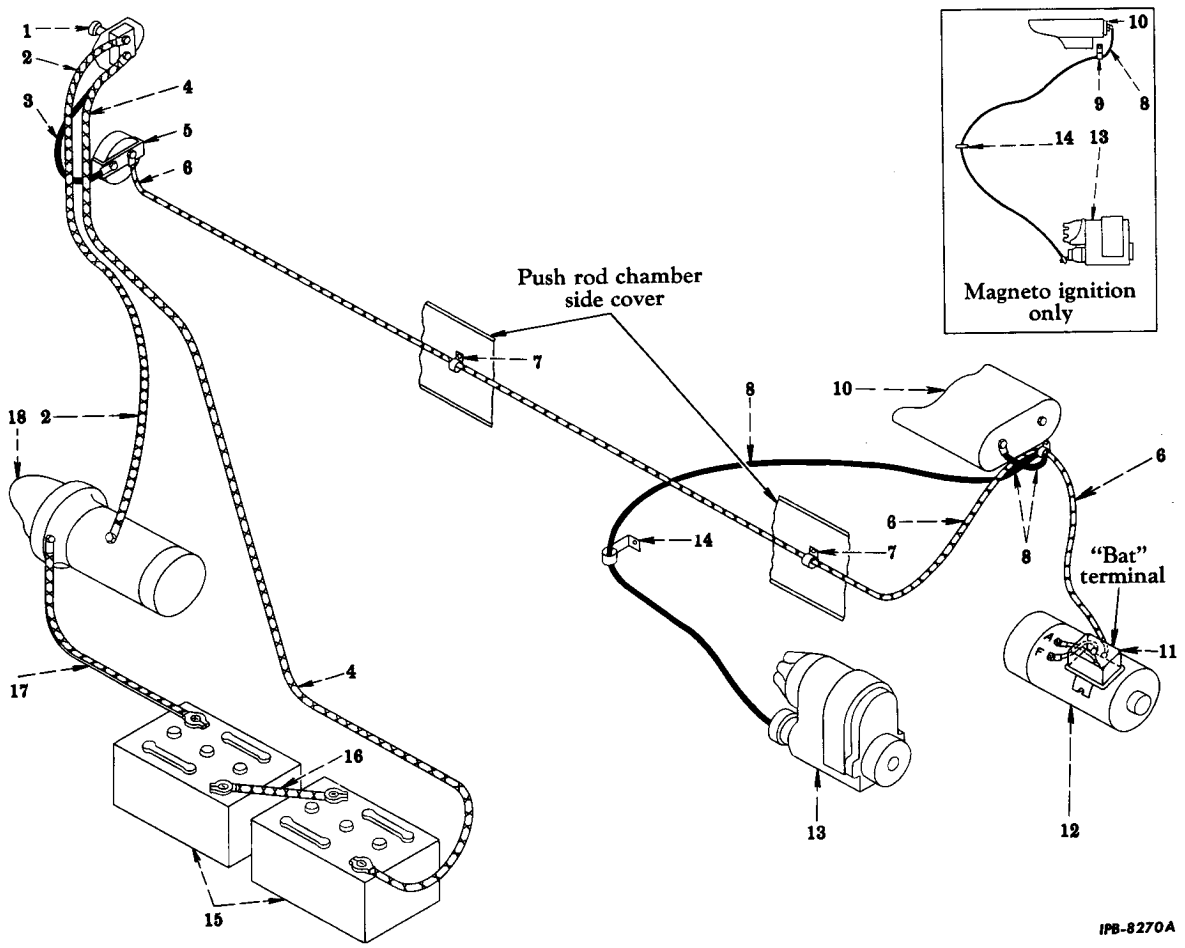
4. Remove the two cap screws (Illust. 34) in the magneto timing coupling and rotate the coupling one or two holes at a time, depending on the amount of adjustment that is necessary.

5. Looking from the coupling end, rotate the coupling clockwise to advance timing or counterclockwise to retard timing. To turn coupling clockwise, insert a wire or nail to the coupling oiler to lock the pawl (Illust. 35).

6. Insert the cap screws into the coupling and remove the nail or wire from the oiler.

7. Crank the engine to see that the impulse coupling trips when the timing pointer is between the "DC/1-6" and "MAG" mark.

8. Install the magneto drive cover.



Illust. 36
Wiring diagram for power units equipped with electric starting and magneto ignition, and for magneto ignition only.

Ref. No.	Description	Ref. No.	Description
1	Switch, starting.		front end cover).
2	Cable, starting switch to cranking motor.	11	Regulator, voltage.
3	Cable, ammeter to starting switch.	12	Generator, with voltage regulator.
4	Cable, battery to starting switch.	13	*Magneto.
5	Ammeter.	14	*Clip, cable (rubber covered) (spark plug cables).
6	Cable, ammeter to "BAT" terminal of voltage regulator.	15	Batteries (special).
7	Clip, cable (on push rod side chamber cover).	16	Cable, battery-to-battery.
8	*Cable, magneto to ignition cut-out switch.	17	Cable, battery-to-ground.
9	*Clip, cable (rubber covered) (mounted on intake manifold front end).	18	Motor, cranking.
10	*Switch, ignition cut-out (in manifold		*Also for Magneto Ignition only.

GASOLINE STARTING SYSTEM

Carburetor

The carburetor is used only when starting and stopping the engine. The gasoline level is controlled by a float valve mechanism when starting and operating on gasoline. The float valve is locked into its seat, shutting off the gasoline supply to the fuel bowl, when the engine is changed over to operate on the diesel cycle.

Periodically check the flange nuts which secure the carburetor to the manifold, and keep them tight.

Periodically check the screws which secure the fuel bowl to the carburetor body and see that the screws are kept tight to prevent leakage of air past the gasket.

Cleaning the Strainer Screen (Illust. 37)

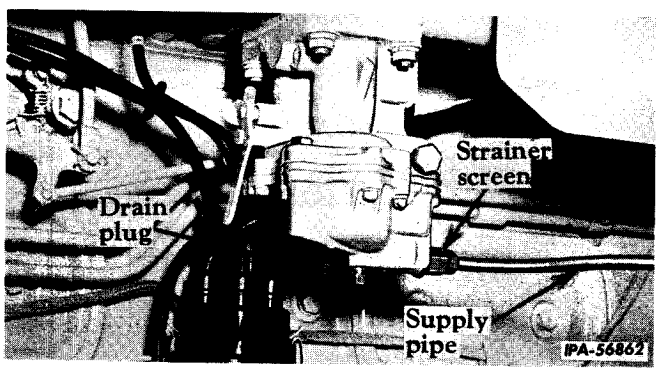
The float valve is protected against dirt and foreign material by a strainer inside the carburetor where the gasoline line connects to the carburetor. This strainer should be removed occasionally and cleaned.

1. Close the gasoline shut-off valve at the gasoline tank (Illust. 9).

2. Disconnect the gasoline supply tube at the carburetor screen retainer.

3. Unscrew the retainer with screen from the carburetor; wash it in kerosene and reassemble it.

4. Open the gasoline shut-off valve.

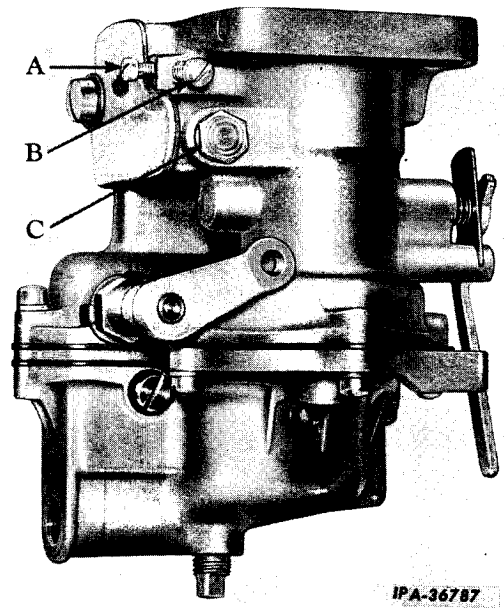


Illust. 37
Carburetor and connections.

Idle Speed Adjustment

In cold weather the idle throttle stop screw should be readjusted to obtain the correct idle speed. Adjustment should also be made if the carburetor has been removed. The correct idle speed is attained when the engine operates steadily without missing under no load.

To adjust the idle speed, start the engine and loosen the idle throttle lock screw "A" (Illust. 38). Turn the idle stop screw "B" clockwise to increase the engine speed and counterclockwise to decrease the engine speed. The correct idle speed with no load is from 800 to 900 rpm. When the engine idles at the desired speed, lock the idle throttle stop screw in position with the lock screw.



Illust. 38
Adjustments on engine side of carburetor.

Throttle Spring Adjustment

Remove the plug "C" next to the idle stop screw "A" (Illust. 38). Start the engine. Using a screwdriver, turn the throttle spring screw clockwise to increase the engine speed and counterclockwise to decrease the engine speed. The correct speed is from 1000 to 1200 rpm.

NOTE: This speed will be held only until the correct velocity has been obtained, after which the engine speed will decrease to 800 to 900 rpm.

Removing the Carburetor (Illust. 37)

1. Shut off the gasoline supply at the gasoline tank.

2. Open the drain plug and drain all gasoline from the carburetor.

3. Disconnect the gasoline supply pipe at the carburetor strainer.

4. Remove the pin which secures the yoke to the shut-off rod.

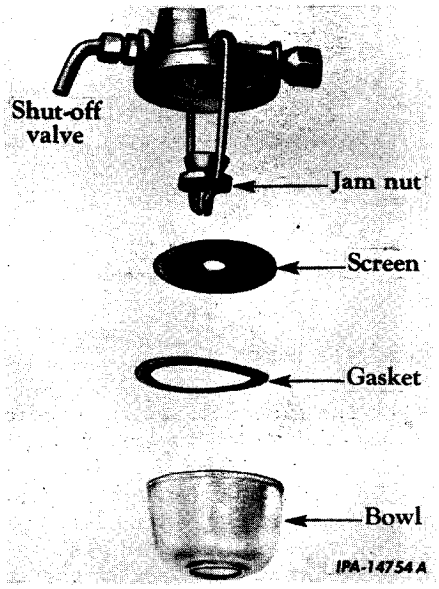
5. Remove four nuts and lock washers which secure the carburetor to the intake manifold, and remove the carburetor and gasket.

6. Assemble the carburetor on the engine in reverse order of removal. When installing the carburetor, be sure to use a new gasket.

Cleaning the Gasoline Strainer and Sediment Bowl

The gasoline strainer under the gasoline tank acts as a combination water trap and sediment bowl. It must be cleaned after a certain period of operation. Close the shut-off valve. Loosen the nut below the glass bowl and swing the bail aside to lower the bowl. The wire screen should come away from the bowl, but if it sticks to the cork gasket it can be removed with the fingers. Clean and wash the bowl and screen.

When reassembling the strainer, be sure that the cork gasket between the bowl and the main body is in good condition and that it does not leak.

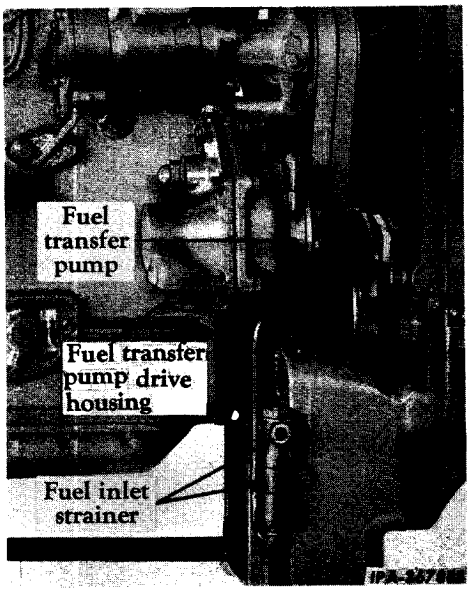


Illust. 39
Gasoline strainer and glass bowl removed for cleaning.

DIESEL FUEL SYSTEM

Fuel Transfer Pump

If the power unit is equipped with a fuel transfer pump it should not be tampered with. In case any problem is experienced, the pump should be removed and taken to your International Construction Equipment distributor or dealer.

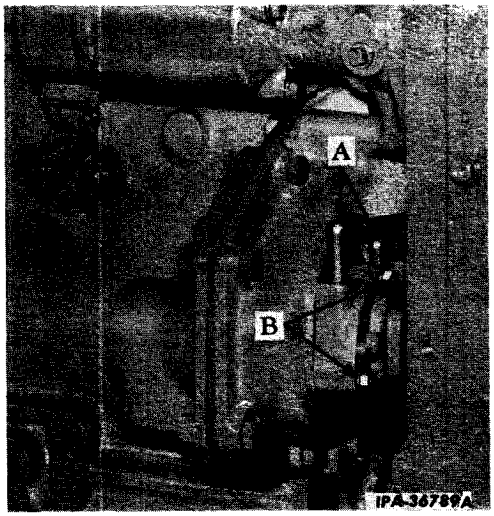


Illust. 40
Fuel transfer pump and strainer.

Removing the Fuel Transfer Pump

Disconnect both fuel lines at "A" (Illust. 41) and remove three cap screws "B" which secure the pump to the crankcase front cover. Remove the pump with the bracket.

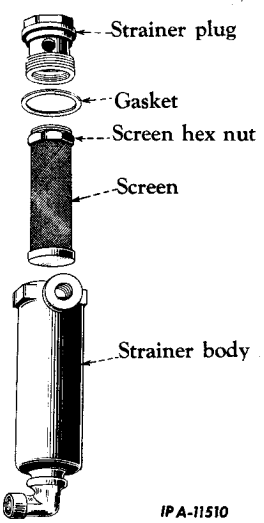
When reinstalling the fuel transfer pump, reverse this procedure.



Illust. 41
Removing the fuel transfer pump.

Fuel Transfer Pump Strainer

Inside the fuel transfer pump strainer is a fine-mesh screen which must be removed and cleaned. Unscrew the strainer plug. Disconnect the screen by unscrewing its hex nut from the plug. Wash the screen in kerosene, and also clean the plug and the strainer body.

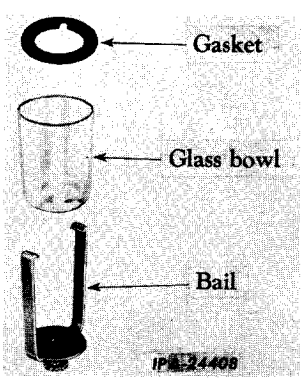


Illust. 42
Fuel transfer pump strainer disassembled.

Draining the Water Trap

The diesel fuel water trap, located below the auxiliary filter, is attached to the filter base casting.

Flush the water and sediment from the trap by opening the drain valve in the filter base just above the trap. Do not close the shut-off valve on the fuel line or open any vents when flushing the trap. When all water and sediment has been flushed from the trap, close the drain valve.



Illust. 43
Diesel fuel water trap strainer.

Cleaning the Water Trap

1. Close the diesel fuel shut-off valve.

2. Loosen the thumb nut under the glass bowl and remove the bail and bowl.

3. Wash the bowl in kerosene to remove all dirt and sediment.

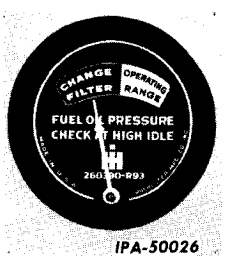
4. Be sure the glass bowl gasket is in the proper place and in good condition. Reassemble the glass bowl and bail and tighten the thumb nut by hand.

5. Open the fuel shut-off valve and vent the fuel system as described under "Venting the Diesel Fuel System" on page 9.

Fuel Filter Element

Fuel filter elements cannot be cleaned and must not be disturbed except when it becomes necessary to replace them.

The need for frequent venting of the final fuel filter indicates either air leakage into the fuel lines, or that the auxiliary filter has become clogged, restricting the fuel flow to the engine.



Illust. 44
Fuel oil pressure indicator.

When to Replace Fuel Filter Elements

1. When the fuel oil pressure indicator (Illust. 44) located on the injection pump, shows the pointer in the red "CHANGE FILTER" area with the engine operating (either on gasoline or diesel cycle), one or both of the fuel filter elements must be replaced, or the fuel system is clogged at some point. This may also be accompanied by loss of power or misfiring of the engine.

2. Before replacing the filter elements, service the water trap. Refer to "Cleaning the Water Trap" preceding.

3. If the indicator pointer remains in the red area after servicing the water trap, replace the auxiliary fuel filter element.

4. If the indicator pointer remains in the red area after replacing the auxiliary fuel filter element, replace the final fuel filter element.

NOTE: It is advisable to check the auxiliary fuel filter at the water trap drain valve for traces of water every day or more frequently under severe conditions. If water is found, it indicates that more frequent servicing of the water trap is necessary to obtain full service from the auxiliary fuel filter element.

Precautions When Replacing Filter Elements

Cleanliness cannot be overemphasized. Be careful not to allow dirt, water, etc., to get on the element. Keep new elements in the original package until ready for installation.

Before loosening the filter case cover nut, clean the outside of the case and base thoroughly with kerosene to prevent dirt or foreign material from entering the base when the case cover is removed.

Replacing the Auxiliary or Final Fuel Filter Elements

1. Clean the outside of the case and base thoroughly with kerosene to prevent foreign materials from entering when the case cover is removed.

2. Close the fuel shut-off valve on the tee of the auxiliary filter, then open the filter vent valve and the base drain valve; allow the fuel to drain.

3. Unscrew the filter cover nut and lift the filter cover from the case.

4. Remove the old element. (The element may come out with the cover, in which case it can be separated easily from the cover.)

NOTE: Do not remove the plug in the case stud.

5. AUXILIARY FILTER ONLY: Remove the water separator screen from the bottom of the case and clean the screen thoroughly in kerosene.

6. Clean the inside of the case and base thoroughly with kerosene.

7. Inspect the filter cover gasket and replace if necessary.

8. AUXILIARY FILTER ONLY: Be sure that the water separator screen is in place at the bottom of the case with the spring up.

Illust. 45
Fuel filters disassembled.

9. Place the new filter element in the case, sliding it down over the stud. Insert the new element carefully, using a slight twisting motion to prevent damage to the seal ring in the bottom pilot.

10. Install the cover and draw it down tight with the cover nut (the cover nut turns in the cover and is held by a retaining ring).

11. Vent the fuel system as described on page 9.

Primary Pump Filter Screen

The primary pump of the injection pump has a filter screen that must be cleaned whenever the auxiliary fuel filter element is changed. Remove the nut and filter screen assembly from the primary pump filter body and wash in kerosene. Precautions should be taken that no dirt or foreign material enters the filter body upon removal or replacement of the filter screen.

Fuel Injection Pump and Governor

Do not attempt to adjust the fuel injection pump or the governor.

In case of unsatisfactory operation of the engine, due to possible problems in the fuel

(Continued on next page.)

system, check over the instructions on the preceding pages for servicing the various units of the fuel system. If the problem is not overcome consult your International Construction Equipment distributor or dealer to inspect the fuel injection pump.

Removing the Fuel Injection Pump

1. Set the compression release lever in the gasoline starting position.

2. Disconnect the coil cable at the ignition cut-out switch terminal on the manifold front cover to avoid accidentally starting the engine.

3. Disconnect the governor control rod from the injection pump control rod.

4. Close the fuel shut-off valve at the auxiliary fuel filter base. Open the drain valves in the base to drain the filters.

5. Remove the injection pump drain plug to drain the oil from the pump.

6. Keep all parts clean. Thoroughly clean the outer surfaces of the pump and all connections with kerosene before removing any fuel lines from the pump.

7. Disconnect all fuel lines leading to the injection pump and cover the openings to prevent dirt or dust from entering the pump.

8. Loosen the coupling nut on both ends of the fuel injection pipes and, as each pipe is removed, tag it for identification. Also, immediately cover the openings at the injection pump and the fuel injection nozzles to prevent dirt or dust from entering the pump and the engine.

9. Pry the rubber boot from the groove in the timing adjuster coupling "C," Illust. 46.

10. Remove the four cap screws holding the pump bracket to the crankcase and lift the injection pump and bracket from the engine.

Installing the Fuel Injection Pump

Check the injection pump timing coupling spacer for wear. If excessive wear is present, replace the spacer. Coat the entire surface of the timing coupling spacer with a thin film of chassis lubricant. Place the spacer on the injection pump drive shaft flange.

Be certain that the injection pump is rotated so that the driving lug on the timing coupling adjuster (which is drilled to accept the dowel) lines up with the dowel on the drive shaft coupling.

Lift the fuel injection pump with the mounting bracket into position. If the driving lugs on the timing coupling adjuster do not line up properly with the slots in the spacer, either rotate the pump coupling adjuster and the pump drive flange sufficiently to line them up or loosen the cap screws "A" and rotate the adjuster only to line up the driving lugs (Illust. 46). Slide the pump all the way forward and install the cap screws which secure the mounting bracket to the crankcase.

The injection pump timing coupling is made so that, if the driving lug on the adjuster and the dowel in the driving flange are engaged, the pump will be timed to the proper cylinder of the engine. Rotate the pump drive flange until the timing groove "E" lines up between the third and fourth grooves from the engine side looking at the adjuster top (Illust. 46). Hold the coupling in this location and tighten the cap screws "A."

Timing is now set at one-half notch retard (one pump degree). The center groove is the "O" timing.) For the correct timing refer to instructions under "Timing Fuel Injection."

Remove the surplus lubricant from the timing coupling spacer and pry the boot over the spacer.

Connect the governor control rod, fuel lines and injection pipes.

CAUTION: When reassembling pipe nuts on the fuel lines to the injection pump, turn each nut with a wrench until you can feel the nut solidly contact the sleeve. From that point, apply one sixth turn to one third turn with the wrench.

Install the drain plug in the injection pump. Close the drain valves in the fuel filter base and open the fuel shut-off valve on the auxiliary filter tree.

Add lubricating oil to the pump until it reaches the oil level valve. Refer to "LUBRICATION GUIDE" for correct grade of lubricant.

Connect the coil cable to the ignition cut-out switch.

Start the engine on gasoline and vent the air from the diesel fuel system. Refer to pages 7 and 8.

Convert the engine to the diesel cycle and note engine operation. If the engine operates

roughly or smokes at high idle after the engine is warmed up, check and adjust the fuel injection timing.

Timing Fuel Injection (Illust. 46)

A timing adjustment is provided on the injection pump drive between the booted coupling and the injection pump. This adjustment is to compensate for differences in fuel, manufacturing tolerances of parts, eventual timing gear and drive coupling wear and differences in replacement injection pumps. It is provided to enable the operator to maintain fuel injection at peak efficiency.

The pump drive flange "D" is marked with a V-groove at "E" for gauging the degree of adjustment. Timing coupling "C" has an adjustment indicator at "B" that consists of seven notches graduated two degrees apart. The pump is driven at one-half engine speed thus two degrees movement of the pump coupling equals four degrees on engine crankshaft. The adjustment is normally set at one to two degrees pump retard. (Looking at coupling as in Illust. 46 three to three and one-half notches from engine side of coupling.) Due to previously mentioned variations, best timing for an individual engine may vary. Best timing will normally fall between one-half notch advance and two notches retard (one degree advance and four degrees retard on pump).

NOTE: Looking at pump as in Illust. 46, move top of flange "D" toward engine to retard timing and away from engine to advance timing.

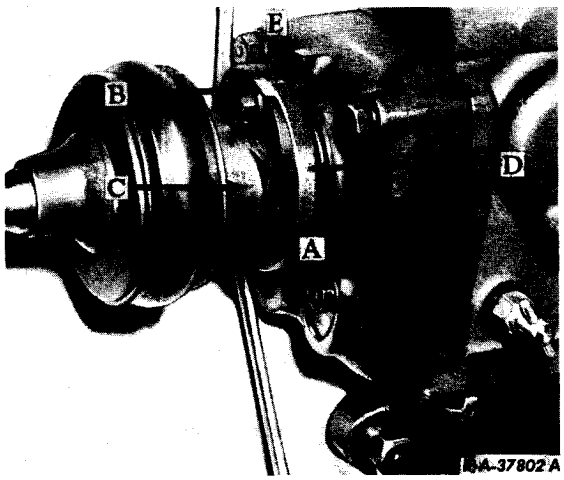
If the engine smokes at high idle, it is usually an indication of fuel waste. Loss of power under load may be caused by incorrect fuel injection timing. Smoke at high idle generally is a sign that fuel is being injected into the engine too late. When timing is too far advanced it is indicated by a very harsh sounding engine.

To find best injection timing proceed as follows:

1. Warm up engine to operating temperature and observe performance, then stop the engine and crank so that the markings are visible.

2. Loosen cap screws "A" and turn pump drive flange "D" to move the V-groove one notch at a time either way from its present setting at "B," depending upon whether advance or retard is required. Tighten cap screws "A" and run engine to observe effect of timing change.

3. Repeat adjustment as required until best timing, as indicated by minimum harshness and a clear exhaust, is found.



Illust. 46
Injection pump coupling showing timing.

EXTENDED SHAFT AND OUTBOARD BEARING

This equipment is used with a Rockford clutch. For maintenance and adjustment of this clutch refer to "POWER TAKE-OFF CLUTCH" which follows.

The outboard bearing located in the outboard bearing bracket must be lubricated as specified in "PERIODIC INSPECTIONS" on pages 9 and 10.

POWER TAKE-OFF CLUTCH

The function of the clutch is to transmit the power of the engine to the attached machinery without undue strain on the machincal parts of either the machinery or the engine. The clutch permits the engine power to be connected or disconnected at the will of the operator.

The clutch is engaged by pushing forward the clutch lever located on the side of the housing. This places the internal levers in an over-center position, thereby exerting pressure on the frictional facings.

Maintenance

This over-center clutch is designed to require a minimum of attention. It is important, however, to follow the lubrication instructions given in the "LUBRICATION GUIDE."

Too much emphasis cannot be put on the fact that overlubrication is as detrimental to the clutch as underlubrication. Best results can be obtained by close adherence to the instructions for lubrication given in the "LUBRICATION GUIDE."

(Continued on next page.)

Adjustment

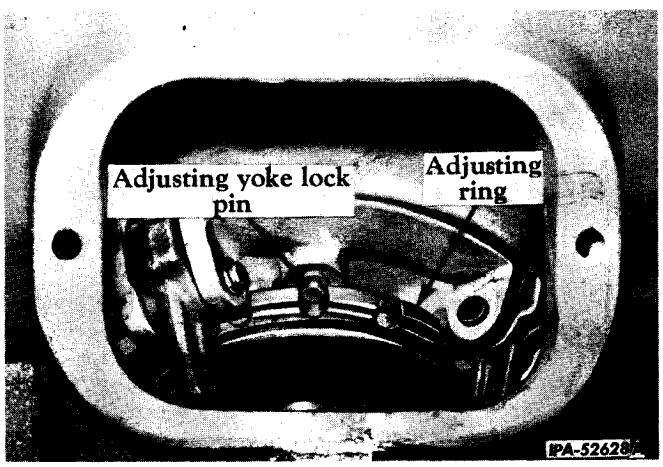
Adjustment is required when the definite over-center engagement is no longer felt and a diminished effort is required to push the clutch lever forward.

Rapid wear of the clutch facings will result if slippage takes place while the engine is under heavy load.

Adjustment must be made as follows:

1. Remove the clutch inspection cover.

2. TWIN-DISC CLUTCH ONLY: Disengage the clutch and slowly crank the engine until the adjusting yoke lock pin appears. Depress the pin and turn adjusting ring right (clockwise) until the operating lever requires a distinct pressure to engage (Illust. 47). A new clutch generally requires several adjustments until friction surfaces are worn in.

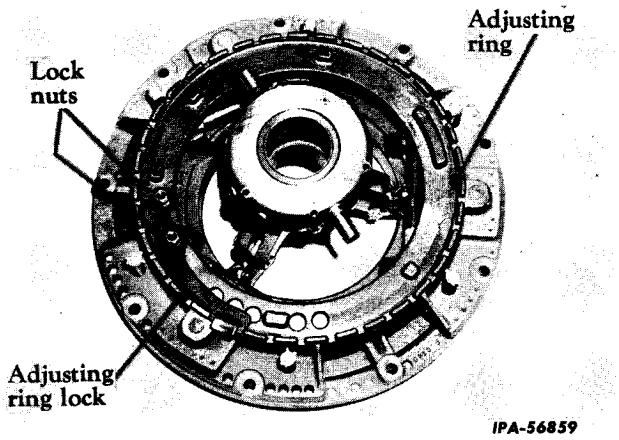


Illust. 47
Adjusting the Twin-Disc clutch.

ROCKFORD CLUTCH ONLY: Disengage the clutch and slowly crank the engine until the adjusting ring lock appears. Loosen the nuts on the lock and disengage the lock from the notches in the back plate (Illust. 48.). Turn the adjusting ring right (clockwise) until the operating lever requires a distinct pressure to engage. A new clutch generally requires several adjustments until the friction surfaces are worn in.

3. TWIN-DISC CLUTCH ONLY: Secure the adjusting yoke lock pin.

ROCKFORD CLUTCH ONLY: Engage the adjusting ring lock on the back plate and tighten the adjusting ring lock nuts.



Illust. 48
Adjusting the Rockford clutch.

4. Start the engine and check that the driven member is free, with the clutch disengaged.

5. Install the clutch inspection cover.

STORING THE POWER UNIT

When the power unit is not to be used for a period of time it must be stored in a dry and protected place. Leaving equipment outdoors, exposed to the elements, will result in materially shortening its life.

The following procedure must be followed when the power unit is placed in storage for 30 days or more.

We recommend that caution be taken in starting an engine that has been in storage. Refer to starting procedure on page 37.

1. Thoroughly wash or clean the power unit.

2. Run the engine long enough to warm the oil in the crankcase. Change the lubricating oil filter elements as described on pages 18 and 19. Follow the entire procedure including the draining and filling of the crankcase.

3. Completely lubricate the rest of the power unit as outlined in the "LUBRICATION GUIDE" on pages 12 and 13.

4. If there is a shut-off valve between the fuel supply tank and fuel transfer pump strainer, shut off the valve. Disconnect the fuel supply line at the transfer pump strainer. Attach a suitable length of tubing at the fuel transfer pump strainer inlet and place the other end in a can of high quality approved

flushing oil. Use enough flushing oil to run the engine 10 to 15 minutes.

NOTE: In emergencies, a flushing oil mixture of one-half kerosene and one-half good grade of light lubricating oil may be used.

5. Open the shut-off valve on the fuel line at the base of the auxiliary fuel filter. Drain the air trap and fuel filters by opening the two drains on each side of the filter base. Empty the water trap bowl and install. Open the filter air vent valves on top of both filters to assure complete draining. Close the drain valves on filter base.

6. Fill the air trap with approved flushing oil, when the fuel flows from the auxiliary filter air vent valve, close vent valve. Start the engine and operate on gasoline with the engine speed control slightly advanced. When fuel flows from the final fuel filter air vent valve, close vent valve. Open each injection nozzle air vent valve individually until oil appears, then close each vent valve.

7. Continue to operate the engine until it stops from lack of fuel.

NOTE: Engines must not be operated after the flushing operation.

8. Drain the fuel from the gasoline tank and carburetor and clean out the gasoline strainer and sediment bowl.

CAUTION: Gum will eventually form in the gasoline tank and lines if the unit is not used. Gum in passages affects engine starting. It can be dissolved with a mixture of one part alcohol and one part benzol or with acetone.

9. Drain the cooling system and install a "RADIATOR DRAINED" tag.

10. To prevent dirt or moisture from entering the engine, plug up the ends of the exhaust pipes and breather pipe. Remove the air cleaner cap and cover the pipe.

11. Remove the batteries and store them in a cool dry place above freezing (+32°F). The batteries must be fully charged at time of storage. Check the batteries at least once a month for water level and specific gravity. Batteries must never be allowed to run down below three quarter full charge while in storage.

STARTING ENGINES THAT HAVE BEEN IN STORAGE

1. Install fully charged batteries. Be sure they are full to the specified level with water.

2. Remove the coverings from the exhaust pipes, crankcase breather pipe and air cleaner pipe. Install the air cleaner cap.

3. Be sure all cooling system drains are closed and fill the cooling system. Check for leaks and loose connections. Remove "RADIATOR DRAINED" tag.

4. Be sure that the drain plug in the bottom of the carburetor is closed and that the fuel line from the carburetor to the gasoline strainer is properly connected. Open the shut-off valve on the gasoline strainer and fill the gasoline tank.

5. Check the engine crankcase and injection pump oil levels.

6. Close the drains in the diesel fuel system and vent the system of air as described on pages 7 and 8.

CAUTION: Do not accelerate the engine rapidly or operate at high speed immediately after starting.

Keep the doors wide open while operating the power unit.

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Accidents can be prevented with your help

No accident-prevention program can be successful without the wholehearted co-operation of the person who is directly responsible for the operation of equipment.

To read accident reports from all over the country is to be convinced that a large number of accidents can be prevented only by the operator anticipating the result before the accident is caused and doing something about it. No power-driven equipment, whether it be transportation or processing, whether it be on the highway, in the harvest field or in the industrial plant, can be safer than the man who is at the controls. If accidents are to be prevented—and they can be prevented—it will be done by the operators who accept a full measure of their responsibility.

It is true that the designer, the manufacturer, the safety engineer can help; and they will help, but their combined efforts can be wiped out by a single careless act of the operator.

It is said that *"the best kind of a safety device is a careful operator."* We ask you to be that kind of an operator.

As a member of the National Safety Council, we are privileged to use the Green Cross for Safety to designate not only our interest in Safety, but to point out more clearly the safety precautions in this manual.

NATIONAL SAFETY COUNCIL