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GEJ-3847

DIESEL ENGINE
MECHANICAL SERVICE MANUAL

DIESEL-ELECTRIC
LOCOMOTIVE

These instructions do not purport to cover all details or variations in equip- . P, -t nor to provide for every possiblecontingency to be met in connection M..,. installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

TRANSPORTATION SYSTEMS DIVISION

GENERAL ELECTRIC

ERIE, PA. 16501

3·67 (2500)

INTRODUCTION

This manual is intended to aid the maintainer in getting acquainted with the locomotive in general and with the various aspects of the locomotive as relatedtoperforming running maintenance. Running maintenance constitutes such work as terminal servicing, minor repair and adjustments, interchanging small components or any other work operation which will restore the locomotive to service within an eight hour period.

The manual includes service informationpertainingto major equipments and systems as applied to a production model locomotive. Therefore instructions on specific customer modifications will not be included here-in but will be covered in the backshop manual which includes all instructions dealing with heavy and running maintenance work.

Main subjects within this instruction are arranged consecutively under separate section numbers. (Example: Section 4 Lubricating Oil System)

Illustrations identified by figure numbers, within each section show the section number and figure number (Example: Fig. 4-1).

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LOCOMOTIVE DATA

MAJOR EQUIPMENT

Diesel Engine	7FDL16
Main Generator	**GTA-9**
Traction Motors	GE-752
Auxiliary Generator	GY-27
Exciter	GY-27
Air Compressor (Gardner-Denver)	WBO
Air Compressor (WABCO)	3CWDL
Fan Gear Unit	GA-57
Air Brake System	26L
Wheel Diameter (New)	40 inch
Permissible Variations in Size	
(40 Inch Diameter Wheel)	
Wheels on Same Axle	None
Wheels on a Locomotive Unit	25 Tapes

SYSTEM CAPACITIES

Fuel Oil (Large Tank)	**4000** gal
Fuel Oil (Small Tank) (Optional)	1700 gal
Lubricating Oil	380 gal
Cooling Water	300 gal
Engine Governor	2 quarts
Fan Gear Unit	12 quarts
Compressor (Small Crankcase)	10 quarts
Compressor (Large Crankcase)	12 gal
Sand	48 cu ft

BRAKE SYSTEM ADJUSTMENTS

Brake Cylinder Piston Travel (Minimum)	2 1/2 in.
Brake Cylinder Piston Travel (Maximum)	6 in.
Compressor Governor Switch (Cut In)	130 psi
Compressor Governor Switch (Cut Out)	140 psi
Compressor Intercooler Safety Valve	60 psi
Main Reservoir Safety Valve	150 psi
Regulating Valve	Variable
Independent Brake Valve, Full Service	45 psi
Control Air Reducing Valve	70 psi

LOCOMOTIVE DATA

Power Cutout Switch (PCS) (Open)	60 ± 2 psi
Power Cutout Switch (PCS) (Close)	45 ± 1 psi

OPERATING SETTINGS

Diesel Engine, Idle	400 _+ 15 rpm
Diesel Engine, Full Speed	1025 ± 4 rpm
Overspeed Shutdown Trips	1130 10 rpm
Diesel Engine Operating Temperature	160-180 F
Hot Engine Alarm (ETS) (Close)	200 ± 2 F
Hot Engine Alarm (ETS) (Open)	193 ± 2 F
Engine Lubricating Oil Header	
Pressure (Idle)	Approx 20 psi
Pressure (Full Throttle)	Approx 75 psi
Oil Pressure Shutdown (OPS)	
Engine at Idle (40 Second Delay)	7-10 psi
Engine Full Speed	**45-50 psi**
Low Water Shutdown	
Trip Pressure (Second Notch)	0-3 psi
Trip Pressure (Full Speed)	14-18 psi

ENGINE SYSTEMS PRESSURE SETTINGS

Fuel Oil Pump Pressure, **Relief Valve**	**75 psi**
Fuel Header Pressure Regulating Valve	**35 psi**
Lubricating Oil Pump Pressure Relief	
Valve (Begins **to Open)**	**135 psi**

WEIGHTS (Approximate for Lifting Purposes Only)

Complete B- Locomotive (Fully Serviced)	270, 000 lb
Complete C-Locomotive (Fully Serviced)	**360,** 000 lb
One B-Truck (Complete)	43,000 lb
One C-Truck (Complete)	60,000 lb
One B-Truck Frame	6,050 lb
One C-Truck Frame	9,500 lb
One Swing Bolster	**1,475 lb**
One Spring Plank	390 lb
One Motor, Wheel and Axle Assembly	11,600 lb
Traction Motor (Less Gear Case)	7,000 lb

LOCOMOTIVE DATA

Air Compressor (Dry)	1,590 lb
One Battery Tray	300 lb
Engine Hood Assembly (Not Including	
Radiator Hood)	4,000 lb
Fan Gear Unit	860 lb
Each Radiator Fan	**340 lb**
Compressor Drive Shaft and Hubs	**280 lb**
Each Radiator Section	310 lb
Equipment Blower	1,106 lb
Engine and Generator (Complete)	**59,845 lb**
Main Generator with Auxiliaries	**16,695 lb**
Auxiliary Generator and Exciter	690 lb
Engine (Less Generator)	**43,150 lb**
Engine Component Parts	
Main Frame (Bare)	**11,670 lb**
Crankshaft	**3,955 lb**
Turbocharger	**1,425 lb**
Intercooler (Dry)	500 lb
Cylinder (Complete)	760 lb
Piston and Master Rod Assembly	207 lb
Piston and Articulating Rod Assembly	94 lb
Oil Pump	3 50 lb
Water Pump	248 lb
Control Governor	112 lb
Governor Drive Assembly	159 lb
Oil Pan	1, 080 lb
Free-End Cover	**1,330 lb**
End Cover (Generator End)	**89** lb
Exhaust Manifold	570 lb

LOCOMOTIVE DESCRIPTION

GENERAL

The General Electric railroad diesel-electric locomotive is especially designed and built to meet the requirements of modern high-speed freight traffic. The design provides for high horsepower per axle with a minimum of equipment and weight. With available modifications, the locomotive can be used in passenger service.

POWER PLANT

DIESEL ENGINE

The locomotive is powered by a 16-cylinder, four-stroke cycle, turbocharged, diesel engine with 9-inch by 10 1/2-inch cylinders in a 45-degree Vee arrangement. The engine has an integral head and cylinder arrangement which can be removed in a minimum of time. It is equipped with cast-iron pistons, valve-seat inserts and the Bendix fuel system. The cylinder liner is plated with porous chrome to give longer liner life.

GOVERNOR

The Woodward PG engine governor is of the self-contained, electro-hydraulic type. It automatically regulates the horsepower output at each throttle setting.

OVERSPEED PROTECTION

The engine is automatically shut down if the speed exceeds maximum rated rpm by 10 percent.

COOLING SYSTEM

A gear-driven centrifugal pump, integral with the diesel engine, circulates cooling water through the engine, turbocharger, air intercoolers, self-draining radiator, lubricating-oil cooler, air compressor, and cab heater. An expansion tank is equipped with sight gages to indicate water level. The system is pressurized. Abnormally low water pressure automatically shuts down the engine.

ENGINE TEMPERATURE CONTROL

A flow control valve, thermostatically operated, automatically maintains temperature by regulating the flow of cooling water through the radiator sections.

FUEL SYSTEM

A motor-driven pump transfers fuel from the tank, through a strainer and filters, to the injection pumps.

Each cylinder is equipped with high-pressure fuel injection pump and injector.

LUBRICATING SYSTEM

A full-pressure system is supplied by a gear-type pump integral with the diesel engine.

A lubricating-oil reservoir is located in the engine sub-base. Lubricating oil filters, strainer, and water-cooled oil cooler are provided. Abnormally low lubricating oil pressure automatically shuts down the engine.

ENGINE STARTING

The diesel engine is cranked by two, 32-volt, d-c motors from storage battery power.

ELECTRIC TRANSMISSION

TRACTION GENERATOR

One General Electric, GTA-9,traction generator is mounted directly on the engine. It is an alternating-current, single anti-friction bearing, separately excited machine. The output is rectified by a full-wave rectifier.

TRACTION MOTORS

General Electric, GE-752, traction motors are furnished. The traction motor is direct-current, series wound, and is separately ventilated by the cleaned-air system. The armature is mounted in anti-friction bearings.

Motors drive through single-reduction spur gearing. They are supported by, the axles to which they are geared, and by resilient nose suspensions on truck transoms.

CONTROL

The locomotive is equipped with General Electric, railway-type, single end-single unit control, and basic equipment. Control devices are grouped in a pressurized steel compartment, fitted with access doors. The reverser and line contactors are electro-pneumatically operated. Other contactors are magnetically operated. Circuit-breaker type switches are used in control circuits where overcurrent protection is required. Transition is automatic.

EXCITER

One General Electric, Type GY-27, exciter is provided. It is gear-driven from the traction generator, and provides controlled excitation of the traction generator field.

BATTERY-CHARGING GENERATOR

One General Electric, Type GY-27, battery-charging generator is provided.

It is gear-driven from the traction generator, and furnishes power at regulated potential for battery charging, lighting, and control.

STORAGE BATTERY

A 32-cell, lead-acid type storage battery is furnished for starting the engine and to furnish power for lights and other auxiliaries when the engine is shut down.

WHEEL-SLIP CORRECTION

Wheel slip is automatically detected by comparison of output signals from an alternator mounted on each axle. Slip is corrected by automatic application of sand and reduction of power.

GROUND RELAY PROTECTION

If a ground occurs, the engine speed returns to idle, power is removed, the alarm bell rings, and visual indication is given to the operator.

OPERATING CONTROLS

Controls and instruments for operatingthe locomotive are grouped at the operator's station and at auxiliary panels in the operator's cab.

Operating Controls:

Controller with throttle reverser, and selector levers.
Engine start push buttons. Engine stop pushbutton. Brake valves.
Sander valve. Bell ringer valve. Air horn valve.
Window wiper.
Circuit breakers and switches.
Emergency multiple-unit engine stop button.
Emergency fuel trip.
Ground relay reset push button.

Instruments:

Air brake gages. Load meter.

Warning Indicators:

Low engine water pressure — alarm bell and warning light.
Low engine lubricating oil pressure — alarm bell and warning light.
High engine water temperature — alarm bell and warning light.
Wheel slip — buzzer and warning light.
Ground relay — red indicator.
Engine shutdown — alarm bell.
No battery charge — alarm bell and warning light.
Crankcase overpressure switch — alarm bell and warning light.

Some accessories and modifications may be provided to suit customer needs.

LOCOMOTIVE BRAKES

AIR BRAKES

Schedule 26L with F control valve air equipment is furnished.

Locomotive brakes may be operated either independently or with train brakes. Connections for furnishing compressed air to the train brakes are provided at each end of the locomotive.

COMPRESSOR

One, three-cylinder, two-stage, water-cooled, engine-driven air compressor furnishes air for the locomotive and train braking systems.

LOCOMOTIVE DESCRIPTION

Compressed air displacement:

Idle engine speed............................ 112 cfm
Full engine speed........................... **282 cfm**

RESERVOIRS

Reservoir capacity of 56,000 cu inch is furnished for storing and cooling air for the brake system.

BRAKE EQUIPMENT

Brake cylinders are mounted on the truck frames, and operate fully equalized brake rigging which applies two brake shoes to each wheel.

Brake rigging is furnished with hardened steel bushings, and adjustment is provided to compensate for wheel and shoe wear.

HANDBRAKE

A wheel-operated hand brake, located on the outside of the short hood, is provided for holding the locomotive at standstill.

RUNNING GEAR

The running gear of the locomotive consists of two, four-wheel, two-axle, side-equalized, swing-motion, swivel trucks; or two, three-axle, lateral-motion, single-center plate, swivel trucks.

On the four-wheel truck frame, the bolster, and the spring plank are of cast steel. The frame is supported by two equalizers on each side, with coil springs between the equalizer and the frame. Elliptic springs are applied between the bolster and spring plank. The spring plank is supported by forged-steel swing links pinned to the truck frame.

LOCOMOTIVE DESCRIPTION

On the six-wheel truck, the frame is of cast steel. The center load is distributed by the cast-steel "floating bolster" to four rubber mounts which rest on the truck frame and provide controlled lateral motion. The truck frame is supported by alloy—steel coil springs over the journal boxes. Friction-type snubbers damp vertical oscillation.

WHEELS

Solid, multiple-wear, rim-treated, rolled steel, of 40-inch diameter. The wheels have standard AAR tread and flange contour.

AXLES

Axles are of forged open-hearth steel, conforming to AAR material specifications.

JOURNAL BOX

Journals are equipped with sealed, grease-lubricated, roller bearings. Pedestal openings of the truck frame are lined with renewable, steel, wear-resistant plates.

CENTER BEARINGS

Large center bearings are equipped with hardened steel liners, arranged for lubrication and protected by dust guards.

SIDE BEARINGS

Side bearings, with renewable wear-resistant steel plates, are provided.

SAFETY HOOKS

Body and truck safety hooks are provided to prevent slewing in case of derailment and to permit the trucks to be lifted with the superstructure.

LOCOMOTIVE DESCRIPTION

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SUPERSTRUCTURE

The welded-steel superstructure consists of a short front hood, an operator's cab, an engine hood, and a radiator compartment. The engine hood is bolted to the underframe, and is removable.

FRONT HOOD

The front (short) hood contains a top-serviced sandbox. A door in the front bulkhead of the operating cab provides access to the inside of the hood.

OPERATING CAB

The sides and roof of the operating cab are insulated and steel lined. The floor, raised above the underframe, is insulated and covered with laminated hardboard.

The cab has safety glass windows in the front, rear, and each side, providing visibility in all directions. Two-pane center windows on each side of the cab have a sliding sash equipped with latches. All other windows are fixed.

Doors, in diagonally opposite corners of the operating cab, provide access to walkways along the hoods. The doors have windows, weather stripping, and provision for locking.

WALKWAYS

Platform walkways, with handrails and non-skid treads, are provided at each end of the locomotive and along the hoods.

ENGINE HOOD

The engine hood encloses the diesel engine, the traction generator, and the equipment blower.

LOCOMOTIVE DESCRIPTION

Full-height side access doors extend the length of the engine and generator on both sides of the hood. Doors in the roof provide access to engine cylinders. Detachable roof sections permit removal of equipment.

RADIATOR COMPARTMENT

The radiator compartment contains the radiators, fan and gearbox, air compressor, and engine air cleaners. The radiators are roof mounted. A reinforced screen over the air outlet opening is removable to permit removal of the radiators and the fan and gearbox. Dynamic braking grids, when provided, are mounted along each side of the radiator compartment. An end section holds a sandbox, serviced from the roof. Rear headlights, classification lights, and number boxes are mounted on this section.

EQUIPMENT COMPARTMENTS

Main propulsion control equipment is located on the left side of the locomotive, beneath the operating cab. This compartment, maintained under positive air pressure to keep out dirt and water, contains contactors, reverser, braking switch, resistors, and auxiliary electrical devices.

All air-brake devices and air-operated equipment, battery trays, and air filter assemblies for the engine are located in easily accessible compartments along the sides of the locomotive.

VENTILATION

Mechanically filtered air is provided through self-cleaning air cleaners located in the underframe. Clean air is delivered under pressure for equipment cooling, pressurization and cab ventilation. Engine air is cleaned by self-cleaning air cleaners and oil bath air filters.

LOCOMOTIVE DESCRIPTION

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UNDERFRAME

The underframe is made of rolled-steel sections and plate.

Hoods, cab, equipment, and tanks are supported by the main frame members. Space between these members is enclosed with plate, top and bottom, to form an air duct which distributes clean air throughout the locomotive.

WEARPLATES

Renewable, wear-resistant, hardened-steel plates are applied to the center-bearing, side-bearing pads, and draft gear housing.

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COUPLERS

AAR, Type E, top-operated couplers with rubber-cushioned draft gear are provided at each end of the locomotive.

PILOTS AND SIDE STEPS

A pilot with footboards is provided at each end of the locomotive. Side steps provide access to the platform.

LIFTING AND JACKING

Four jacking pads, in combination with lugs for cable slings, are integrally cast in the side bolsters.

FUEL TANKS

A heavy-gage, welded-steel fuel tank is bolted to the underframe between the trucks. Filler connections and fuel level gages are furnished on each side of the locomotive. Emergency fuel shutoffs, clean-out plugs, and water drains are provided.

DIESEL ENGINE
DESCRIPTION & SPECIFICATIONS

COMPONENT LOCATION TERMS

The following terms will be used throughout this book, in locating various components on the engine. (See Fig. 3-1.) Their designation or explanation is as follows:

FREE END — The end of the engine where the turbocharger and intercoolers are mounted.

GENERATOR END — The end of the engine where the generator is mounted.

RIGHT AND LEFT SIDE — The right or left side of the engine is determined by viewingthe engine while facing the generator end.

CYLINDER LOCATION — The cylinders are numbered from the FREE END to the GENERATOR END. (Number 1 Right and 1 Left cylinders are nearest the turbocharger. Number 8 Right and 8 Left cylinders are nearest the generator.)

CRANKSHAFT ROTATION — During engine operation, the crankshaft rotates clockwise when viewed from the FREE END, or counterclockwise when viewed from the GENERATOR END.

ENGINE SPECIFICATIONS

Model	7FDL16
Number of Cylinders	16
Stroke Cycle	4
Cylinder Arrangement	45-Degree V
Bore	9 in.
Stroke	10 1/2 in.
Compression Ratio	12.7-1
Idle Speed	400 rpm
Maximum Governed Speed	**1025 rpm**

Firing Order. . . . 1R - 1L - 3R - 3L - 7R - 7L - 4R - 4L
8R -8L-6R-6L-2R-2L-5R-5L
Turbocharger..Single
Engine Dimensions
Height (Over-all Including Stack).............8 ft. 10-3/4 in.
Length (Over-all Including Generator) . 21 ft. 8-7/16 in.
Width (Over-all).......................................5 ft. 8-1/4 in.
Weight (Including Generator) ....57,000 lb

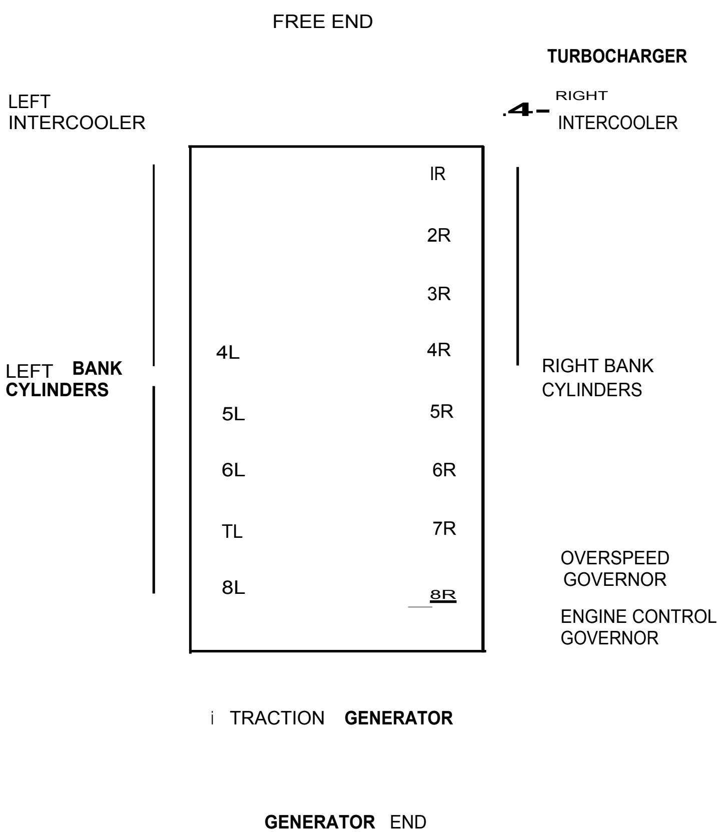

Fig. 3-1. Schematic overhead view of engine

ENGINE DESCRIPTION

General Electric had developed the FDL16 engine for use in diesel-electric railroad locomotives. Its design and rating is based on extensive laboratory tests backed up by thousands of hours of field experience.

A cross-section view of the engine is shown in Fig. 3-2. External views of the engine are shown in Fig. 3-3 and Fig. 3-4.

The following brief description merely highlights the principal features of the engine. Each component is more fully described in other sections of the book.

MAIN FRAME

The engine main frame is a single-piece casting of special ductile cast iron reinforced by ribs and gussets. Further strength and rigidity are added to the frame by bolting the main bearing caps horizontally as well as vertically. Four machined surfaces are used for mounting the main frame on the locomotive platform. Corrosion problems created by coolants common in other types of engines are completely eliminated. The cooling water does not contact any part of the frame. The crankcase inspection covers are light-weight with a quick-acting single handle release.

CRANKSHAFT

The crankshaft is forged of high-quality steel, and hardened for long life. The journal surfaces are precision ground, and all bearing surfaces are force fed with lubricating oil. A removable, split drive gear, mounted on the generator end of the shaft, drives the camshafts, and through gears, the control and overspeed governor. A pump drive gear, mounted on the free end of the crankshaft, is torsionally isolated from the crankshaft and, through an idler gear, drives the lube oil pump and water pump.

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The traction generator armature is directly bolted to the crankshaft flange.

BEARINGS

Replaceable, precision-fit, main and connecting rod bearings are used. They have steel backs and are lined with a copper-lead alloy. The crankshaft thrust bearings are located in No. 8 main bearing. The camshafts rotate in replaceable, split-sleeve type, aluminum bearings.

VIBRATION DAMPERS

A sealed, viscous-type damper is mounted on the free end of the crankshaft. This unit dampens and controls crankshaft torsional vibration.

CAMSHAFT

Two sectional camshafts of high-alloy steel are used to operate the engine valves and fuel pumps. These shafts are mounted in the frame on each side of the engine, and are directly gear-driven from the crankshaft at one-half crankshaft speed. Each sectional camshaft is made up of nine, individual, precision-machined sections connected together with stud bolts and nuts.

CONNECTING ROD ASSEMBLY

Each connecting rod assembly consists of a master connecting rod and an articulated connecting rod. These rods are made of forged alloy steel. The articulated rod bolts to a pin fitted in the master connecting rod. The master connecting rod is fastened around the crankshaft by a bolted-on cap. This design provides for a maximum of bearing surface area.

PISTONS

The one-piece pistons are of a special cast iron, giving them the ductility needed for long piston life. Each

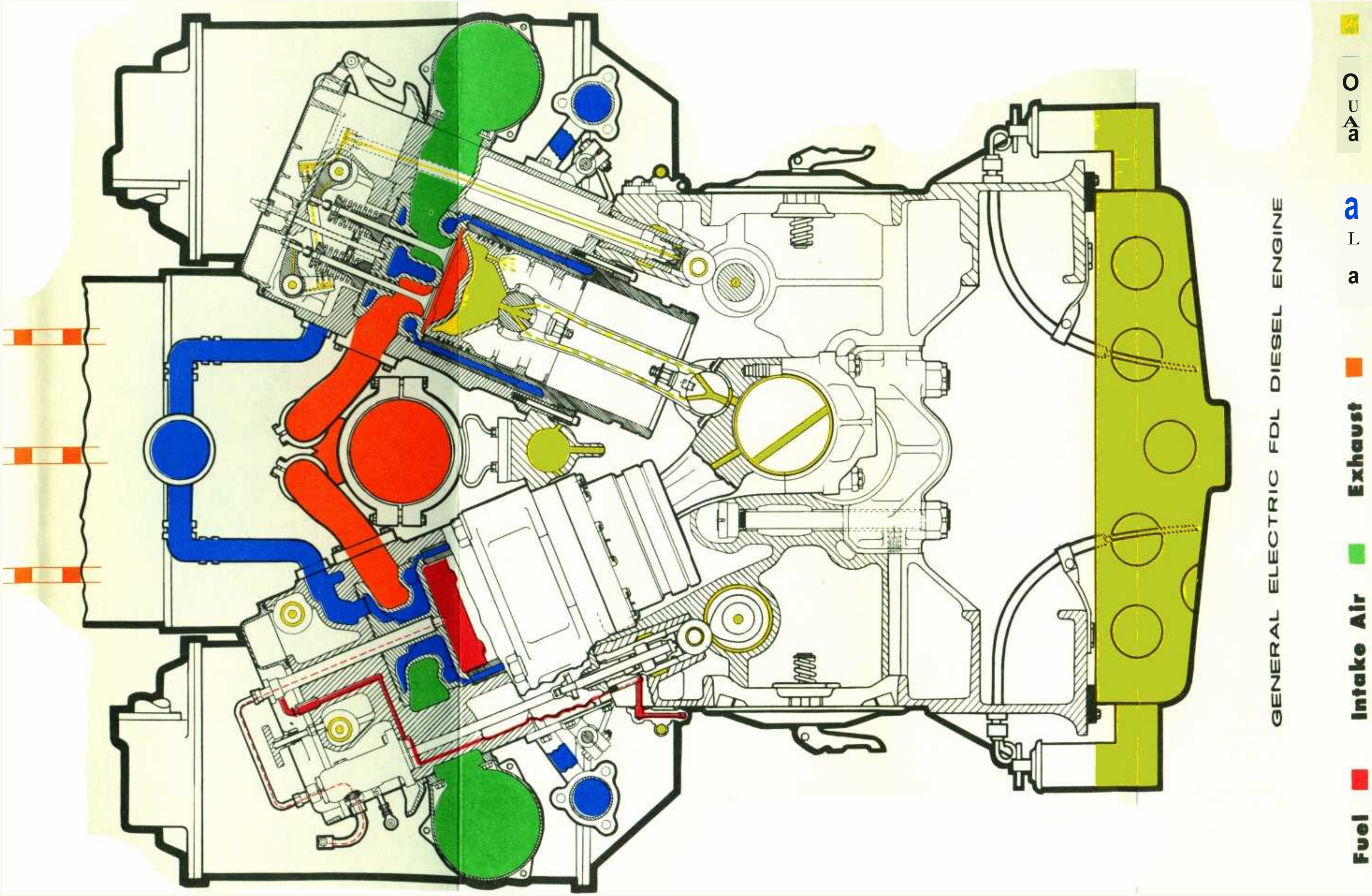

Fig. 3-2. Cross-section view of engine

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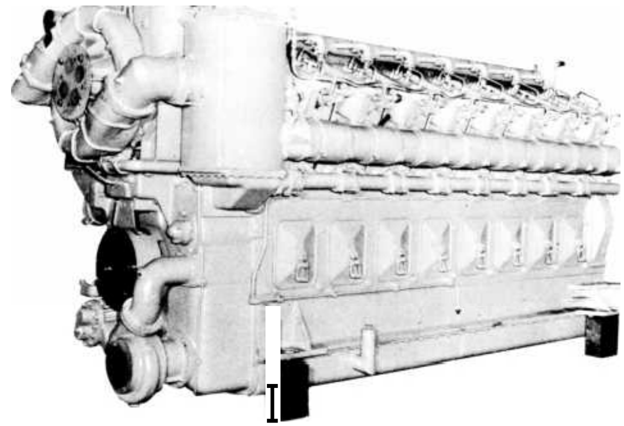

Fig. 3-3. Oblique view of engine—free end

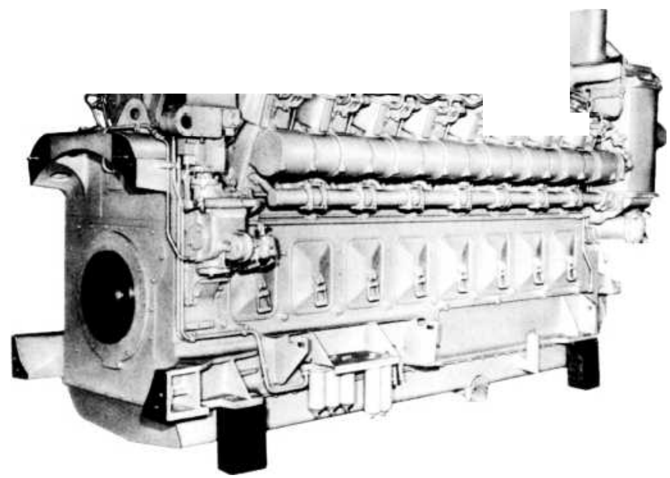

Fig. 3-4. Oblique *view* of engine—generator end

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piston is equipped with four compression rings and two oil rings. The piston rings may be inspected, or new rings installed, by removing the cylinder without disconnecting the piston. The lower piston area is tin-plated to aid rapid piston break-in and to prevent scuffing which would cause cylinder damage. The pistons are lubricated and cooled by oil. Oil is forced through holes drilled in the connecting and articulated rods,to the piston pins, and the cavity under the piston crown.

CYLINDERS

Cylinder jacket castings are of a special ductile cast iron, with the removable cast-steel cylinder head bolted in place in the jacket. The steel intake and exhaust valve seats are an integral part of the cylinder head. The valves are arranged with the two intake valves outboard and the exhaust valves toward the center of the engine "V." This design allows for unidirectional gas flow and provides optimum engine "breathing" which results in lower exhaust temperatures and longer engine life. The fuel pump, injection nozzle, valve rocker arms, and allied valve equipment is located within the upper portion of the cylinder jacket casting. The cylinder jacket is bolted to the engine frame by bolting lugs, located at the bottom of the jacket.

CYLINDER LINERS

Renewable, water-cooled, centrifugal cast-iron cylinder liners are provided. The liner wear-surfaces are plated with chrome to give longer liner life. The upper end of the liner is seated on two gaskets. The liners are installed in the cylinder jackets with an interference fit, and are secured in place with a bolted clamping ring.

FUEL INJECTION PUMP

An impulse- or "jerk"-type fuel injection pump is mounted in the top of each cylinder head, and operates through a pushrod from the camshaft. An adjustable

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tappet, located below the pump pushrod, provides adjustment for pump timing. The pump increases fuel pressure for injection, accurately measures the quantity to be injected, and delivers the fuel at the proper time to the fuel nozzle.

FUEL NOZZLES

An injection nozzle is mounted in the center of each cylinder, and is connected to the fuel injection pump by a short high-pressure line.

Fuel is forced through tiny holes in the nozzle tip which atomize the fuel into a very fine mist in a symmetrical pattern for proper combustion. The injection nozzles are made up of several easily replaceable components.

ENGINE CONTROL GOVERNOR

The engine is equipped with a electro-hydraulic, speed-regulating governor which is equipped with a small, internally mounted, load-controlling rheostat. The governor is mounted on top of the engine main frame at the generator end, and is gear-driven from the right camshaft gear. The governor maintains desired engine speeds at all loads, by regulating fuel rack travel to the fuel pumps. The governor has its own oil supply and its own oil pump which supplies the pressure needed to regulate the governor's operation.

TURBOCHARGER

A single turbocharger, mounted on top of the main frame at the free end, is driven by the engine exhaust gases, and provides air at approximately twice atmospheric pressure to the cylinders. The turbocharger is water cooled and lubricated with oil from the engine's pressurized system.

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INTERCOOLERS

The engine is equipped with two intercoolers, which are small enclosed radiators mounted on each side of the engine. They are connected between the turbocharger and each air intake manifold. Part of the cooling system water flows through the intercoolers, and compressed air from the turbocharger blows across the radiator cores. The water absorbs heat from the air, which allows cooler air to be delivered to the cylinders.

MANIFOLDS

The air intake manifolds are mounted to the outside of each bank of cylinders. They are sectional in construction for ease in alignment and quick engine maintenance. The exhaust manifolds, mounted in the "V" of the engine, are stainless steel with gasketed flange connection to each cylinder and the turbocharger. The large exhaust pipe sections have slip joints, sealed by bellows at appropriate intervals to compensate for thermal expansion with varying engine loads.

AIR SYSTEM

Incoming engine air first passes through a dry-type, primary air cleaner. This cleaner contains a multitude of special tubes which act as miniature cyclonic dirt separators. Better than 95 percent of the air-borne dirt is removed by the cleaner and is discharged through tubing to the turbocharger exhaust stack. The cleaned air then passes through panel-type, oil-bath air filters for additional filtration before it enters the turbocharger.

COOLING SYSTEM

Cooling water is circulated through the system by an engine-mounted water pump. The pump is mounted on the free-end cover, and is gear driven from the crankshaft. Cooling water is forced through the engine, turbocharger, oil cooler, and intercoolers to carry engine heat away.

Hot water flow is controlled by a flow control valve which directs water to the roof-mounted radiators where the water is cooled by forced air from the gear-driven radiator fan.

FUEL SYSTEM

Fuel is pumped through the system by an externally mounted, electric-motor-driven fuel booster pump. The pump transfers fuel from the locomotive fueltank, through filters, to each fuel injection pump. Excess fuel returns to the tank through a pressure regulating valve. A relief valve is installed near the pump to protect the system against excessive pressure.

LUBRICATION SYSTEM

Lubricating oil is circulated through the engine by a single, gear-driven, lube pump mounted on the free-end cover. A relief valve is installed to protect the system against excessive pressure. An externally mounted, water-cooled, oil cooler is used in the system. The cooler removes heat which the oil picks up in cooling the pistons and other engine parts.

LUBRICATING OIL FILTERS

A full-flow strainer and externally mounted filters are installed in the lubricating oil system to filter out abrasives or foreign matter.

SAFETY DEVICES

The engine is equipped with an overspeed governor which shuts the engine down if the engine speed exceeds a predetermined safe value. The governor is mounted on the governor drive gearbox located at the generator end, and is gear driven from the camshaft gear. When the governor trips, it closes butterfly valves located in the air intake manifolds, shutting off air to the engine, and also signals the control governor to shut off the fuel sup-

DIESEL ENGINE DESCRIPTION & SPECIFICATIONS

ply to the cylinders. A manual reset button is provided to reset the governor after an overspeed trip. This overspeed governor is failsafe. Any failure of the overspeed mechanism will automatically shut the engine down.

Two independent safety devices, one to detect low-engine lube oil pressure, and one to detect low water pressure, are built into the speed-regulating governor. These devices provide protection from either condition throughout the entire engine speed range. Should the lube oil or water pressure drop below the established safe value, the engine is automatically shut down. Manual reset buttons are provided to reset the devices after they have been actuated. Indicating lights are provided to inform the operator which condition has caused the engine to be shut down.

An alarm bell and a red indicating light are provided to inform the operator if the engine water temperature exceeds a safe value.

CRANKING

The engine crankshaft is directly connected to the (DC) traction generator armature. When the generator is electrically energized (from batteries) through its start field, the generator acts as a motor to rotate the crankshaft to start the engine. (On those engines equipped with alternators (AC), two electric-start motors are energized by the batteries to turn the engine crankshaft; through a geared ring mounted on the alternator, to start the engine.)

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LUBRICATING OIL SYSTEM

DESCRIPTION

The engine lubricating oil system provides pressure lubrication to bearings within the engine, and carries away heat produced by friction and combustion.

The lubricating oil system consists of the following components in their order of oil flow. (See Fig. 4-7.)

1. Engine crankcase
2. Pump
3. Relief valve
4. Filter
5. Bypass valve
6. Cooler
7. Regulating valve
8. Strainer
9. Engine supply system

An oil pan is bolted to the main frame, to enclose the bottom of the crankcase and hold the oil supply. Two oil fill openings, one on each side of the crankcase, are sealed by expandable plugs. Two dip sticks, one on each side of the engine, are used to measure the crankcase oil level.

Oil from the crankcase is drawn over an inverted trap and into the suction side of the gear-type lube oil pump.

OIL FLOW INSIDE THE ENGINE

Oil discharged from the pump is piped to the lube oil filter. A relief valve protects the system against excessive pressure.

The oil flows through the filter and then to the lower end of the coil cooler. Water flowing through tubes inside the cooler removes heat from the oil.

Oil discharged from the top of the cooler is piped to the engine free-end cover andthroughthe strainer mounted in the cover.

LUBRICATING OIL SYSTEM

An oil pressure regulating valve, also mounted in the cover at the strainer inlet, controls engine oil header pressure and discharges excess oil to the crankcase.

OIL FLOW OUTSIDE THE ENGINE

The main engine supply header and branch passages within the main frame conduct oil to all main bearings and to four of the camshaft bearings (No. 1 and 9 bearing, each bank). Oil enters the crankshaft from the main bearings and flows through angularly-drilled passages in the shaft to the crank-pin bearings.

The oil passes from the crank pin to the articulation pin. It lubricates the articulation pin and passes through the drilled passage in the main and articulated rods to lubricate the piston pins. The oil then passes to the pistons. It is shaken around in the chamber under the piston crown. It cools the whole piston head and then flows out through an orifice back to the cylinder.

Oil entering the four camshaft bearings is conducted lengthwise through the drilled camshafts. Holes drilled radially into the shafts supply oil to each of the other shaft bearings.

The camshaft bearings contain annular grooves connecting to drilled passages in the engine main frame. Oil flows through these passages to the valve and fuel push rod cross-heads.

Oil also then flows upward through the valve push rods to supply lubrication to the working valve parts at the top of the cylinder. Oil return is through the valve push rod cavities to lubricate the cams and cam rollers, then to the crankcase.

The free-end cover bearing and the idler-gear bushings are lubricated through a passage from the oil header to an annular groove around the cover bearing. Another

LUBRICATING OIL SYSTEM

drilled passage connects the annular bearing groove to a drilled passage in the idler-gear shaft. The auxiliary drive gear, located on the crankshaft next to the vibration damper, is lubricated internally by oil flowing through a passage within the shaft and through the gear hub. Oil from these bearings returns by gravity to the crankcase.

The turbocharger bearings receive lubrication through an external line, flange-connected to the oil header at the free-end cover. From the turbocharger, oil is returned to the crankcase through a pipe, also flange-connected to the cover.

Lubricating oil is piped to the governor drive assembly and to the low oil pressure shut-down device, located on the engine control governor. This pipe is flange-connected to the engine oil header at the generator end. Oil from the governor drive gear case returns to the crankcase internally.

The oil supply for the overspeed governor is maintained in a small reservoir built into the governor drive gear case. The reservoir is kept filled by an oil passage in the gear case.

The camshaft gears are splash-lubricated through an orifice and pipe from the engine oil header.

The bearings and drive gears of the oil and water pumps are lubricated by running partially submerged in lube oil contained within the free-end cover reservoir.

LUBRICATING OIL PRESSURE

Oil pressure must be maintained at all times during engine operation. Insufficient or no oil pressure will cause extensive damage to bearings, pistons, cylinders, and other moving parts within the engine.

The low lube oil pressure device will stop the engine and turn on a yellow indicating light in the operator's cab if a condition of insufficient oil pressure exists.

LUBRICATING OIL SYSTEM

When the engine is operating within its normal temperature range, the oil header pressure will be approximately as noted on the DATA Sheet.

During engine starting, a time delay built into the low oil pressure shut-down device allows time for engine oil pressure to build up. If pressure fails to build up within the time allowed, the low oil pressure device will trip and prevent the engine from starting.

LUBRICATING OIL SERVICING (See Fig. 4-7)

FILLING

To service the lubricating oil system, proceed as follows:

1. Check that drain valves A, B, and C are closed.

2. Fill the crankcase, either through the crankcase cover doors or through one of the oil fill pipes, with the correct quantity of new lubricating oil. The oil must conform to the required specifications. Fill to the FULL level mark on the dip stick.

3. WITH THE ENGINE IDLING, THE OIL LEVEL MUST BE BETWEEN THE "FULL" AND "LOW" MARKS ON THE DIP STICK.

DRAINING

The lubricating oil system is drained by the use of three valves, which are identified as Valve A, Valve B, and Valve C. The following list identifies the valve, or combination of valves, which must be opened to drain the various portions of the system.

1. Valve A (the crankcase drain valve) is opened to drain the main oil supply from the engine crankcase.

LUBRICATING OIL SYSTEM

2. Valve B (the end-cover drain valve) drains the oil filter and oil cooler overboard.

3. Valve C (the filter drain back valve) drains the oil filter and oil cooler back to the crankcase.

4. With valves B and C both open, the oil filter, oil cooler, and front end drain overboard.

CHANGING OIL

1. With the engine stopped, remove the pipe cap from the drain pipe. The pipe extends below the platform over the fuel tank on the right side of the engine.

2. Arrange barrels or a drain hose system to catch the used oil.

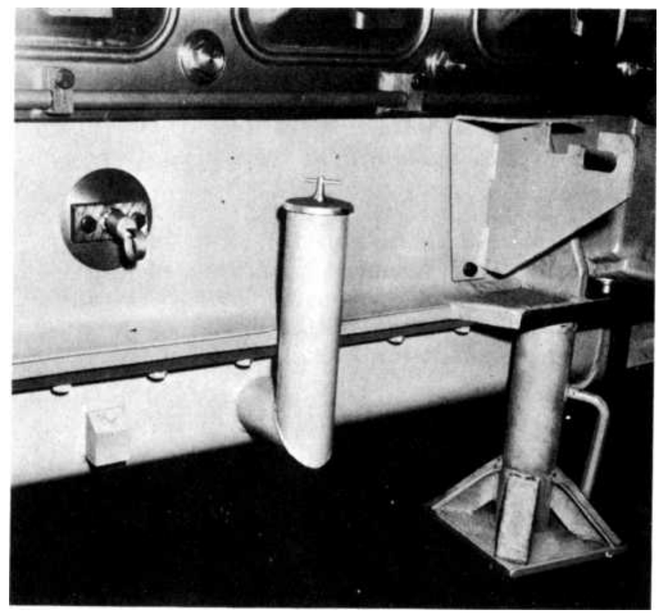


Fig. 4-1. Lube-oil fill pipe and oil-level dip stick

LUBRICATING OIL SYSTEM

3. Open the crankcase drain valve (A), end-cover drain valve (C), and filter drain valve (B).

4. Remove the vent plug on the filter cover.

5. Clean the strainer:

a. Remove the strainer cover and element.

b. Remove the element end covers. Clean the element, using a suitable cleaner or low-pressure steam. Blow the element dry with compressed air.

c. Inspect the strainer screen to be sure there are no holes or cracks which will permit foreign particles to pass through.

d. Renew all gaskets.

e. Reassemble the strainer and tighten the cover nuts evenly.

CAUTION: *UNEVEN OR EXCESSIVE TIGHTENING OF THE COVER NUTS MAY CAUSE THE COVER TO BREAK.*

6. Renewing Filter Elements

To renew the filter elements, proceed as follows:

NOTE: *Remove the oil filter vent plug when draining the filter. Replace tightly when through. Filter draining may be expedited by applying air pressure (not over 50 psi) at the filter vent. Observe applicable safety precautions.*

a. Drain the filter by opening valve C and removing the filter vent plug. The oil level in the filter will drop by gravity to the level in the crankcase.

LUBRICATING OIL SYSTEM

b. Loosen the filter cover clamps and open the hinged cover after the oil has been drained from the filter tank.

c. Remove the wing nuts and the element hold-down plates.

d. Remove the used elements and place them in a suitable container to catch the drippings.

e. Clean any sludge deposits from the filter shell.

f. Install new filter elements. (See the Renewal Parts Catalog for the correct replacement part.)

NOTE: *Do not use cotton waste filters.*

7. Install the element hold-down plates and wingnuts. Tighten the nuts evenly. HAND TIGHTEN ONLY. Be sure the filter elements are all seated and clamped securely.

8. Inspect the filter cover gasket for possible damage, and replace it if necessary. Close the filter cover and tighten the clamping bolts evenly.

9. Replace and tighten the vent plug.

RELIEF AND REGULATING VALVES

Pressure and flow within the lube oil system is automatically controlled by two pressure-operated valves.

1. Pump Relief Valve
2. Engine Pressure Regulating Valve (where used)

These valves are held closed by adjustable spring pressure. When sufficient oil pressure develops, it will overcome the spring pressure, causing the valve to open and pass oil.

The function of each of the two valves within the system should be thoroughly understood before any attempt is made to change their settings. Normally, these valves do not get out of adjustment; however, they may fail to function properly due to leakage caused by dirt holding the valve off its seat, or dirt wedged around the valve stem causing erratic valve operation. When disassembling a valve for cleaning, always mark the adjustment so that it may be returned to its correct setting without removal from the system.

PUMP RELIEF VALVE

The pump relief valve, located near the outlet of the lube oil pump, protects the system against excessive oil pressure which may develop should the system become restricted or the filters become dirty. If the pump discharge pressure exceeds the valve operating pressure, the valve will be forced open, permitting oil to flow to the free-end cover, thus limiting pressure. The oil pump relief valve can best be set by removing it from the locomotive and adjusting it on a test stand similar to the one illustrated in Fig. 4-2. Instructions for setting the valve are as follows:

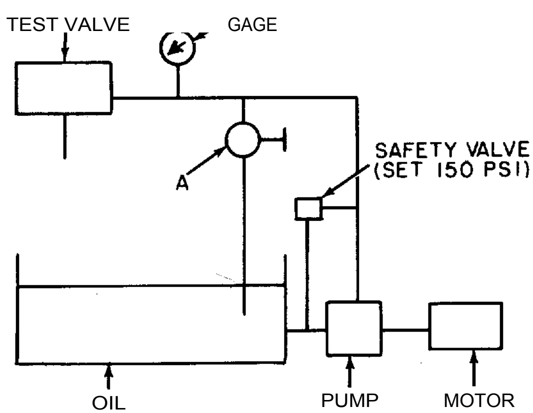


Fig. 4-2. **Test *arrangement* for adjusting valves**

O

1. Start the pump with A open.

2. Close A until the set pressure is reached.

3. Adjust valve until oil starts to flow. If the pump flow is 20 gpm or less, the valve can be set with A closed completely.

If necessary to set the valve on the locomotive, it can be done with clean filters and cold oil (100 F or less). Start the engine. At idle, set the valve at the proper pressure. (See DATA Section.)

PRESSURE REGULATING VALVE

The main lube oil header pressure regulating valve is a self-contained device located inside the left-bank camshaft access opening in the free-end cover. The valve body is sealed to the end-cover oil passages by "0" rings, and is held in place by bolts. Access to the pressure adjustment screw is obtained by removingthe cap. (See Fig. 4-3.)

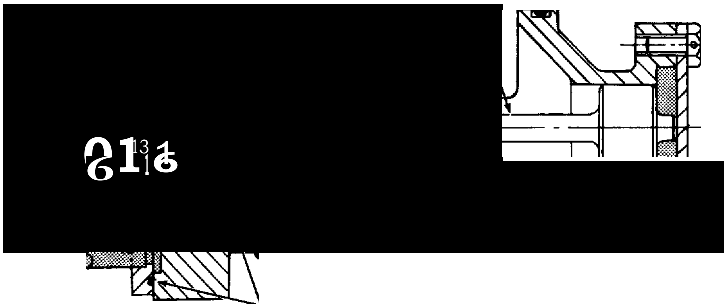
This valve maintains a relatively constant engine oil header pressure, although the volume of oilflowingthrough the system continues to change as a result of engine speed change.

Oil pressure from the engine header is applied to the inner end of the valve regulating piston, in opposition to the spring force. Therefore, as the engine oil header pressure tends to drop due to plugging of the strainer, the spring force becomes more effective, thus raising the pressure setting of the valve to compensate for the increased pressure drop across the strainer.

Adjustment

The regulating valve may be adjusted as follows:

1. Make sure the strainer element is clean. Then, warm the engine to normal operating temperature.



1 Cap
2 Adjustment screw with lock nut
3 Piston spring
4 Regulating piston
5 "O" ring
6 Valve body
7 "O" ring
8 Oil pressure connection from engine lube oil header

Fig. 4-3. Lube-oil pressure regulating valve

Fig. 4-3 (E-11969A)

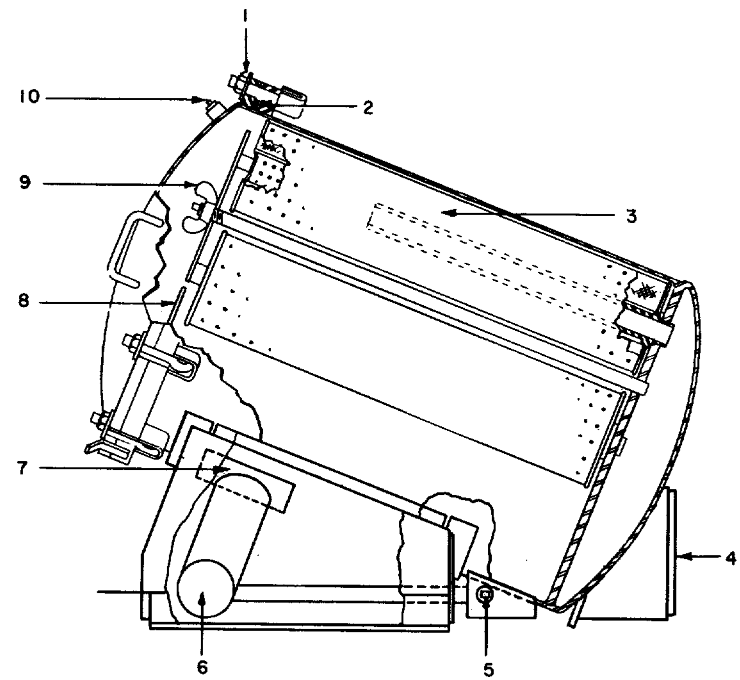
2. Remove the bolted cover from the valve. Then, operate the engine at throttle notch eight. Loosen the lock nut and turn the adjustment screw "in" or "out" to set 75 psig on the cab gage. Allow sufficient time for the pressure readings to stabilize between adjustments. Turning the adjustment screw in will raise the pressure.

3. Tighten the lock nut securely and replace the cap.

LUBE OIL FILTER
(See Fig. 4-4)

The lube oil filter is a fabricated cylindrical steel shell. It has a hinged and gasketed cover which is clamped

Fig. 4-4 (E-9993B)



1 Cover clamp bolt	6 Oil inlet from pump
2 "O" ring	7 Baffle
3 Filter element	8 Hold-down plates
4 Oil outlet to cooler	9 Hold-down-plate wing nut
5 Pipe plug	10 Vent plug

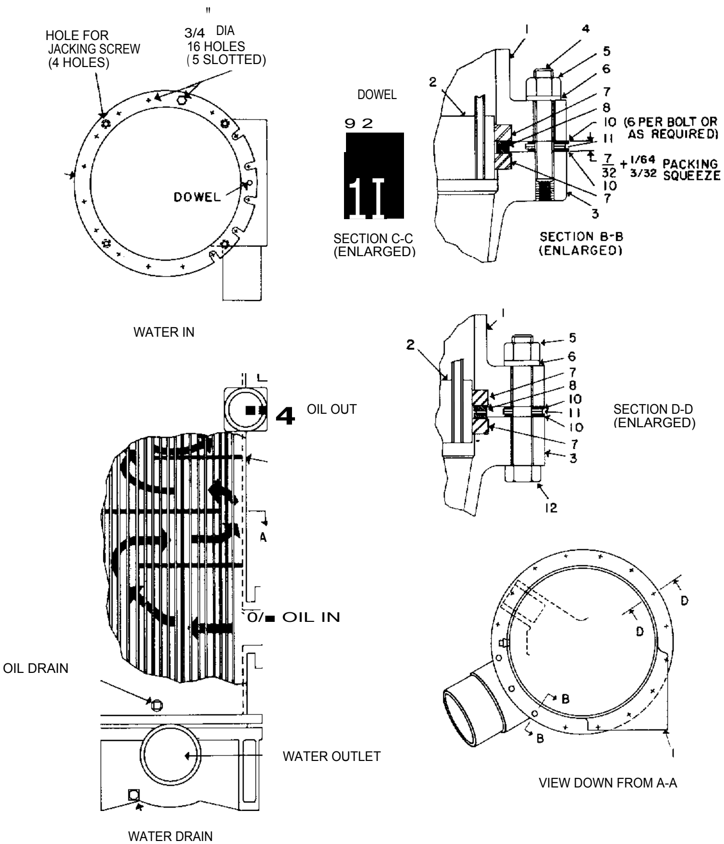
Fig. 4-4. Lube-oil filter

to hold maximum system pressure. The filter shell is supported by a fabricated steel frame which is part of the filter assembly.

Internally, the filter is arranged with two separate cavities. Oil flowing into the filter shell passes inward through the eight elements located in the upper cavity, downward through the element centers into the lower cavity, and out through the outlet pipe.

LUBE OIL COOLER

The lube oil cooler is a fabricated steel shell containing vertical water tubes. (See Fig. 4-5.)



1 Shell	5 Hex nut	9 Gasket
2 Tube bundle	6 Lockwasher	10 Shim
3 Bonnet	7 Packing ring	11 Spacer
4 Stud	8 Gland ring	12 Hex bolt

Fig. 4-5. Lube-oil cooler

The cooler is mounted in a vertical position, with its top flange bolted directly to the underside of the water storage tank. Water from the tank flows downwardthrough the tubes to the bottom header which is connected to the suction side of the water pump.

Oil from the filter enters at the bottom of the cooler and flows upward around the tubes to the oil outlet which is connected to the engine free-end cover. Internal baffles direct oil flow across the tubes, to produce maximum cooling.

The tubes are secured to their end sheets by expansion rolling. The upper tube sheet is clamped and sealed between the upper cooler flange and the water tank. The lower tube sheet is free to move vertically in the shell, to compensate for thermal expansion. A seal, consisting of two packing rings and a packing-ring spacer, located at the lower header flange, prevents leakage between oil and water sections but allows movement of the tube sheet at its lower end. Compression of the rubber packing rings is controlled by a spacer and adjusting shims at each clamping bolt. (See Fig. 4-5.)

The packing-ring spacer has several "weep" holes drilled through it. Failure of either packing ring will be indicated by oil or water leakage at the flange. This will prevent leakage of oil into the water, and vice versa. (See Fig. 4-5, enlarged view A.)

LUBE OIL STRAINER

The lube oil strainer is built into the free-end cover of the engine, as shown in Fig. 4-6. Five "0" rings seal the area between the strainer housing and the free-end cover, and are labeled A through E in Fig. 4-6. A hole, vented to atmosphere and located between "0" rings A and B, prevents oil from bypassing the strainer should the "0" rings develop leakage. Leakage past either "0" ring will be indicated by oil seepage from the hole. This

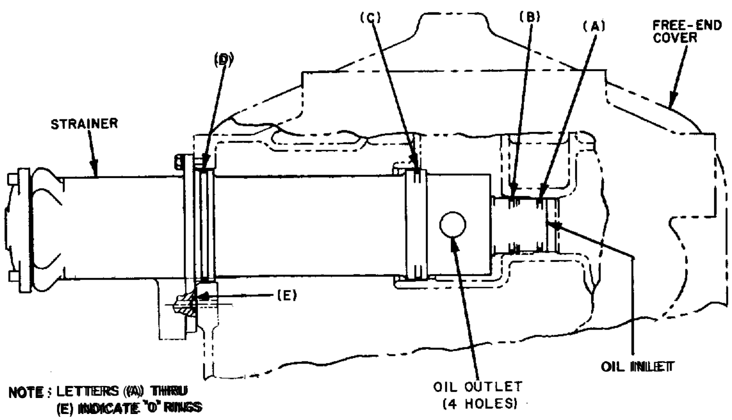


Fig. 4-6. Lube-oil *strainer* arrangement

hole is externally located in the free-end cover just to the right of the engine timing pointer.

There will be no external indication of leakage past "0" ring C, but leakage may be suspected if the lube oil pressure drops below normal and other parts of the system are in good condition.

Leakage past "0" rings D or E will be noticed by oil on the outside of the free-end cover below the strainer.

HOUSING REMOVAL

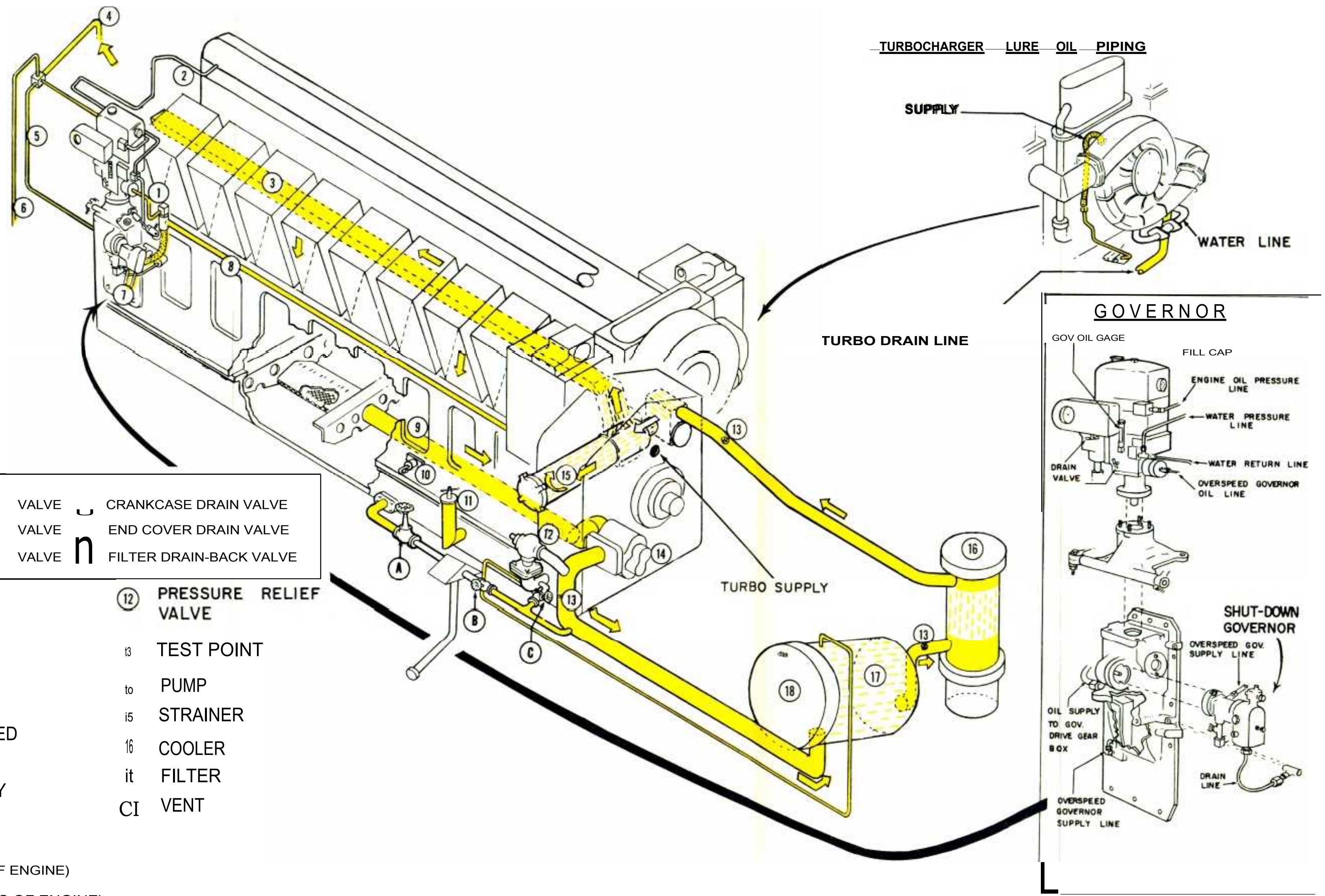
To remove the strainer housing, take out the three, 5/8-11 bolts around the strainer flange. The strainer may then be jacked out by inserting three, 5/8-11 by 2 inch bolts in the tapped jacking holes of the mounting flange and turning in on the bolts evenly until the strainer comes free.

HOUSING INSTALLATION

Before reinstalling the strainer "0" ring, grooves on the exterior should be cleaned and new "0" rings should be installed. Inspect and clean the sealing surfaces in the free-end cover. Lubricate the "0" rings. When inserting the strainer into the free-end cover, make sure that the small "0" ring (E) is in the round groove in the strainer flange back of the drain valve. If necessary, extra long 5/8-11 bolts may be used temporarily in the mounting flange to assist in pulling the strainer into its seat.

LUBRICATING OIL SYSTEM DATA

Oil Capacity .... 385 gal
Pressure Relief Valve (Set with lube oil cold) .... 150 psi
Header Pressure Regulating Valve (when used) .... 75 psi
Engine Header Pressure (Normal operating temperature at governor supply line)
Engine Idle (Approximately) .... 20 psi
Engine Full Speed .... 75 psi
Torque Values
Lube Pump Drive Gear Nut .... 375-400 lb/ft



VALVE	␣	CRANKCASE DRAIN VALVE
VALVE		END COVER DRAIN VALVE
VALVE	n	FILTER DRAIN-BACK VALVE

❑ OVERSPEED GOVERNOR OIL PRESSURE

• WATER LINE

• CAST⁻ IN HEADER

® FROM MAIN OIL HEADER

• OIL SUPPLY TO **GOVERNOR DRIVE GEAR BOX**

© **CAB GAGE LINE**

O7 DRAIN LINE FROM OVERSPEED GOVERNOR

Oe SUPPLY LINE TO BUTTERFLY ACTUATOR

• PUMP SUCTION LINE

10 OIL DIP STICK (BOTH SIDES OF ENGINE)

11 FILL OPENINGS (BOTH SIDES OF ENGINE)

(12) PRESSURE RELIEF VALVE

t3 TEST POINT

to PUMP

i5 STRAINER

16 COOLER

it FILTER

CI VENT

Fig. 4-7. Lubricating-oil system

FUEL OIL SYSTEM

DESCRIPTION

The engine fuel supply is contained in a fuel tank located below the locomotive platform. Fuel is drawn from the tank by the electric-driven fuel-booster pump, and circulated through the system. (See Fig. 5-9.)

The fuel system consists of the following components, listed according to fuel flow from the fueltank and through the system:

1. Fuel tank
2. Fuel heater (optional)
3. Primary filter
4. Fuel booster pump
5. **Relief valve**
6. Secondary filter
7. Engine fuel header
8. Injection equipment
9. Regulating valve
10. Fuel drain headers
11. Single-element fuel strainer

The suction side of the system isbetweenthe tank and the booster pump. Fuel is drawn through afuel heater (optional) and through a single-element fuel strainer before reaching the pump.

The pressure side of the system is between the booster pump and the pressure regulating valve which discharges excess fuel back to the tank. Fuel discharged by the booster pump flows to a large, single-element, primary fuel filter. A relief valve is connectedtothe pump discharge, and protects the booster pump from overloads caused by flow restrictions in the pressure side of the system.

The three-element, secondary fuel filter serves to more completely filter foreign particles from the fuel. Fuel is conducted from the secondary filter, through a pipe, to the engine fuel header.

Individual flexible hoses, connected between the injection pump inlet fittings, make up the engine fuel header. The fuel header first supplies fuel to the injection pumps on the left bank, then crosses over near the turbocharger and supplies the injection pumps on the right bank.

Excess fuel returns to the tank through a regulating valve. The regulating valve is adjusted to maintain pressure in the engine fuel header.

Two fuel drain headers, one on each side of the engine frame, collect fuel leaking back from the injectors and high-pressure pumps, and direct it back to the fuel tank.

FUEL TANK

The locomotive is equipped with a single fuel supply tank, centrally located below the platform. The tank is equipped with two fill openings, one on each side of the tank. Two fuel-level sight gages, one near each fill opening, are standard equipment on the tank. Fuel-level dial gages may be applied to the tank as optional equipment. One sump, located lengthwise at the bottom of the tank, is equipped at both ends with a condensate drain valve and a larger drain opening which contains a plug. Two vent pipes vent the tank to atmosphere.

ELECTRIC EMERGENCY FUEL CUT-OFF

The electrically operated, emergency fuel cut-off system is arranged with three emergency trip switches, one located near each tank fill opening and one in the operators cab. Momentarily depressing any one of these push buttons will stop the fuel booster pump, thus stopping the flow of fuel to the engine. At the same time, a signal to the engine governor stops the engine. The system is restored to normal operation by depressing a "reset" button in the operators cab or, upon starting the engine, the system will be reset automatically.

FUEL SERVICING

FUEL OIL SPECIFICATION

The fuel oil recommended for the engine must be distilled fuel, and should conform to the American Society for Testing Materials (ASTM) Specification D-975 No. 2-D. For extreme low temperatures or for engines at high altitudes, number 1-D fuel with a minimum cetane value of 45 may be used.

FILLING

Fuel filling may be done from either side of the locomotive, by applying the fuel hose to the fill opening (fill fittings may differ depending on customer preference). Observe the upper sight gage periodically during filling, to determine when the tank is full.

The fuel supply may be determined at any time by observing the upper and lower sight gages, or the fuel dial gage (if used), for the indicated fuel level.

DRAINING

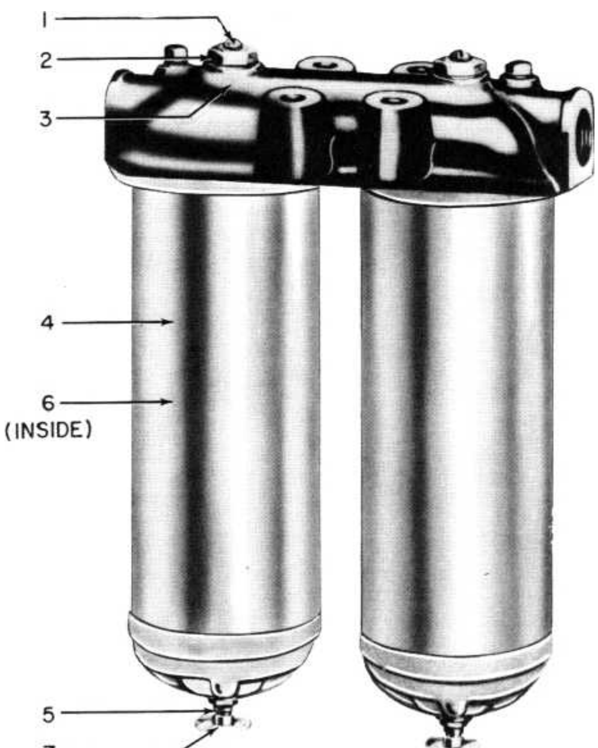
The fuel tank should be periodically drained of accumulated water condensate. This may be accomplished by temporarily opening the condensate drain valves at each end of the tank sumps. These valves are made with a straight thread screw which contains a drilled passage and has an internal stop to limit the number of turns they can be opened. If an excessive amount of water is found in the fuel tank, a check of the engine fuel filters, system, and fuel supply should be made immediately. If water is permitted to enter the fuel system, it can cause extensive damage to system parts.

Large quantities of fuel may be quickly drained from the tank by removing the drain plug from each end of the tank sumps. The sump end-covers may be removed to gain access to the tank when internal cleaning becomes necessary.

FUEL OIL STRAINER AND FILTERS

DESCRIPTION (See Fig. 5-1)

The fuel injection equipment is protected from foreign material by a fuel oil strainer and a primary and a sec-



1 Air vent screw
2 Cover nut
3 Filter head
4 Shell assembly
5 Center bolt
6 Filter element (inside)
7 Drain cock

Fig. 5-1. Fuel filters

ondary filter. The strainer is attached to a bracket mounted on the right side of the engine near the fuel booster pump. The primary and secondary filters are attached to a bracket mounted on the left side of the engine.

The fuel strainer assembly consists of a fabricated steel can, housing a single, fine-mesh, monel-wire screen element. The strainer is connected to the suction side of the booster pump and removes relatively large particles of foreign matter from the fuel before it reaches the pump.

The primary fuel filter assembly consists of a large steel can which houses a single large filter element (see DATA Section). The primary filter is pipe-connected to the booster-pump fuel discharge opening.

The secondary fuel filter assembly consists of a cast manifold and three filter shells; each shell contains a filter element. The shells are arranged for parallel flow, and the assembly is pipe-connected between the primary filter and the engine fuel header. The primary and secondary filters complete the fuel filtering process, by removing the small foreign particles in the fuel to protect the engine fuel injection equipment.

ELEMENT CLEANING AND CHANGING

A gradual drop in fuel flow and header pressure indicates that the fuel strainer or the fuel filters have become restricted and should be either cleaned or replaced.

Fuel Strainer

To remove and clean the strainer element:

1. Remove the drain plug from the strainer housing to drain the housing.

2. Loosen the wing nuts on the strainer cover, and remove the strainer element.

3. Remove the rubber grommet from the end of the strainer element. Flush the element in a cleaning solution and blow dry with clean air.

4. Flush out the strainer housing with clean fuel oil and blow dry with clean air.

5. Inspect the rubber grommet and the rubber "0" ring in the housing under the strainer cover. If either item is damaged, install a new one.

6. Install the grommet in the strainer element, and replace the cleaned element.

7. Replace the drain plug and fill the strainer shell with clean fuel oil.

8. Replace the strainer cover and tighten the cover wing nuts evenly and carefully.

Primary Fuel Filter

When conditions indicate the primary fuel filter should be replaced:

1. Drain the filter by removing the drain plug located at the bottom lower end of the filter housing.

2. Loosen the cover clamping bolt and slowly remove the cover to prevent the filter element hold-down spring from flying out.

3. Remove the filter element.

4. Thoroughly flush the filter housing with clean fuel oil, and blow dry with clean air. Inspect the rubber "0" ring in the housing under the cover. If damaged in any way, replace with a new "0" ring.

5. Install the drain plug and insert a new filter element.

6. Replace the hold-down spring and cover. Tighten the cover bolt.

Secondary Fuel Filter (See Fig. 5-1)

When the secondary fuel filter elements have to be - replaced, proceed as follows:

1. Open the drain cock and drain the filter shells.

2. Loosen the cover nuts until free, then lower the shell assemblies.

3. Remove and discard the used filter elements. Flush with clean fuel oil and blow out the filter shells. Close the drain cocks.

4. Remove the protective wrapper from the filter elements and install the elements in the filter shell. Press the elements down firmly and fill the shells with clean fuel oil.

5. Use new shell gaskets, and place the shells against the filter heads. Engage the center bolts and tighten the nuts securely.

6. Start the fuel-booster pump. Loosen the air vent screws. When the fuel leakage is free of air bubbles, close the vent screws.

7. Check the shell gaskets, vent screws and drain cocks for leakage after a short period of fuel-booster pump operation.

BOOSTER PUMP AND MOTOR

DESCRIPTION

The fuel-booster pump is a gear-type pump, driven directly by an electric motor through a flexible coupling.

It maintains a constant supply of fuel to each cylinder injection pump.

The pump housing is constructed as part of the motor end cover, which eliminates shaft alignment problems. The motor base is fastened to its supporting bracket which is bolted to the side of the engine frame on the left side of the locomotive.

Pump rotation is indicated by an arrow on the pump housing. The direction of rotation is CCW when looking at the pump drive-shaft end.

INSPECTION AND MAINTENANCE

When the pump fails to work properly or external leakage appears, check the coupling parts, pump housing, rotors, and idler gear for wear and chipped or worn pump parts.

Care must be taken, when connecting pump piping, that the pump housing is not distorted by misaligned pipes. Also, when applying pipe compound, apply the compound to the male fittings only, to prevent compound from entering pump and system. Pipe compounds contain abrasive material which will damage pump parts if allowed to enter the system.

PUMP AND MOTOR

The 75-volt, d-c motor is compound-wound andtotally enclosed. The armature shaft rotates on sealed ball bearings. The motor commutator brushes can be removed by removing gasketed covers over the brush openings.

The fuel-pump motor assists in regulating fuel header pressure. The motor is constructed to have a variable speed range from 1800 rpm to 2200 rpm, when pumping against 40 psi and 0 psi, respectively.

FUEL OIL SYSTEM

NOTE: *Do not run the pump without fuel for longer than two minutes. Pump gear damage will result from lack of fuel oil which lubricates the pump parts.*

ENGINE DRAIN SYSTEM

A slight leakage of fuel from the injection pump and the injection nozzle on each power cylinder is normal. This leakage of fuel is required to lubricate the pump and injection nozzle parts, and must be drained to the fuel tank.

A system of passages within each cylinder assembly conducts leakage fuel through the upper portion of the cylinder, around the base of the injection pump, and downward through the pump push-rod cavity.

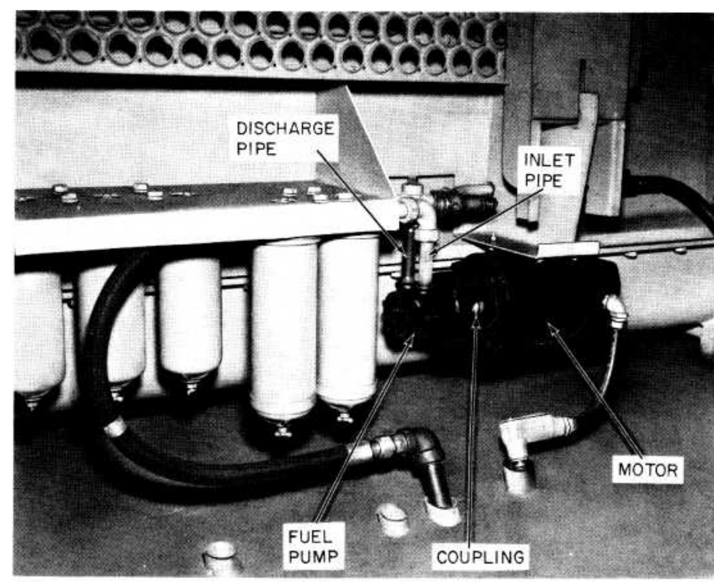


Fig. 5-2. Fuel booster pump

Passages in each cylinder base are aligned with drilled passages within the engine main frame. A fuel drain header pipe is attached to each side of the engine main frame, with a connector to each of these passages to collect drainage fuel. Each header pipe is constructed with an open stand pipe at one end. The other end is connected to return drainage fuel to the fuel tank.

The fuel drain system must remain free of obstructions to permit gravity flow of fuel to the tank. If the system should become clogged, fuel dilution of the lubricating oil may occur.

SYSTEM PRIMING

Normally, it is not necessary to prime the fuel system, as the regulating valve will vent the system when the booster pump is started. However, it is good practice when replacing a primary filter element, to fill the filter shell with clean fuel before installing. This will assure against pump damage due to insufficient lubrication during initial start, and allow quicker priming of the system.

RELIEF VALVE

DESCRIPTION (See Fig. 5-8)

A relief valve (A) is located in the fuel system between the booster pump discharge and the secondary filters. The valve protects the booster pump motor against electrical overloading, and protects the system against excessive pressure caused by clogged secondary filters or fuel flow stoppage in the pressure side of the system.

ADJUSTMENT

1. Remove 1/2-inch pipe plug and install a calibrated 100-psi test gage at the test point (1).

2. Cap-off the fuel header after it leaves the 8-R pump.

3. Start the booster pump and observe the test pressure gage. See DATA for the correct valve setting.

4. To correct the valve setting, remove the valve cap, loosen the adjustment locknut, and adjust the slotted screw to set the desired pressure. Turn the screw "in" to raise the pressure. Turn the screw "out" to lower the pressure.

5. Tighten the locknut and replace the valve cap. Check the gage reading and stop the booster pump.

6. Remove the test gage and restore the piping to normal.

REGULATING VALVE

DESCRIPTION (See Fig. 5-9)

A pressure regulating valve (B) is mounted near the secondary fuel filter, and is located in the system between the fuel tank and the engine header. It is set to maintain the fuel header pressure when measured at test point (2). See DATA for the correct valve setting. When setting the fuel header pressure, the engine must be stopped, the primary and secondary filters must be clean, and the fuel in the system must be free of air bubbles.

When fuel header pressure drops slowly over a period of time, it is usually a condition of clogged fuel filters rather than incorrect setting of the pressure regulating valve. Filter elements should be renewed first; then, if necessary, adjust the pressure regulating valve as follows:

ADJUSTMENT

1. Install a 100-psi test gage at test point (2).

NOTE: *Be sure the fuel strainer element has been cleaned and new elements have been installed in the primary and secondary filters.*

2. Start the fuel booster pump and engine. With the engine operating at idle speed, read the pressure indicated on the test gage. See DATA Section.

3. Remove the valve cap and loosen the adjustment locknut. Adjust the slotted screw to set the desired pressure. See DATA for valve setting. Turn the screw "in" to raise the pressure or "out" to lower the pressure.

4. Tighten the adjustment locknut, and replace the valve cap. Check the gage reading.

5. Stop the engine and booster pump, remove the test gage, and replace the pipe plug.

FUEL INJECTION EQUIPMENT

PUMP REMOVAL (See Fig. 5-3)

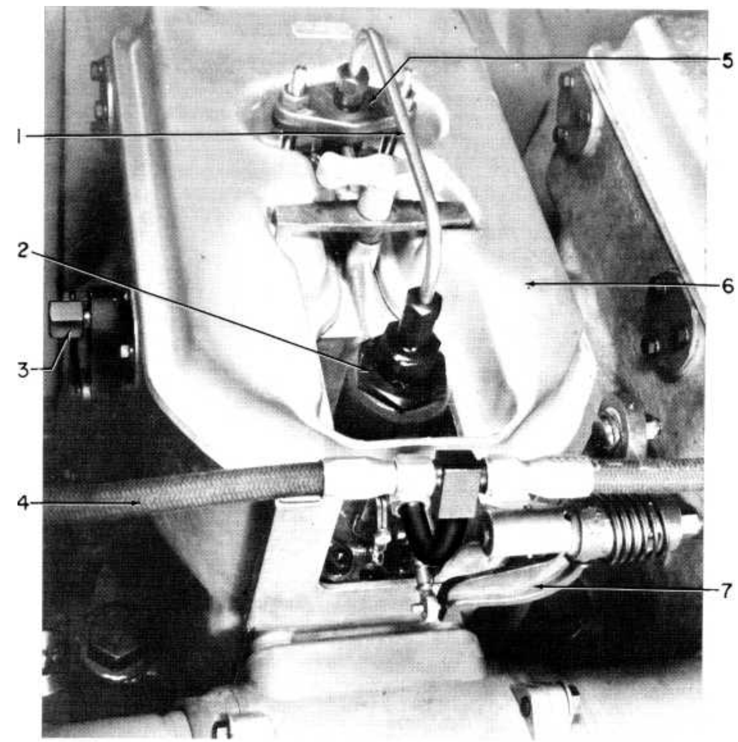
1. Remove the spring clip and the adjustable link that connects the pump rack to the fuel control linkage.

2. Wash the high-pressure line connections, using a stiff bristle brush and fuel oil, before disconnecting.

3. Remove the high-pressure fuel line between the pump and injector. Cover the openings in the pump and fittings with threaded or plastic caps.

4. Remove the fuel branch line between the fuel header line and pump. Cover the header pipe connections after the fuel has drained from the header. Apply a clean plug to the inlet connection of the pump.

5. Remove the mounting bolts at the base of the pump, using special shaped wrenches. Lift the pump from the



1 High-pressure line
2 Fuel injection pump
3 Compression release plug
4 Fuel header line
5 Fuel injection nozzle hold-down clamp
6 Cylinder cover
7 Pump rack linkage

Fig. 5-3. **Connections to fuel-injection *pump***

engine. Cover the area where the pump was removed, to prevent foreign matter from entering the engine, unless a spare pump is installed immediately.

6. Remove the fuel inlet tee, and apply a clean plug to the inlet connection.

INSTALLATION (*See* **Fig. 5-3**)

CAUTION: *BEFORE INSTALLING PUMPS ON THE ENGINE, SHORTEN THE TAPPET ROD LENGTH. REMOVE THE COVER AT THE BOTTOM OF THE CYLINDER. (SEE FIG. 5-4.) LOOSEN THE LOCKNUT AND TAPPET NUT, USING TWO OPEN-END WRENCHES. TURN THE TAPPET ADJUSTING NUT AND LOCKING NUT FOUR OR FIVE TURNS CLOCKWISE. EXCESSIVE TAPPET ROD TRAVEL CAN DAMAGE THE PUMP AND TAPPET ROD ASSEMBLY.*

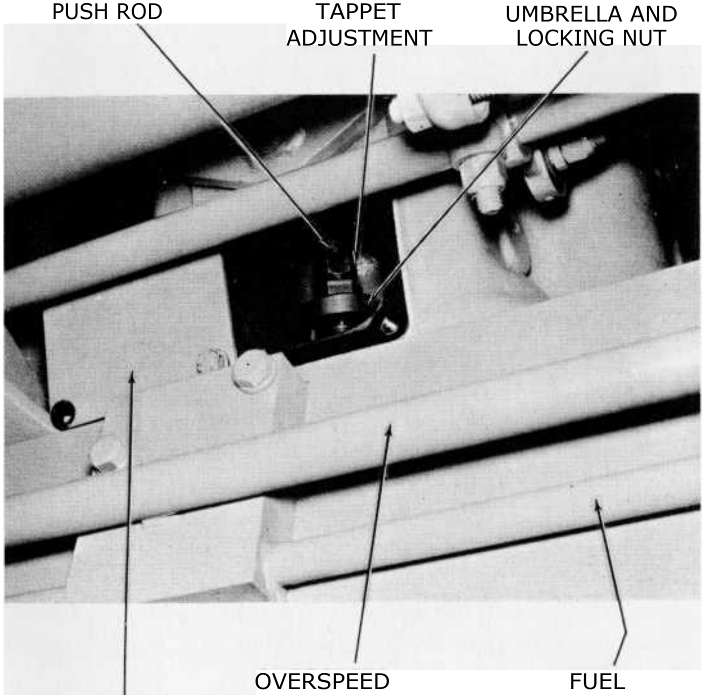


***Fig. 5-4.* Fuel-injection pump tappet-rod adjustment**

5-4 (E-9979A)

NOTE: *When installing a pump, be careful that no dirt or foreign matter enters fuel-oil lines, connections, or the engine. Keep the plugs or seals in place until connections are to be made.*

1. Install the pump on the cylinder, and secure the mounting bolts. See DATA for bolt torque.

2. Connect the fuel header and high-pressure fuel lines.

3. Install the adjustable link between the pump rack and the fuel control linkage. Secure the link with the spring clip.

PUMP TIMING ADJUSTMENT
(*See* **Fig. 5-5 and 5-6**)

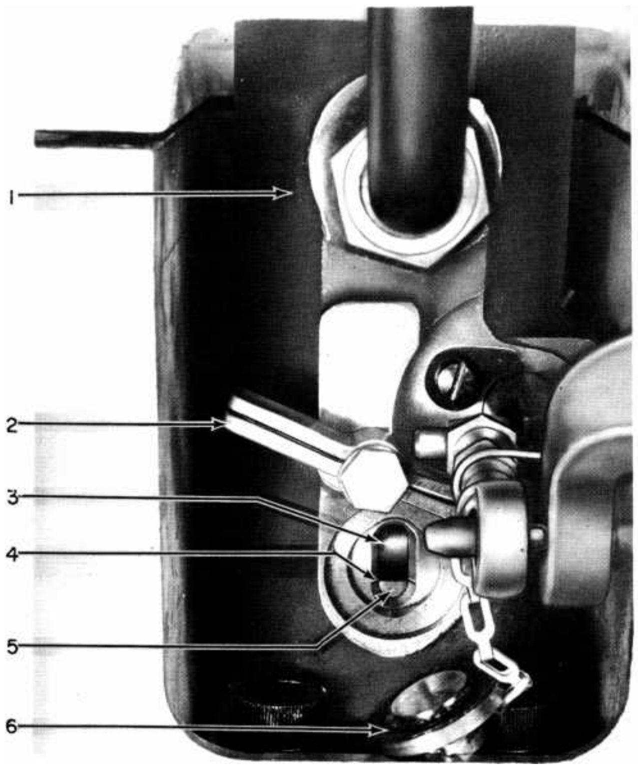
When timing the fuel injection pumps, the following indicating marks must be referred to:

1. Scribed lines at the pump timing window.

2. "Set marks" on the timing ring of the barring-over hub.

A timing window, covered with a plug, is located on the lower outside of the pump housing. Each side of the window is scribed with a timing line. The plunger follower in the pump appears behind the timing window, and its upper edge is used to set pump timing. (See Fig. 5-5.) When the pump is properly timed, the upper edge of the plunger follower will exactly line up with the scribed timing marks at the edge of the pump window.

The engine timing ring is located on the outer face of the barring-over hub at the free-end of the engine. The ring contains four pump "set" marks, and each mark contains two numbers. The numbers identify the eight pairs of opposite cylinders. For example: (1-8) (2-7).



1 Injection pump
2 Plug clamp bar
3 Timing window
4 Scribe lines
5 Plunger follower
6 Timing window plug

Fig. 5-5. *Injection-pump timing window*

There are two indicating points mounted above the timing ring. One pointer indicates right-bank timing and the other indicates left-bank timing. When viewing the timing ring from the free-end of the engine as in Fig. 5-6, note the right-bank indicating pointer appears on the left-

Fig. 5-5 (E-9973)

Fig. 5-6 (E-9981)

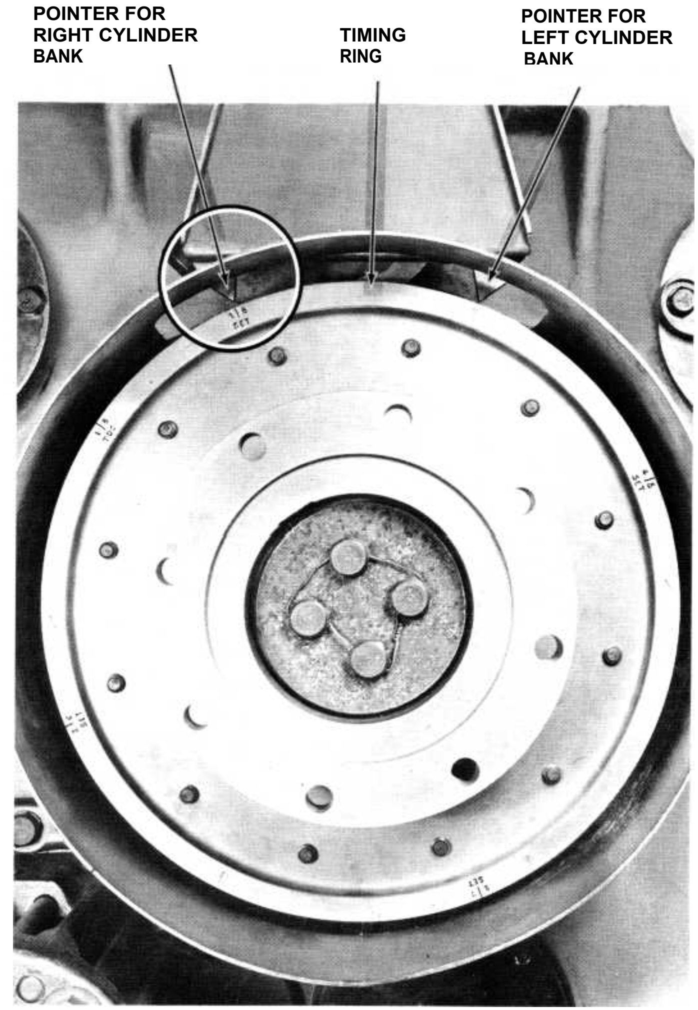


Fig. 5-6. ***Fuel-pump*** *set marks on timing ring*

FUEL OIL SYSTEM

hand side. The left-bank pointer appears on the right-hand side.

NOTE: *Use care not to confuse the "1-8 TDC" mark with the "1-8 SET" mark.*

CAUTION: *INCORRECT INJECTOR PUMP* ***TIMING CAN CAUSE EXCESSIVE PUMP PLUNGER TRAVEL, WHICH MAY RESULT IN DAMAGE TO THE PUMP:***

NOTE: *Tappet settings on the inlet and exhaust valves of a cylinder can be checked, and if necessary, readjusted at the same time the fuel pump on the cylinder is being timed.*

Number 1 right cylinder pump is used as an example, and is a good starting point to use when all engine pumps are tc be timed.

1. Back off the compression release plugs one full turn on all cylinders.

2. Remove the cylinder head covers and plugs from the fuel pump timing windows.

3. Remove the covers that are over the tappet-rod adjusting nuts. (See Fig. 5-4.)

4. Using the barring-over tool, slowly bar the crankshaft over in its direction of rotation until the timing mark "1-8 SET" exactly lines up with the right-bank pointer. (See Fig. 5-6.)

5. Check that all valves are closed onthe 1-R cylinder (firing stroke). If the valves are closed, a small amount of free movement will be noted by manually moving the rocker arms.

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FUEL OIL SYSTEM

6. If the valves are not closed, rotate the crankshaft one more revolution in the direction of the rotation. Stop on the "1-8 SET" mark and recheck the valves.

7. Adjust the fuel pump tappet nut on the 1-R cylinder until the top edge of the plunger follower is exactly aligned with the scribed marks at the sides of the fuel pump timing window. (See Fig. 5-5.)

8. Lock the tappet nut securely and recheck the alignment of the pump timing marks. If they are correct, proceed with the pump on the 1-L cylinder, using the left-bank pointer. Again using the "1-8 SET" mark, turn the crankshaft until the mark is exactly aligned with the left-bank pointer.

9. Proceed to the next cylinder in the firing order and repeat until all 16 cylinders have been timed. Make sure each tappet nut is locked before leaving it.

10. After all the pumps have been timed, replace the tappet-rod adjustment covers, cylinder head covers, and fuel pump timing window plugs. Remove the barring-over tool.

FUEL NOZZLE

FUNCTION

The nozzle is the device used to inject metered amounts of fuel into the cylinder clearance, at the exact required instant during the compression stroke.

The valve in the nozzle seals the fuel passage into the nozzle tip, and prevents leakage of fuel during the rest of the cycle.

The spray holes atomize the fuel into a very fine mist in a symmetrical pattern, to mix with the compressed air to start ignition and maintain combustion.

DESCRIPTION

The fuel-injection nozzle, see Fig. 5-7, is located in the cylinder head, and injects fuel oil directly into the cylinder. It consists of a holder body with a fuel inlet duct and drain duct, a valve and valve body, nozzle tip, valve loading spring, stop plate, spring pressure adjusting shims, and assembly nut to hold the assembly together.

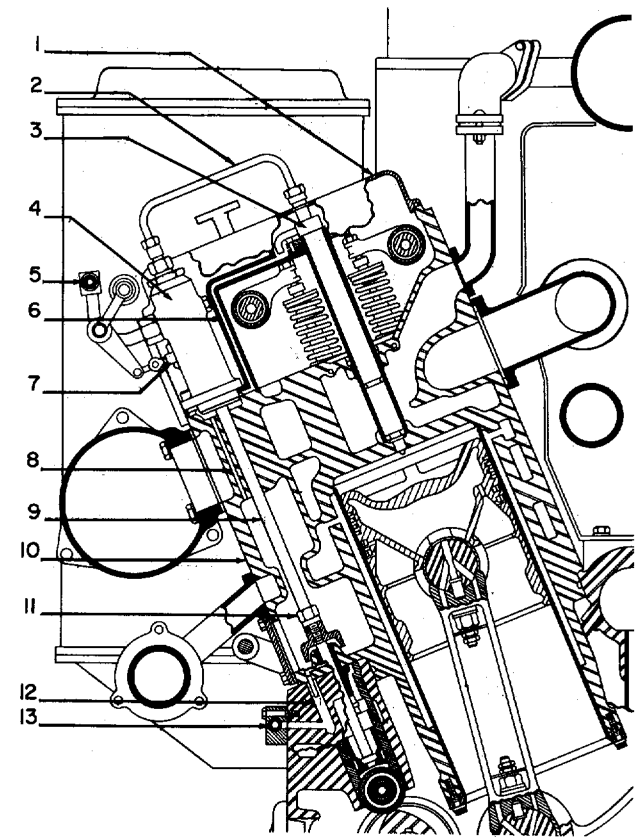
When the hydraulic pressure of the fuel (3500 to 3800 psi), in the chamber between the valve seat and valve, exceeds the valve-spring pressure, the valve is forced open.

When the valve is open, fuel oil at high pressure flows from the chamber between the valve and valve seat, down to the nozzle tip, and is sprayed into the cylinder through the spray holes in the nozzle tip. As the holes are only a few thousandths of an inch in diameter, the oil sprayed through them forms a fine mist which mixes with the compressed air in the cylinder to form a combustible mixture. This mixture is then ignited by the heat created by compressing the air trapped in the cylinder. It burns rapidly and produces the increased pressure needed to drive the piston on the power stroke.

A small quantity of fuel leaks upwards between the valve stem and valve bore to lubricate these parts. It then goes through a drain line from the nozzle holder body into a drain compartment under the cylinder-head cover. From here it is drained through a tube in the fuel-pump housing and combines with drain fuel from the fuel-injection pump, eventually returning to the fuel tank through the fuel return header.

REMOVAL

To service the injection nozzle, it must be removed from the engine. Clean all pipe joints and the cylinder head, using fuel oil and a stiff bristle brush. Disconnect the high-pressure fuel line and remove the nozzle holder.



1 Cylinder head cover
2 High-pressure fuel line
3 Fuel nozzle
4 Injection pump
5 Fuel inlet
6 Fuel drain passage in pump enclosure casting
7 Control rack
8 Fuel drain passage
9 Injection pump push rod
10 Cylinder
11 Push rod adjustment and locknut
12 Fuel drain passage
13 Fuel drain header

Fig. 5-7. Cutaway view showing fuel-injection system in cylinder

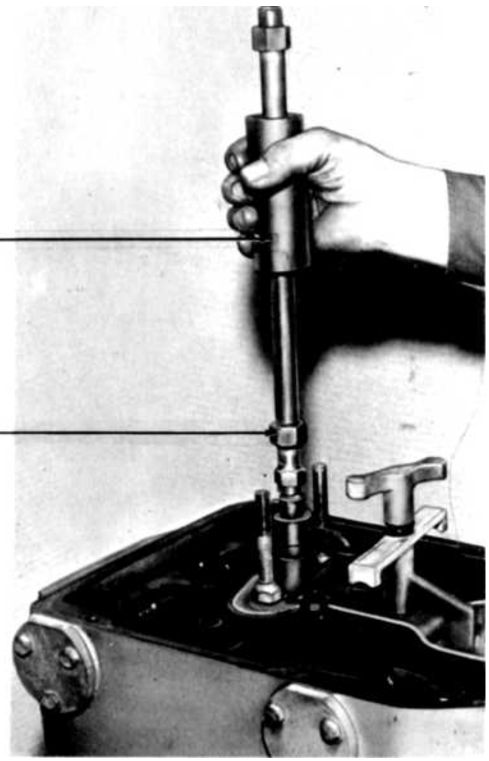


Fig. 5-8. Nozzle knocker tool

(If the nozzle holders are bound due to carbon build-up, they can be removed using the nozzle knocker tool shown in Fig. 5-8.) After the nozzle holder is removed, remove its gasket from the bottom of the cylinder-head recess.

INSTALLATION

1. Clean out all the carbon in the nozzle-holder recessed port in the cylinder head, and make sure the tip end of the nozzle holder is clean.

2. Place a new copper gasket on the small end of the nozzle. A small amount of grease can be used to hold the gasket in place.

3. Insert the small end of the nozzle holder into the recessed port. Orient the fuel drain and place the clamp plate over the nozzle holder and holder studs.

4. Apply self-locking nuts and tighten them to the torque value listed in the DATA Section.

CAUTION: *PROPER TIGHTENING OF THE NOZZLE CLAMPING BAR NUTS IS IMPORTANT. IF THEY ARE NOT TIGHT ENOUGH, THE EXHAUST GASES WILL CAUSE A CARBON BUILD-UP BETWEEN THE FUEL NOZZLE AND NOZZLE PORT, CAUSING THE NOZZLE HOLDER TO BE BOUND IN PLACE. IF THE CLAMPING BAR NUTS ARE TIGHTENED EXCESSIVELY, PARTS OF THE NOZZLE VALVE ASSEMBLY 1I'LL BECOME DISTORTED, CAUSING THE NOZZLE VALVE TO LEAK. EXCESSIVE TIGHTENING OF THESE NUTS CAN ALSO CAUSE CRACKS TO DEVELOP BETWEEN TIIE NOZZLE OPENING AND VALVE SEAT BORES OF THE CYLINDER HEAD, AND IN EXTREME CASES, CAN RESULT IN UNSEATING OF THE EXHAUST AND INLET VALVES.*

5. Remove the protective caps from the ends of the high-pressure line and from the pump and nozzle connections. Apply the high-pressure line and tighten the nuts. Be certain no dirt gets into the connections. Check for leaks at these points when the engine is started.

STORING SPARE NOZZLES

If the fuel nozzle assembly is not immediately installed on the engine, pour clean, SAE-10, lubricating oil into the fuel inlet and drain holes. Sealthe openings, using caps and plugs or a commercially prepared hot plastic dip of ethyl cellulose.

Protect the nozzle tip by covering the spray holes with grease. Dip the nozzle in a hot plastic dip of ethyl cellulose. To avoid damage, handle the parts carefully and store them in a clean dry area.

Never take a chance with injection equipment. If it needs renewing, renew it, rather than trying to extend its life.

DATA

TANK CAPACITY

Large Tank... 3000 gal
Small Tank.. 1700 gal

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FUEL BOOSTER PUMP

RPM.. 1800
Pressure...40 psi
Fuel...3 gpm

VALVE SETTINGS

Pump Relief...75 psi
Pressure Regulating..**35 psi**

INJECTION PUMP

Timing (Beginning of **injection) . . . .** **28 degrees BT DC**

TORQUE VALUES

Injection Pump Adapter Sleeve .... **320-340** lb-ft
Delivery **Valve** Holder.................................. **300-320** lb-ft
Fuel Nozzle Mounting Nuts................................**30-35** lb-ft
Nozzle Assembly Nut.................................... 130-150 lb-ft
Injection Pump Mounting Bolts..........................**45-50 lb-ft**

1. CYLINDER DRAIN
2. FUEL HEATER (IF USED)
3. FUEL STRAINER
4. FUEL PRESSURE GAGE
5. TANK SIGHT GAGE
6. FUEL LEVEL GAGE (IF USED)
7. TANK FILL
8. TEST POINTS
9. PRESSURE REGULATING VALVE
10. PRESSURE RELIEF VALVE
11. BOOSTER PUMP
12. CONDENSATE DRAIN VALVE
13. DRAIN PLUG
14. FUEL TANK
15. TANK VENT
16. FUEL HEADER
17. PRIMARY FUEL FILTER
18. SECONDARY FUEL FILTER

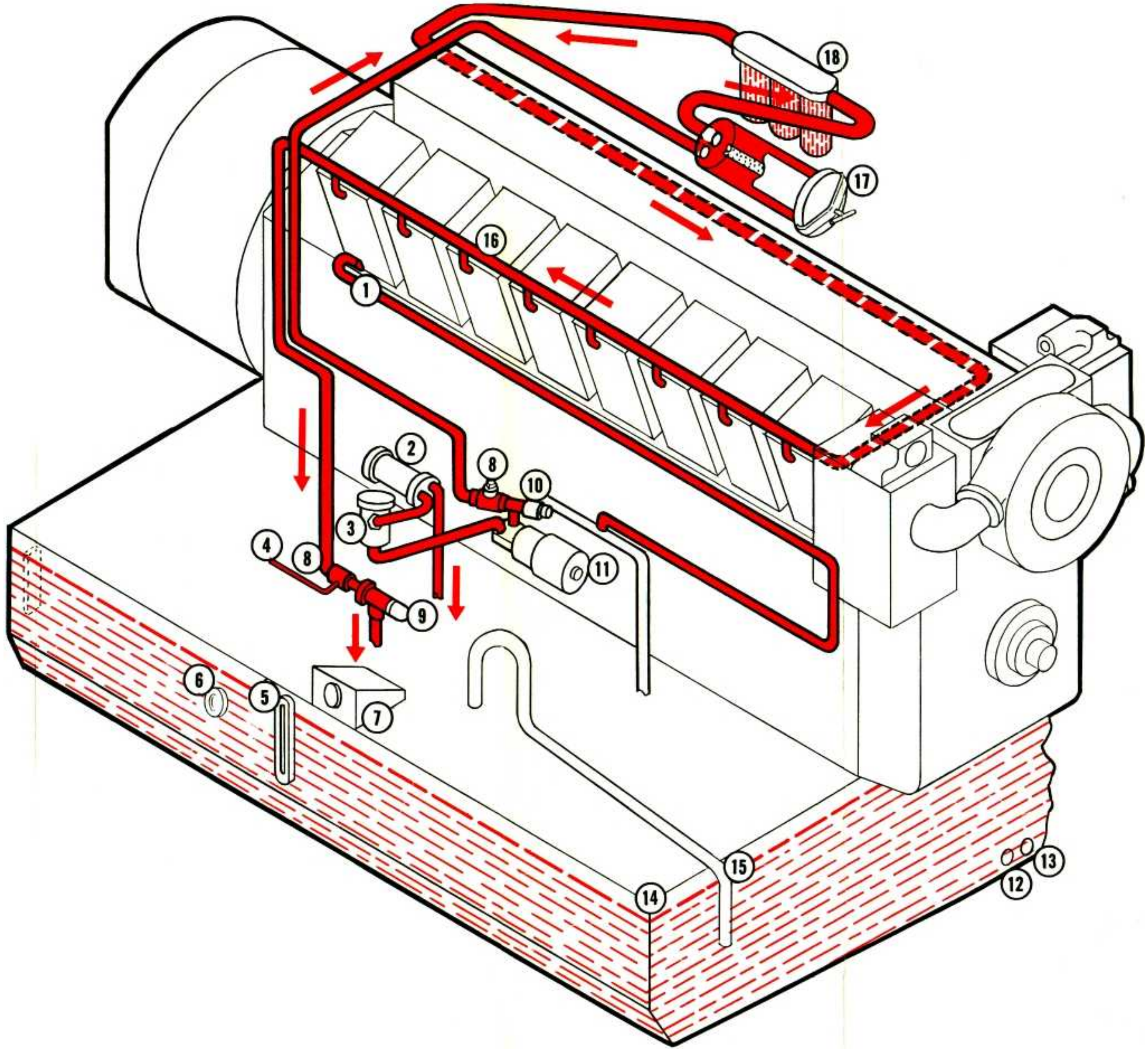

Fig. 5-9. Engine fuel-oil system

COOLING WATER SYSTEM

DESCRIPTION

COMPONENTS

The locomotive cooling system is a pressurized water system which maintains an essentially constant engine operating temperature throughout the load range and with wide variations in ambient temperature. The system also supplies heat to the cab heater and to the water-cooled air compressor. (See Fig. 6-5.)

The cooling system consists of the following principal components:

1. Water storage tank
2. Water pump
3. Water inlet headers
4. Water discharge header
5. Flow control valve
6. Radiator sections
7. Cab heater
8. Lube oil cooler
9. Valves and interconnecting pipes

SYSTEM OPERATION

The water storage tank, located just forward of and slightly below the radiator panels, contains the supply of "working coolant" in the system. Two fill openings, equipped with spring-loaded caps, are located near the top of the water-storage tank. The openings are situated to allow water to be added to the tank from either side of the locomotive.

> NOTE: ***Some locomotive models may be equipped with only one water*** *fill, usually on the right side of the locomotive.*

Water leaving the storage tank is drawn downward through vertical tubes in the lubricating oil cooler,and is then conducted to the suction side of the engine-driven centrifugal water pump. To simplify piping and system draining, the lubricating oil cooler is bolted directly to the storage tank at its lowest point. The cooler is supported from the locomotive platform by three adjustable feet.

Water discharged from the pump enters a lateral passage in the free-end cover of the engine, where it is distributed to the inlet water header pipes, the turbocharger, and the intercoolers.

The inlet water headers, one along each side of the engine, distribute cooling water to the cylinders. These headers are made up of eight sections which are individually removable. Each section is bolted to its cylinder and connected to adjacent sections by Dresser couplings.

The cylinders contain wet-type liners surrounded by vertical passages. Cool incoming water flows downward through these passages and upward and out through additional passages in the cylinder head.

The engine intercoolers, which remove heat from combustion air, are constructed with a fabricated steel case enclosing a fin and tube-type radiator core. Cooling water, from the free-end cover, enters at the bottom of each intercooler, passes vertically three times through the core, and is then discharged at the top of the cooler. Water flow through each intercooler is limited by an orifice in the cooler discharge opening.

The turbocharger, located at the free-end of the engine, receives its cooling water through two openings in the top surface of the free-end cover. These openings are aligned with openings in the base of the turbocharger bracket, and the mating connections are sealed by "0" rings.

Water is discharged from the turbocharger at three openings near the top on its exhaust gas inlet side. These

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openings are in turn connected to the discharge pipe from the left intercooler.

Water is supplied to the air compressor and the cab heater by a pipe connected to the inlet water header on the left side of the engine, and is returned to the system through a pipe which extends along the right side of the engine and which is connected to the. bottom header on the lube oil cooler. If desired, a fuel heater, which is optional equipment, may be connected into this line. The compressor is supplied from a pipe connected to the flow-control valve and discharged into the radiator return pipe.

The discharge water header is centrally located lengthwise over the engine, with its discharge opening connected to a junction box at the top of the right intercooler. Branch pipes, welded into the header, are connected to individual cylinders by Dresser fittings. Water flowing from the inter coolers, turbocharger, and discharge water header combines at the junction box and is conducted to the flow control valve.

The flow control valve is mounted at the forward left corner of the water storage tank, and regulates the temperature of the system by routing the water flow from the engine as follows: (See Fig. 6-5.)

1. Directly to the water storage tank — when minimum engine cooling is required.

2. To the forward two radiator sections — when partial cooling is required.

3. To all radiator sections — when full engine cooling is required.

Water cooled in the radiators is then returned to the storage tank. For minimum engine cooling, the flow of water to the radiators is cut off by the flow control valve, and the water left in the radiator sections and piping is quickly drained to the storage tank by gravity flow.

COOLING WATER TREATMENT

In order to maintain the efficiency of the diesel engine cooling water system and to protect against corrosion or erosion of the various metals in contact with the fluid, the water used should be kept clean and within proper limits of alkalinity, hardness, and inhibitor concentration. This may be accomplished by using a sodium chromate water treatment compound at concentrations between 4000 ppm and 2500 ppm minimum.

Any dry form of treatment should be completely dissolved before being added to the cooling system. Solutions should be prepared in open containers ,with adequate ventilation. Parts and decks should be washed clean of dried on or spilled compound.

WARNING: *CHROMATE COMPOUNDS ARE TOXIC, AND SUITABLE PRECAUTIONS MUST BE TAKEN BY PERSONS HANDLING THEM TO AVOID INHALING THE FUMES OR DUST AND TO AVOID SKIN CONTACT WITH SOLIDS OR SOLUTION.*

The coolant should be checked with sufficient frequency, particularly until its condition reaches a steady state, to ensure that it is maintained within the recommended limits. Checking periods should not exceed one month. See Point 5.

1. Limited by presence of non-ferrous components in the cooling system.

2. If coolant should become contaminated with sludge, dirt, or oil, the cause of the contamination should be found and corrected, and **the system cleaned** as described under COOLING SYSTEM MAINTENANCE.

3. Approximately one pound of commercial chromate treatment (such as Nalco 38, Dearborn 517, or equivalent) is required for each 20 gallons of raw water in order to allow for gradual dilution of the concentration.

4. Raising water level in expansion tank of locomotive system from "Low at Idle" to "Full at Idle" requires approximately 60 gallons of water.

5. A water treatment testing kit is available under GE Cat. No. 147X1225. Using this kit in a simple four-step procedure, permits the maintainer to read from a table the number of pounds of chromate water treatment which should be added to the locomotive cooling water system to restore it to a 4000 ppm concentration.

COOLING WATER SYSTEM

FILLING

The locomotive cooling water system can be filled through either of two fill openings located near the top of the water storage tank. The openings are situated to allow water to be added from either side of the locomotive. (See Fig. 6-5.)

NOTE: *Some locomotive models may be equipped with only one water fill, usually located on the right side of the locomotive.*

Two water-level sight gages are located on the water storage tank, and they are marked to indicate the normal water levels which occur throughout the various operating conditions of the cooling system. When the locomotive is operating, large fluctuations will occur in the level of the water in the sight gages and the storage tank. This is normal, and is caused by water in varying amounts being diverted from the storage tank to the radiators during intervals of cooling.

When filling the system from a completely drained condition, adjust the water to the proper level with the engine idling, to allow trapped air to vent from the system.

COOLING WATER SYSTEM

NOTE: *Water will be forced out of the fill **pipes** by the pressure in the system if the fill caps are removed when the water level is above the "FULL AT IDLE" mark on the gage, or if the system is excessively hot. Before removing the caps, drain some water from the system, or allow the system to cool down. In either case, slowly turn the fill caps to allow the system pressure to be vented before removing the caps.*

CAUTION: *DO NOT OPERATE THE LOCOMOTIVE IF THE WATER SUPPLY DROPS BELOW THE LEVEL MARKED "LOW AT IDLE" OR "LOW LOADED" ON THE SIGHT GAGE. THE ENGINE MAY OVERHEAT AND BECOME DAMAGED IF OPERATED WITH THE WATER BELOW THE INDICATED LEVELS. ADD TREATED WATER TO THE PROPER LEVEL WITH **THE** ENGINE IDLING.*

DRAINING
(See Fig. 6-5)

The cooling system is equipped with three, manually operated valves, a main system drain valve (A), located near the base of the lubricating oil cooler, and two cab heater shut-off valves (B) and (C), located in the operator's cab near the cab heater.

NOTE: *Because this is a pressurized system, drainingtime will be greatly reduced ifthe system is vented to atmosphere by removing one of the fill caps.*

The system can be completely drained by opening valves A, B, and C. In freezing weather, the 1/4-inch drain plug must also be removed from the water pump impeller casing.

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COOLING WATER SYSTEM

CAUTION: ***TO PREVENT THE CAB HEATER*** *CORE FROM FREEZING DURING EXTREMELY COLD **WEATHER, HEATER** VALVES B AND C MUST REMAIN FULLY OPEN AT ALL TIMES. IF, IN AN **EMERGENCY,** THE VALVES MUST BE CLOSED, THE PIPE CONNECTIONS TO THE HEATER CORE MUST BE LOOSENED TO PERMIT THE CORE TO DRAIN.*

FLOW CONTROL VALVE

The flow control valve has no manual adjustments. The valve is made up of eight thermostats, two piston-type valves, and a filter screen, all housed in a fabricated steel case. The valve case is mounted over an opening in the water-storage tank, and is connected to the engine by a single pipe, and to the radiator sections by two pipes. Three removable covers permit access to the control valves internal parts. A rectangular cover is over the eight thermostat units, and two circular covers are over the V_1 and V2 piston-type valves. A 1/2-inch pipe boss is provided in the outer side of the case, to permit installation of a temperature test gage.

VALVES WITHIN THE CASE

Thermostat Valves

The thermostats function as two-way valves. When water temperature is below their operating point, as in Fig. 6-1 (A), they pass the water directly through their cylindrical bodies to the water tank below.

When the water temperature increases, the temperature-sensitive compound in the bulb (located on top) expands, overcoming spring pressure and forcing the skirt downward. (See Fig. 6-1 (B).) As this skirt moves, the opening at the bottom becomes more and more restricted, while the **previously** closed opening at the top of the skirt - increasing in size - permits water pressure to start building up in the adjacent chamber.

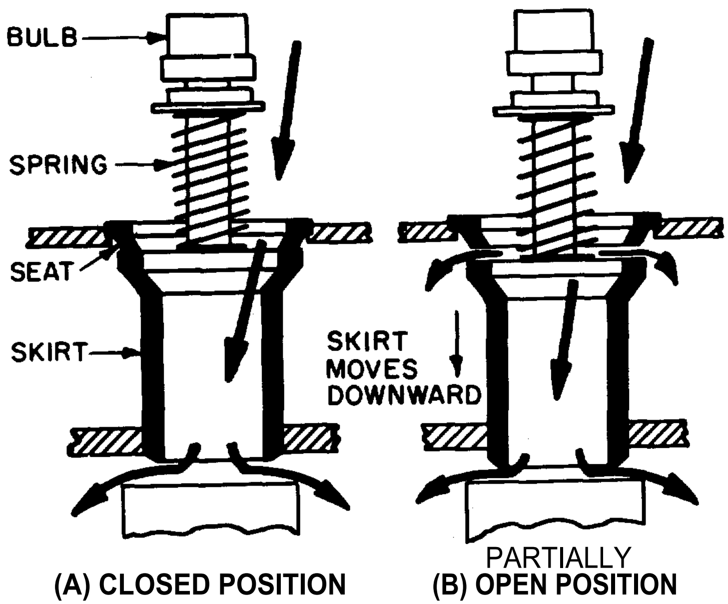


Fig. 6-1. Operation of thermostats

Fig. 6-1 (E-9989)

Piston-Type Valves

Conditions of flow through the radiator are controlled by the two "snap action" piston-type valves, V1 and V2. (See Fig. 6-2.) Vertically mounted within the case, the valves each consist of an upper and a lower piston connected by a stem. These valves are identical and interchangeable. The center portion of each valve is hollow to permit water which leaks past the upper piston to return through the valves to the storage tank; thus, leakage has no effect on the operation of the system. To assure accurate operation, the weight of each valve is held within close limits during manufacture.

Successful operation of the system during freezing weather depends upon water flow through the radiator

sections being either at a high rate or completely off. If trickles of water are permitted to pass through the radiators, ice would form in the tubes. The "snap action" of the piston-type valves accomplishes this purpose.

COMBINED OPERATION

The flow control valve regulates the temperature of the cooling system by directing water flow in the following manner:

1. When minimum engine cooling is required (Fig. 6-2):

   Water discharged from the engine enters Chamber A to flow downward through the filter screen and thermostats. Since the thermostats are below operating temperature, water passes through their lower openings to the tank.

2. When partial engine cooling is required (Fig. 6-3):

   As the engine discharge water temperature rises, the thermostats begin to operate. Downward movement of the skirts partially restricts water flow to the tank. At the same time, openings at the top of the lower skirts allow water to enter Chamber B.

   Pressure now begins to develop in Chamber B. When the thermostats have moved their skirts enough to cause this pressure to reach approximately 4 psi, valve VI "snaps" upward to the limit of its travel.

   Chamber B is now open to Chamber C, and Chamber C is closed to the storage tank by the lower piston of valve V1. Water flows from Chamber C through the pipe connection to radiator sections 1 and 2.

COOLING WATER SYSTEM

At the moment valve VI opens, water pressure in Chambers B and C falls somewhat below 4 psi; thus, valve V_2 does not open. Valve V1 remains up, however, because the area of the bottom of its upper piston that is exposed to pressure is still large enough to hold VI up, even with reduced pressure.

If cooling demands are now satisfied, and water temperature remains approximately constant, no changes in valve position take place. Small variations in cooling requirements are satisfied by slight opening or closing of the thermostats to modulate the flow.

If cooling requirements should fall off, the thermostats will close the opening at the top of the skirt (and open the exit to the tank) sufficiently to lower the pressure in Chambers B and C to the point that gravity will pull valve V_I down to closed position, resulting again in the situation depicted in Fig. 6-2. Air from the storage tank enters Chamber C to vent the radiator, permitting it to drain.

3. When full engine cooling is required (Fig. 6-4):

   If, with valve V1 open, engine discharge water temperature continues to rise, the thermostats will still further restrict water flow to the storage tank, and, at the same time, allow increased flow to Chambers B and C. Pressure in these chambers again begins to increase. When the pressure reaches approximately 4 psi for the second time, valve V_2 will "snap" upward to the limit of its travel.

   Chamber C is now open to Chamber D, and Chamber D is closed to the storage tank by the lower piston of valve V_2. Water flows from Chamber D through the pipe connection to radiator sections 3, 4, 5, and 6.

COOLING WATER SYSTEM

   Water is now flowing to all radiator sections, resulting in maximum cooling by the system. As before, small variations in cooling requirements are satisfied by slight opening or closing of the thermostats to modulate the flow.

4. When engine cooling requirements decrease:

   When cooling requirements decrease sufficiently, the sequence of operation previously described will reverse. The thermostats will gradually reduce the water flow, and, thus reduce the pressure in Chambers B, C, and D. Because of the higher rate of flow, the greater decrease in pressure will occur in Chamber D, causing valve V_2 to close first. When valve V_2 closes, the flow of water to the radiator sections 3, 4, 5, and 6 will be shut off. At the same time, the radiator sections will be vented to the storage tank by the lower piston on valve V2, thus permitting the water remaining in the sections to quickly drain to the tank.

   Water pressure in Chambers B and C will be increased somewhat by the closing of valve V2; thus valve VI will remain open.

   If cooling requirements continue to decrease, the thermostats will further reduce pressure in Chambers B and C. When the pressure in Chamber C becomes sufficiently low, valve V_1 will close, shutting off the flow of water to the radiator sections 1 and 2. As with valve V_2, the radiator sections are vented to the storage tank through the lower piston valve V 1,thus permitting the water remaining in these sections to quickly drain to the tank.

INSPECTION AND REPAIRS

It is not necessary to drain the water **system to inspect or to replace the parts in the flow control valve,**

COOLING WATER SYSTEM

since water is only present in the valve during engine operation. Proceed as follows (See Fig. 6-1.):

1. Remove the covers over the thermostats and the V_1 and V_2 **valves.**

2. Check the piston-type valves for free vertical movement, by lifting and releasing them. If their movement is not free, check the valve piston surfaces and the cylinder walls for scoring or foreign materials. Polish the scored surfaces using a 320-grade of emery cloth.

3. Remove the Dresser coupling in the discharge-water line from the engine to the flow-control valve. (See Fig. 6-1.)

4. Remove the collar and the short length of pipe at the flow-control valve, to allow removal of the filter screen.

5. Pull out and clean the flow-control valve filter screen.

6. Inspect the thermostats to make certain they are properly seated.

7. Remove the thermostats and test them for proper operation in agitated hot water. See DATA for the proper temperature values. Renew any defective units.

8. Reassemble the parts and inspect the cover gaskets and the collar "0" ring. Renew the gaskets and "0" ring if damaged and replace the covers.

SAFETY DEVICES

ENGINE HIGH-TEMPERATURE SWITCH

The engine high-temperature switch, mounted on the flow control valve, is a thermal-electrical safety device that functions to alert the operator should the engine temperature become excessive. When the temperature of the water discharged from the engine reaches the temperature setting of the switch, its electrical contacts will close, energizing a light and/or bell in the operator's cab.

COOLING WATER SYSTEM

To assure proper operation, the switch should be inspected and tested in a hot pot.

With the switch in place, remove the cover plate and check to make certain the electrical connections are secure and the contacts are in good condition. The contacts, if burned or pitted, may be dressed (with the circuit de-energized) by using a small, fine, flat file.

CAUTION: *DO NOT SET THE SWITCH ON THE LOCOMOTIVE BY COVERING THE RADIATOR INLET SCREENS. THIS CAN DAMAGE THE ENGINE AIR FILTER SYSTEM. (SEE DATA FOR SWITCHING SETTINGS.)*

CAUTION: *WHEN CONDUCTING THIS TEST, DO NOT ALLOW THE TEMPERATURE OF THE COOLING WATER DISCHARGED FROM THE ENGINE TO EXCEED 205 F.*

Should the switch require an adjustment, its closing and opening settings can be raised or lowered simultaneously by turning the external adjustment screw on the switch case. The differential setting of the switch can be adjusted by changing the magnetic air gap of the movable contact. However, this adjustment is quite difficult to make, and should not be tampered with when adjusting the switch on the locomotive.

When checking an engine high-temperature switch, immerse the switch tube in a pot of agitated water. Slowly raise the water temperature until the switch contacts close, Lower the water temperature until the contacts open-. If necessary, reset the switch to obtain the proper opening and closing values. (See DATA.)

LOW WATER-PRESSURE SHUTDOWN

The low water-pressure shutdown is an automatic safety device used to shut down the engine in the event of cooling water failure.

This device is mounted on the left side of the engine control governor, and is piped to the engine cylinder inlet water header.

If the pressure of the cooling water supplied to the engine cylinders drops below that required for safe operation of the engine, the water pressure device will function to shut down the engine. (For operating and adjustment details,refer to ENGINE CONTROL GOVERNOR instructions.)

RADIATORS
(See Fig. 6-5)

The radiator is made up **of six individual sections,** three on each side of the locomotive, mounted to slope downward from the locomotive center line to the outer sides. Wire screening is mounted over the upper side of the radiators to protect them from damage.

Radiator sections are alternately numbered, starting at the water storage tank. The odd numbers are on the right side of the locomotive, and the even numbers are on the left side.

A pipe connects Chamber C of the flow control valve to the inlets of the radiator sections 1 and 2. Another pipe connects Chamber D of the flow control valve to the inlets of radiator sections 3, 4, 5, and 6. Pipe connections at the radiator sections are made by Dresser fittings, to permit easy removal.

Cooled water flows from the radiator sections through their respective drain header pipes to the water storage

tank. A small pipe, connected parallel to the large drain header pipe, assures complete draining when the locomotive is not on level track.

DATA

TANK CAPACITY

Water Capacity .... **290 gal**

VALVE SETTINGS

Flow Control Valve

Thermostats — Start to Open ....**165 F**
— Fully Open................................. 180 F
— Valve Skirt Travel
(Closed to Fully Open - Min.).. 11/32 in.
Engine Temperature Switch
— Contacts Close .... 200 F ±2
— Contacts Open ....193 F ±2

TORQUE 'VALUES

Water Pump Drive Gear Nut ....200-220 lb-ft

6-2 (E-9946A)

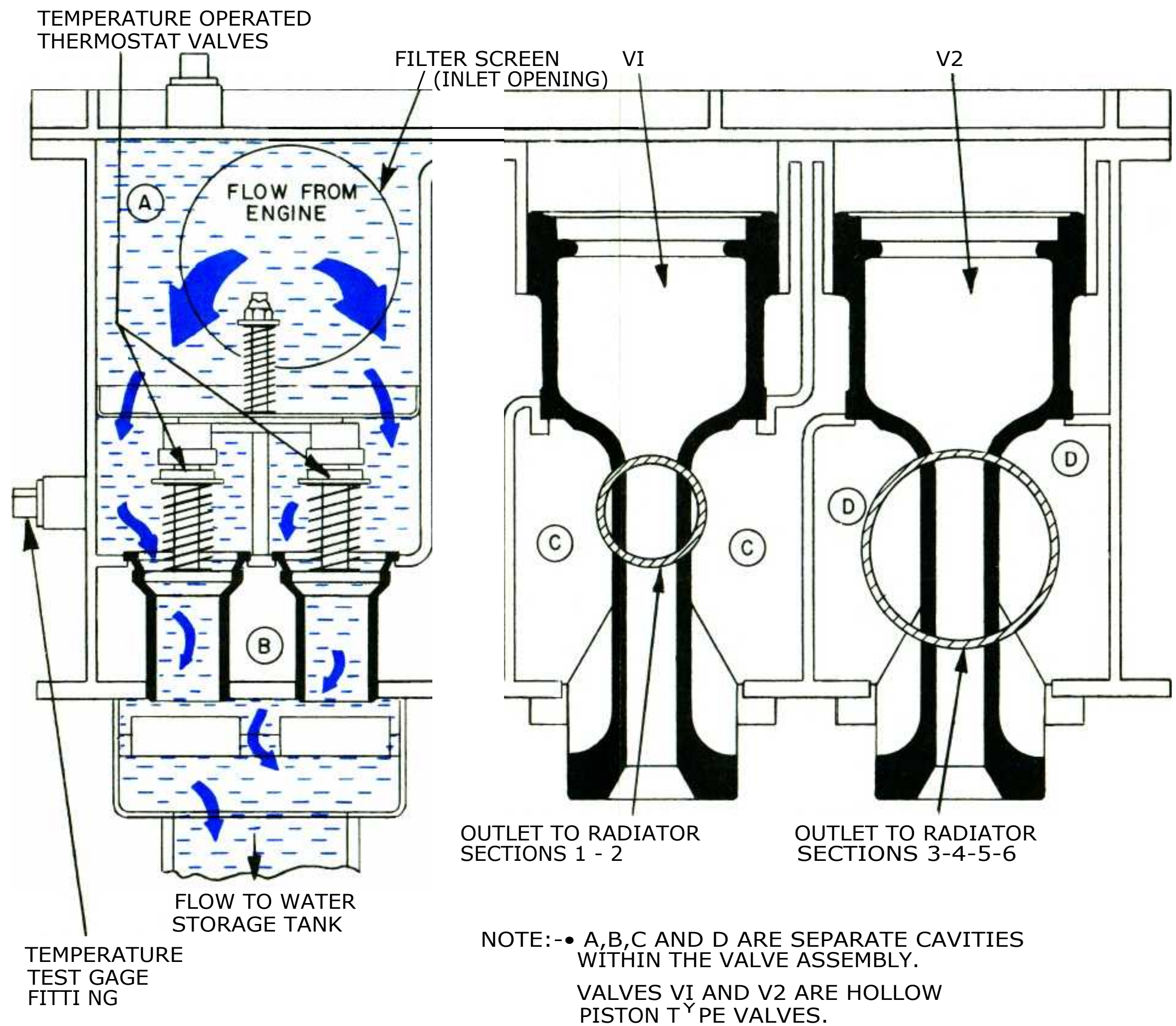
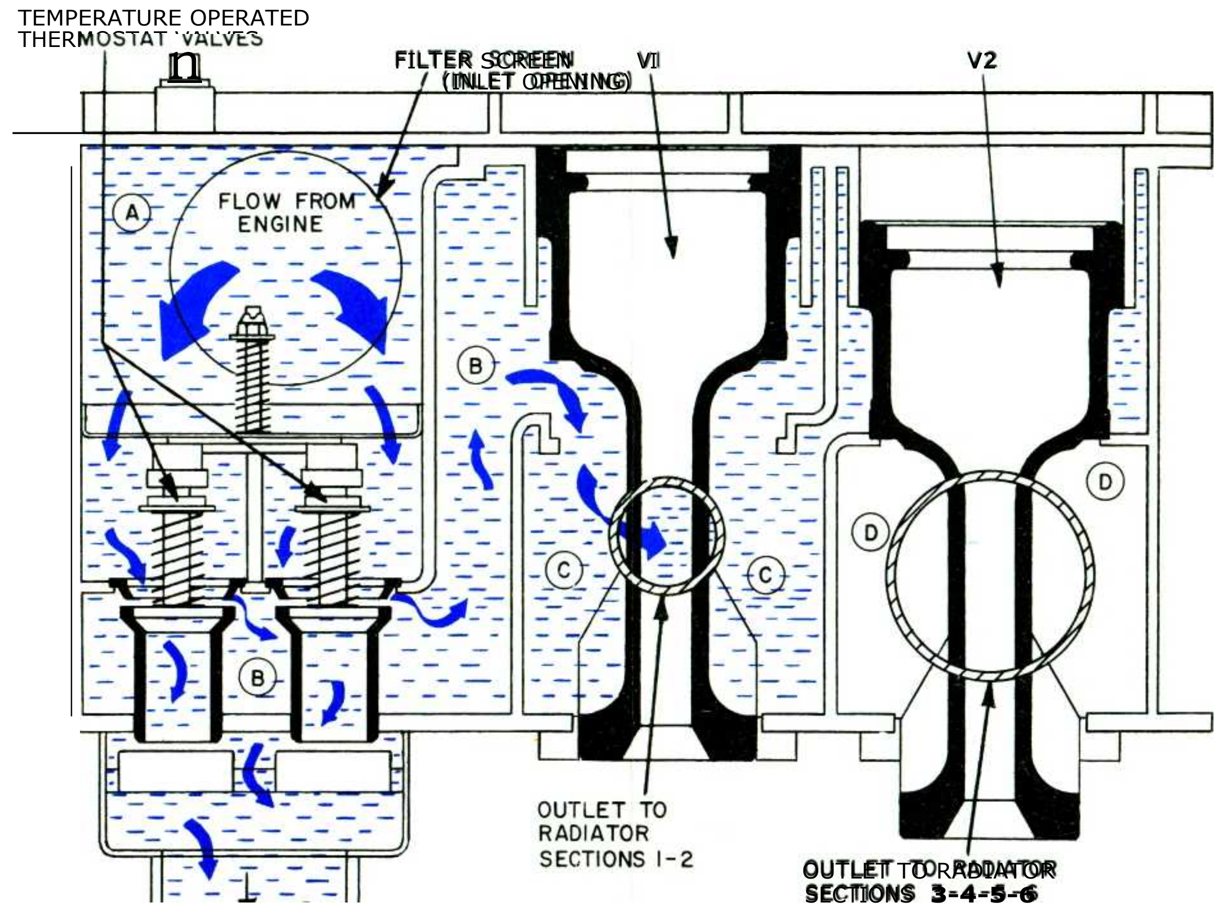


*Fig. 6-2. Flow-control **valve operation** **(Condition: minimum engine** cooling required)*

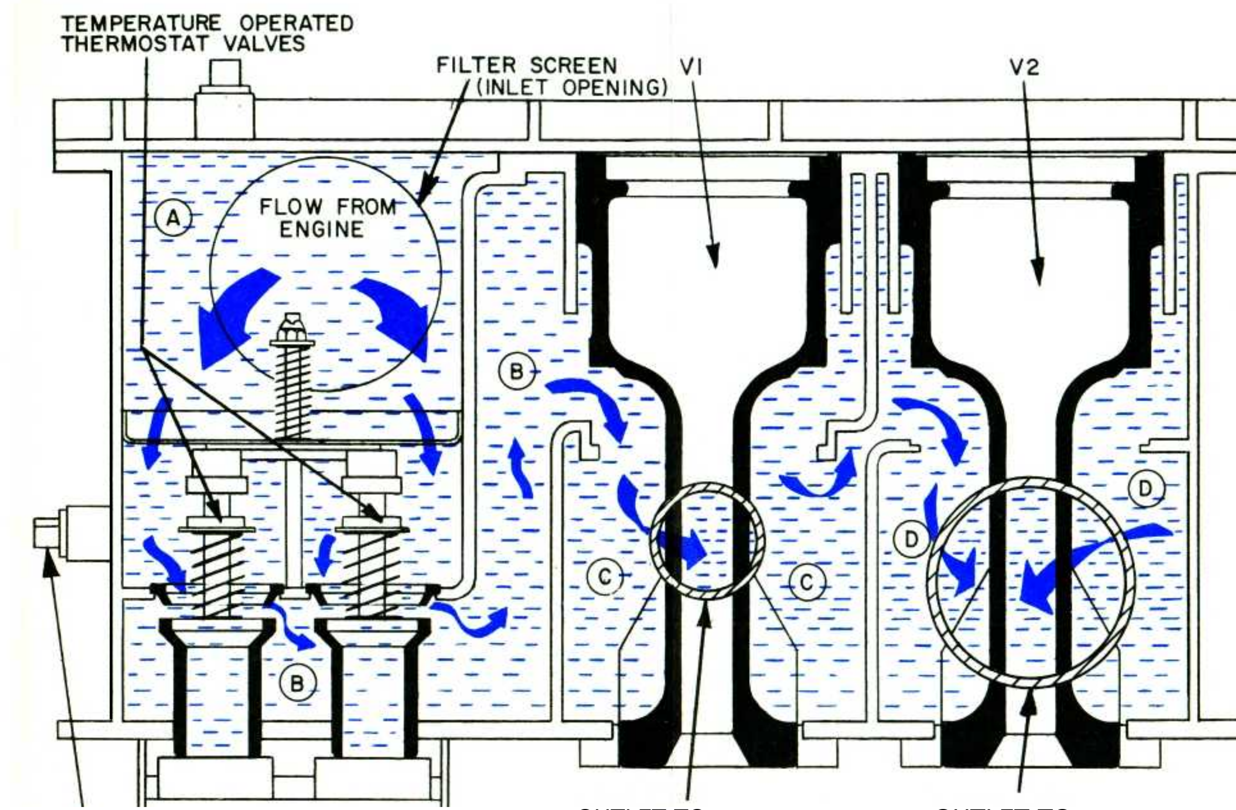


NOTE;- A,B,C AND D ARE SEPARATE CAVITIES WITHIN THE VALVE ASSEMBLY.

VALVES VI AND V2 ARE HOLLOW PISTON TYPE VALVES.

Fig. 6-3. Flow-control valve operation (Condition: partial engine cooling required)

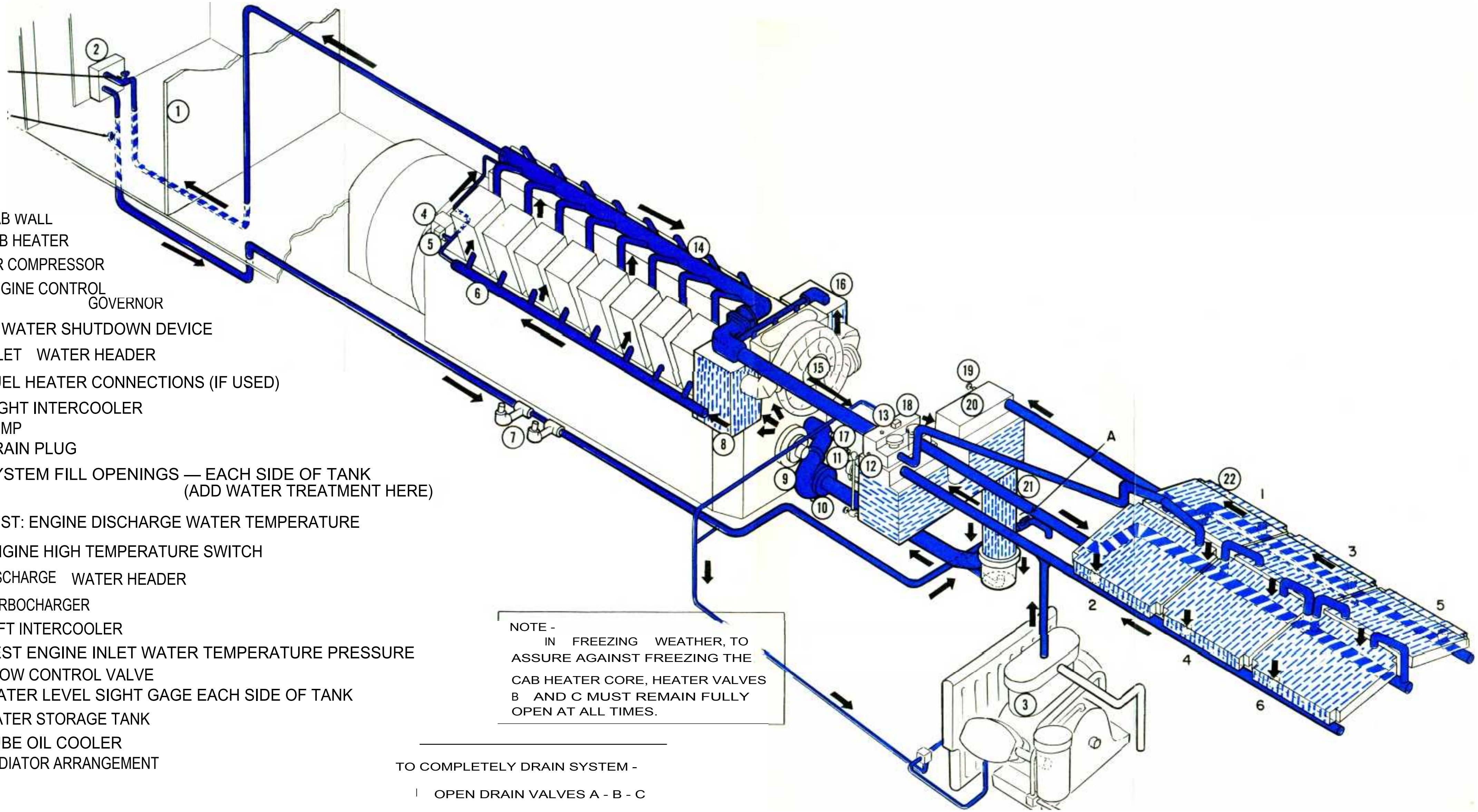
Fig. 6-4 (E-9948A)



NOTE- A,B,C AND D ARE SEPARATE CAVITIES WITHIN THE VALVE ASSEMBLY

VALVES VI AND V2 ARE HOLLOW PISTON TYPE VALVES.

Fig. 6-4. Flow-control valve operation (Condition: full engine cooling required)



O CAB WALL
O CAB HEATER
O AIR COMPRESSOR
O ENGINE CONTROL GOVERNOR
()LOW WATER SHUTDOWN DEVICE
O INLET WATER HEADER
FUEL HEATER CONNECTIONS (IF USED)
RIGHT INTERCOOLER
PUMP
DRAIN PLUG
SYSTEM FILL OPENINGS — EACH SIDE OF TANK (ADD WATER TREATMENT HERE)
12 TEST: ENGINE DISCHARGE WATER TEMPERATURE
13 ENGINE HIGH TEMPERATURE SWITCH
14 DISCHARGE WATER HEADER
TURBOCHARGER
LEFT INTERCOOLER
TEST ENGINE INLET WATER TEMPERATURE PRESSURE
FLOW CONTROL VALVE
WATER LEVEL SIGHT GAGE EACH SIDE OF TANK
WATER STORAGE TANK
LUBE OIL COOLER
RADIATOR ARRANGEMENT

Fig. 6-5. Locomotive cooling-water system

AIR SYSTEMS

DESCRIPTION

EQUIPMENT AIR SYSTEM (See Fig. 7-3)

Air enters the front end of the locomotive through a screened inlet. The incoming air passes first through the equipment blower, then down into the platform. Part of the air moves to the front of the locomotive, passing through an air cleaner. The bleed air is discharged out the bottom of the locomotive. The cleaned air is supplied to the Control Compartment, a cab heater, and front traction motors. The air also moves in the platform toward the rear of the locomotive, and is cleaned by another air cleaner. This cleaned air ventilates the back-traction motors and extended-range, dynamic braking compartment, if used. In the platform directly below the generator, another air cleaner supplies cleaned air to the generator, auxiliary generator, exciter, and to the engine cab for pressurization. The equipment air cleaner is made up of 14 panels, as shown in Fig. 7-1, each panel having 54 individual tubes. Each tube acts as a miniature cyclonic dirt separator. (See Fig. 7-2.) Incoming air enters the vanes in the tubes, causing the air to swirl. Dirt particles, being heavy, go to the outside, and eventually leave the far end of the outer tube. The cleaned air swirling in the central portion is discharged out of the cleaner. The bleed air carries the dirt out of the cleaner.

The small opening at the bottom of each panel permits the separated dirt and bleed air to escape. (See Fig. 7-1.) It is continuously discharged from the locomotive through outlets beneath the underframe.

Test results show that all dirt particles eight microns or larger are removed by this cleaner. (A micron is one-millionth of a meter or approximately 1/25,000 of an inch.)

The cleaned air passes through the cleaner into the main air duct of the locomotive, which has been formed by enclosing the space between the center sills, top and bottom, with metal plates welded air tight.

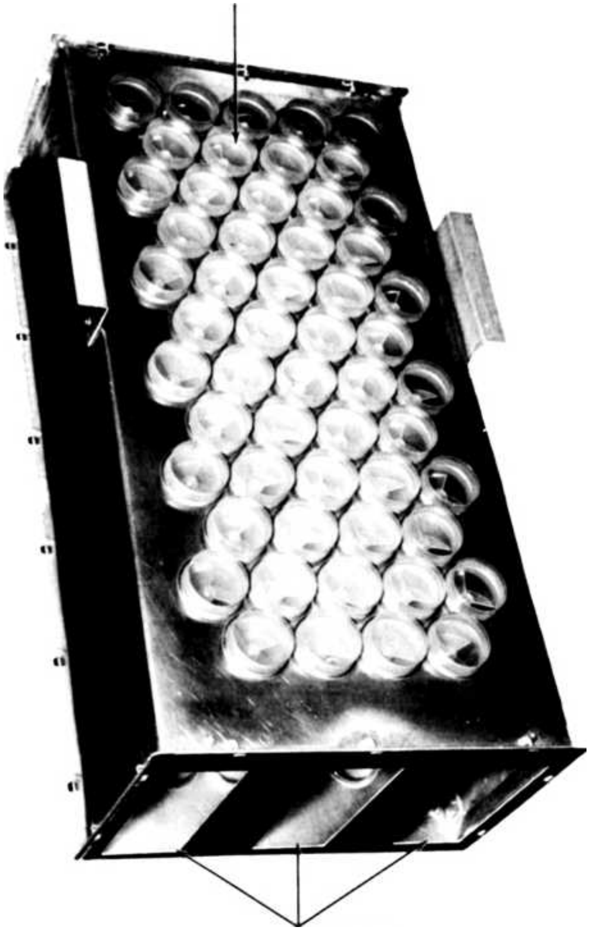


Fig. 7-1. *Air cleaner*

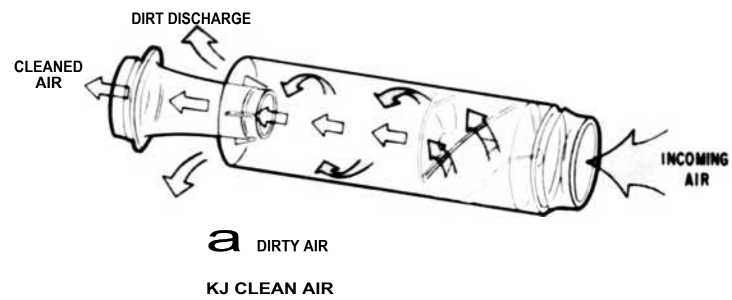


Fig. 7-2. ***Equipment and engine air cleaner tube***

MAINTENANCE

Present experience indicates that periodic cleaning of the air cleaner is not needed. Normal scouring by dust, rain, and snow will provide all the cleaning necessary. If, due to extremely unusual operating conditions, it is felt that cleaning is desirable, remove the cleaner and clean it, using a non-caustic cleaner recommended for aluminum. See DATA portion of these instructions for approved cleaners. Follow the use of cleaners with a light spray of clear water.

Two access holes are provided underneath the locomotive platform through which the cleaners may be removed and the main air duct inspected. The cover on these access holes should be kept tight to prevent leakage of ventilating air.

Felt seals and flexible ducts at points where air from the main duct goes to various pieces of equipment should be kept tight. Poor maintenance of these seals and ducts will result in dirt and moisture gaining entry to the various devices, and can result in enough air leakage to cause overheating.

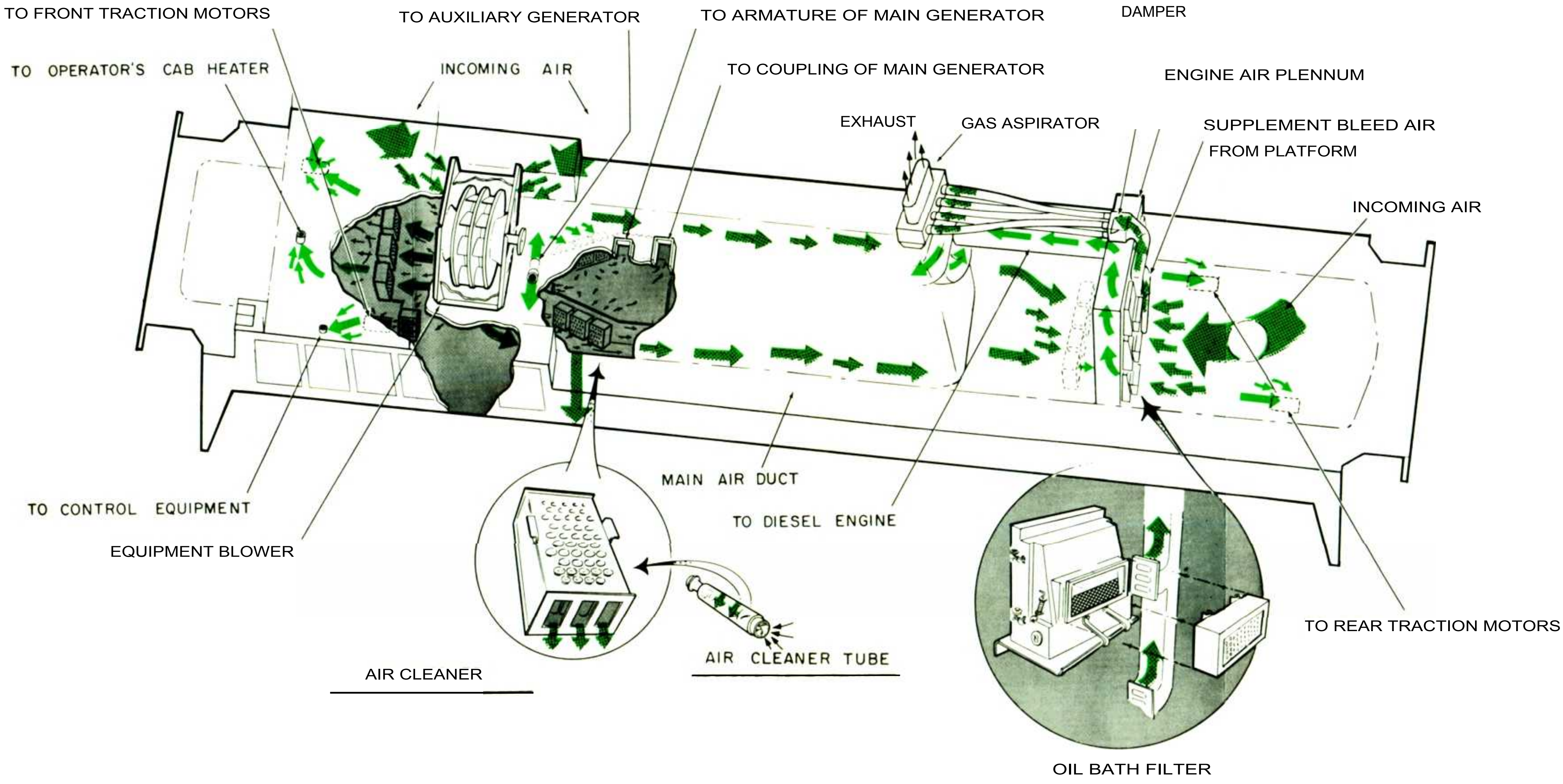


Fig. 7-3. Locomotive air system

ENGINE AIR SYSTEM (See Fig. 7-3)

Air enters the rear part of the locomotive through a screened inlet. Most of this air is used to cool the radiators. Part of the air goes to the engine air cleaning system. The engine air cleaner consists of six air cleaner assemblies mounted to the engine air plenum. Each of these assemblies consists of an air cleaner fastened to an oil bath filter. (See Fig. 7-4.) The air cleaner bleed is accomplished with an exhaust gas aspirator. Supplemental bleed air is obtained from the platform air duct. A bleed air damper, shown in Fig. 7-3, is provided to prevent reverse bleed air flow during adverse operating conditions.

When the diesel engine is running at low speed, all air entering the oil bath filter assembly is deflected downward through the oil. Due to the high velocity of the air as it passes across the surface of the oil pool, droplets of oil are picked up and carried upward to wet the screen of the filter panel. It is this oil, draining back down into the reservoir at the bottom, that carries away dirt particles trapped by the filter screen. The quantity of this dirt is comparatively small due to the cleaning action of the air cleaner.

As the engine speed increases, the spring-loaded baffle in the front of the oil bath filter, as shown in Fig. 7-5, will be deflected by the pressure of the air stream and permit most of the air to go directly to the filter. However, a portion of the air is deflected downward and across the oil pool to maintain the self-cleaning action of the filter.

MAINTENANCE

The entire air duct system between the air cleaners and the turbocharger entrance must be kept air tight. Inspect for cracks and leaks, at each maintenance period. Any leakage in this duct will admit dust, moisture, or engine room vapors.

7-4 (E-13539)

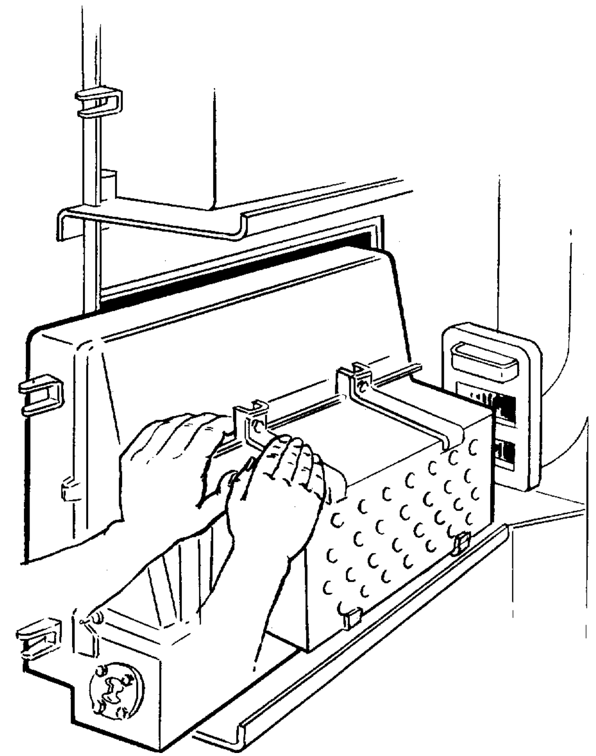


Fig. 7-4. Oil-bath filter installation.

CAUTION: *RUBBER SEALS IMMEDIATELY BEHIND THE OIL BATH FILTER ASSEMBLIES MUST BE KEPT IN GOOD CONDITION. FAILURE TO DO THIS WILL RESULT IN BYPASSING THE FILTER AND PERMIT UNCLEANED AIR TO ENTER THE ENGINE DIRECTLY. THIS WILL RESULT IN HIGH RATES OF WEAR IN THE ENGINE. RENEW THESE RUBRBER SEALS AS NECESSARY.*

ENGINE AIR CLEANER ASSEMBLY

The oil level in the oil bath filter sump should be checked periodically, as listed in the Lubrication and Servicing Schedule. Check the oil level after the engine has been shut down for 10 minutes or longer. The oil level is satisfactory if it is at or above the "Add Oil" mark. Do not add oil. If the oil level is below the "Add Oil" mark, inspect the engine air system to find out why the oil is low and correct. Inspect, clean, and refill the oil bath air filters per the Maintenance Instructions. (See Fig. 7-5.)

Over a long period of time, the oil level may increase due to the accumulation of dirt in the bottom of the filter tanks. When necessary, remove the filters and clean them per the Maintenance Instructions.

To remove and disassemble the engine air cleaner, use the following procedure:

1. Remove the two clips, pull the assembly forward, and slide it out of the locomotive.

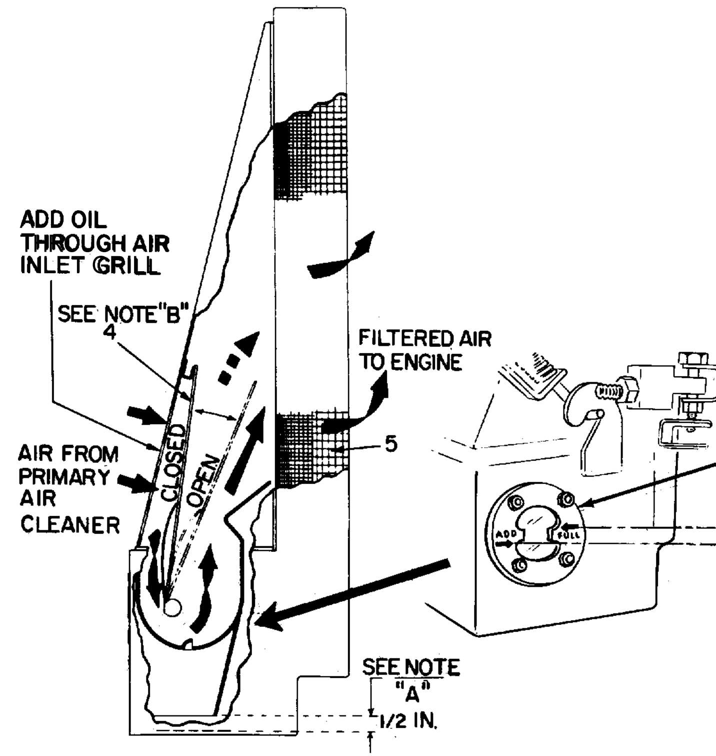
2. Detach the air cleaner from the oil bath cover by removing the four " ° Z" bars.

3. Detach the oil bath cover by loosening and rotating the two bolted clips and turning the two spring clips.

Inspect the engine air plenum for air leaks, cracks, etc., and repair as necessary. Inspect the engine air plenum and bleed air duct gaskets, and replace as necessary.

Inspect the air cleaner for dirt, and clean if necessary, by using a non-caustic cleaner recommended for aluminum. See DATA Section of these instructions for approved cleaners. Follow the use of cleaners with a light spray of clear water.

Fig. 7-5 (E-13538)



NOTE A: Do not let the dirt accumulate above this line.

NOTE B: The baffle opens as the air volume increases, thus keeping the velocity of air across the oil pool relatively constant.

Fig. 7-5. Cross-section view of oil-bath filter

AIR SYSTEMS

Inspect the cover and clean. Use only hot running water to clean the cover. If desired, blow with compressed air, wipe with clean rags, or simply allow the water to drain. After this cleaning has been completed, the baffle plate should be inspected for proper operation. Inspect the gaskets and replace them if necessary.

Inspect the oil bath filter sump and the media, by using a strong light. The media should be clean and dirt free over its entire area at all times, and should be well wetted with oil. It is important that the filter media be clean, because if appreciable dirt accumulates on the media, the air flow is restricted causing high air velocities through the remaining open media. Under these conditions, the ability of the media to separate the oil from the air may be penalized and oil may be carried into the engine. Inspect the bleed-air ducting and aspirator. If the bleed-air ducting and aspirator are intact and the media shows signs of plugging, or dirt in the sump exceeds 1/2 inch, the time between maintenance and cleaning should be reduced accordingly.

CAUTION: *DO NOT USE STRONG CAUSTIC CLEANERS, AS SUCH CLEANERS HAVE A DETERIORATING EFFECT ON THE FILTER MEDIA, PLASTIC SIGHT GAGE, AND ALUMINUM AIR CLEANER.*

Scrape the hard packed dirt cake from the sump by using a scraper, after first pouring off the oil. Clean the sump thoroughly with recommended cleaners. The entire panel and sump assembly should then be flushed vigorously in a vessel containing cleaner, by dipping and draining alternately to flush out any dirt which may be embedded in the filter media.

After filter has drained, hold the panel up to a strong light (200-watt light bulb) and check for imbedded dirt. This is very important. The light should be dimly visible over the entire face of the media, and any dark areas in

AIR SYSTEMS

which the light does not penetrate indicates imbedded dirt which must be removed by additional flushing before the filter is reapplied to the locomotive. Normally, the action of the oil on the panel will keep the media free of such dirt accumulations.

Fill the sump to the "FULL" mark with oil. Reassemble the cover and air cleaner to the oil bath filter and install the assembly into the locomotive as follows:

Push the air filter assembly to within six inches of the normal position as shown in Fig. 7-4. The last six inches of movement should be made with the filter at a slight inward angle, and a hard quick push on the air filter assembly should engage the spring properly. Apply the two clips and tighten to a snug fit. After assembly, inspect the air cleaner to engine air plenum seal, and the air cleaner to bleed duct seal.

During winter operation with air temperatures below 32 F, thoroughly saturate the filter media with recommended oil before filling the sump with oil.

DAMPER

The bleed air damper, shown in Fig. 7-3, is provided to prevent reverse air cleaner bleed air flow. This damper should be inspected for freedom of movement (binding) and intactness of the open and closed stops, and for wear whenever the aspirator or turbo are removed for maintenance.

SUPPLEMENT BLEED

The supplement bleed pipe is shown in Fig. 7-3. This pipe and its connections must be intact.

ASPIRATOR AND FLEXIBLE PIPING

The aspirator and flexible piping should be inspected for cracks and leaks. Failure of these parts will result in premature dirt loading of the oil bath air filters.

AIR PIPE ELBOWS

Connecting elbows between the turbocharger and the intercoolers are constructed with adjustable flanges at the intercoolers. This permits slight variations in alignment between flange connections. When assembling the elbows, the hex nuts on the studs at the intercooler should be loosened several turns to allow for adjustment. Make sure the sealing "0" rings are in place. Install and tighten colts in all the flanges. Now, the next nuts on each side of the adjustable flange may be drawn up evenly, taking care not to distort the flexible elbow in the process. These components are shown in Fig. 7-6.

INTERCOOLERS

The engine is equipped with two intercoolers which affect the temperature of air supplied to the cylinders. Each intercooler has a steel fabricated case enclosing a tube and fin-type radiator core, and is welded to the

Fig. 7-6. Assembling adjustable elbow

0

7-6 (E-9966)

tube sheets. The water headers, at top and bottom, are removable. Air heated by compression and discharged by the turbocharger passes horizontally through the core. Heat is removed and carried away by engine cooling water which flows through the tubes in the core in three passes, up, down, and up again. (At idle or at light loads in cold weather, the air may be warmed by heat flow from the water.)

The radiator core is permanently mounted in the intercooler case, while the top and bottom headers may be removed to permit cleaning and repairs of the tubes.

> **NOTE:** *Intercooler parts such as the case, core, and end headers are not interchangeable. These parts are individually machined and fitted together. Should an intercooler require extensive repair, it should be returned to the factory for reconditioning and proper fitting of new parts.*

Each intercooler should be inspected periodically for dirt build-up in the air passages of the core. If, through poor filter maintenance, dirt is permitted to accumulate in the intercoolers, it will restrict air flow to the engine, thus resulting in high cylinder temperature, smoky exhaust, and loss of horsepower.

To inspect the intercoolers, remove the elbows between the turbocharger and intercoolers, and observe the condition of the core fins through the inlet opening. A light coating of oily dust is normal.

The preferred method of cleaning the cooler is by removing the headers and completely immersing the case and core in an agitated tank containing an appropriate cleaning solution, followed by a thorough rinse with clean water. See DATA for recommended cleaning compounds.

> **NOTE:** *The intercoolers are constructed with core fins made of aluminum; therefore, do not subject cores to cleaning or descaling agents which are harmful to aluminum.*

Before the top and bottom headers are applied, the cooler should be air tested for leaks in the tubes. Construct and apply gasketed blanking plates over the air openings, with one plate adapted for an air hose connection. With the cooler case completely immersed in clean water, apply regulated air pressure of 30 psi maximum to the cooler. Inspect the case and tubes for leaks, as indicated by air bubbles. For later repair, mark the location of leaks, using a wax crayon.

Leaks in the tubes may be eliminated by plugging both ends of such tubes with solder or plugs made of phenolic resin. Renew the intercooler if more than 10 percent of the tubes require blocking. Should a leak develop in the intercooler case, it may be repaired by welding with mild steel welding rod.

INTAKE MANIFOLDS

Air intake manifold bolts must be kept tight to avoid air leaks. (See Fig. 7-7.) When assembling sections of the manifold, such as after a cylinder changeout, care should be taken that the sealing "0" rings are in place and that the beads in the interconnecting tubes are properly centered, as evidenced by the beads being visible at each side, as shown in Fig. 7-8.

EXHAUST MANIFOLD INSTALLATION (AS A COMPLETE PACKAGE)

CAUTION: *THE MANIFOLD MUST BE INSTALLED SO THAT WIIEN ASSEMBLED, THE SYSTEM WILL BE STATICALLY UNLOADED. IMPROPER ASSEMBLY WILL STATICALLY LOAD THE MANIFOLD AND CAN REDUCE SERVICE LIFE. IN ADDITION, TIIE BELLOWS CAN BE EASILY DAMAGED IF THEY ARE PRIED OR IF THE CLAMPING RINGS OR OTHER PARTS ARE DROPPED ON THEM.*

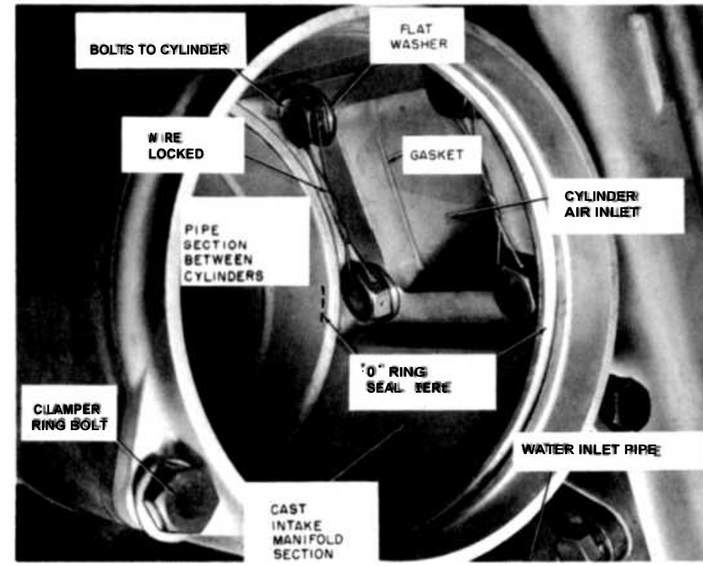


Fig. 7-7. **Section of air manifold installed on cylinder**

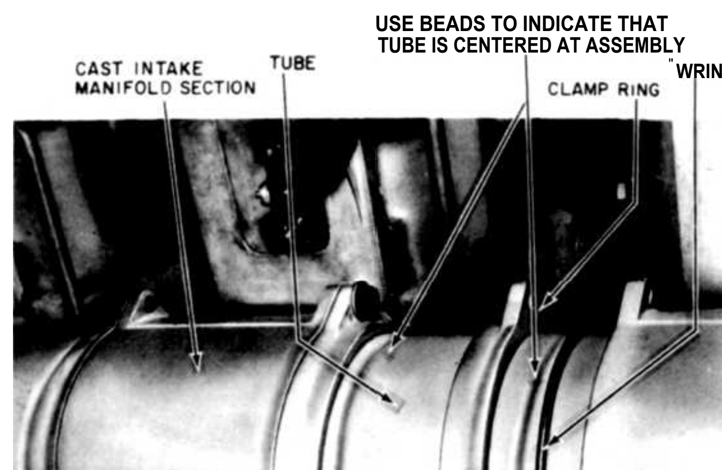


Fig. 7-8. Air-intake manifold

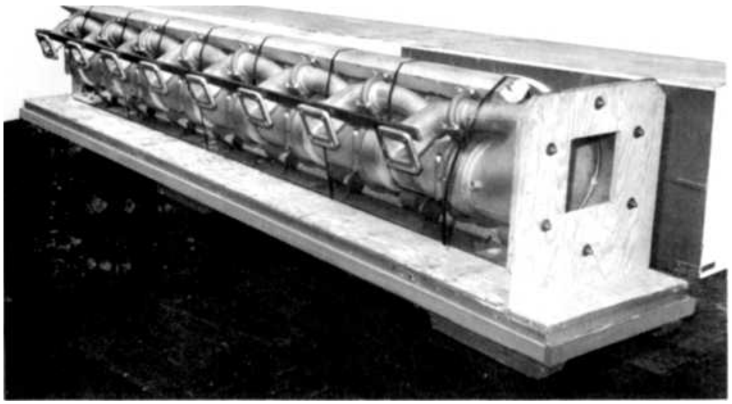


Fig. 7-9. Lifting arrangement

The shipping bars attached on the outside of the elbow flanges have dowels which locate in the flange holes and maintain the correct spacing. These bars should only be removed at the last possible moment before installation.

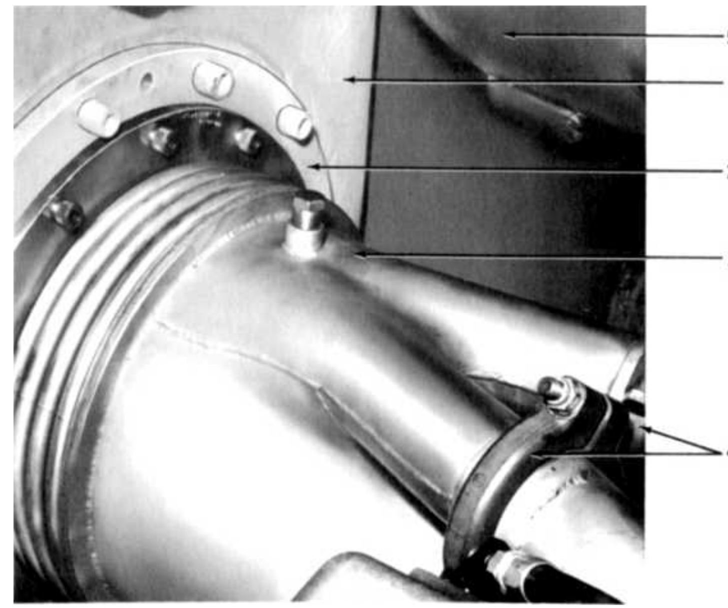
Raise the manifold and the mounting plate by attaching straps to the 4 by 4 located at the top center of the manifold, and place in the engine Vee. The manifold must be lifted carefully, and care must be taken to space the slings so as not to let the manifold sag. (Refer to Fig. 7-9.)

Install and tighten the bolts in the following sequence:

1. Align the mounting plate and install the bolts. Install the rear bolts in the end closure plate, then install the forward bolts. Use heavy lockwashers under all bolts. Torque the bolts. See DATA Section.

2. Mount the manifold to the turbocharger (see Fig. 7-10), using bolts with high-temperature thread compound and heavy lockwashers. Torque the bolts. See DATA Section.

Fig. 7-10 (E-13407)



1 Turbocharger
2 Turbocharger inlet casing
3 Exhaust manifold turbo inlet section
4 Cylinder exhaust elbow clamping rings
5 Engine water discharge header

Fig. 7-10. Exhaust manifold to turbocharger mounting equipment

3. Loosen the elbow clamp ring bolts.

CAUTION: *DO NOT ALLOW ELBOW CLAMP RINGS OR BOLTS TO DROP ONTO THE BELLOWS, AS THIS WILL DENT THE BELLOWS.*

4. Align the manifold elbows to the cylinder exhaust ports, and mount to the cylinder using gaskets, bolts with high-temperature thread compound, and light lockwashers.

AIR SYSTEMS

Torque the bolts. See DATA Section. Do not use pry bars on the bellows to obtain alignment.

5. Visually check the alignment of the main pipe section to the elbows. This alignment can be improved, if necessary, by loosening the main pipe clamp rings and slightly rotating the main pipe section. The seal ring can be shifted slightly to obtain good alignment. Do not use a hammer to rotate the main pipe sections.

6. Torque the main pipe clamp ring bolts. See DATA Section. Clamp ring gaps should be kept equal within 1/16 inch, to avoid bending the bolts.

7. Torque the elbow clamp ring bolts. See DATA Section. Clamp ring gaps should be equal within 1/16 inch, to avoid bending the bolts. If the clamp ring gap closes, a new seal ring should be installed.

8. Retorque all clamp ring bolts after the load box test and after the first month of operation.

SECTION REPLACEMENT

A. To replace a manifold main pipe section, proceed as follows:

> **NOTE:** *Any main pipe section may be replaced without removing the water header. Carefully clean the elbow joint parts, and inspect for nicks which will not seal. Seal rings are reusable.*

Retorque all the clamping ring bolts one month after section replacement.

1. Unbolt the elbow clamp rings on the elbows attached to the section to be removed, and on the left and right elbow just ahead of this section.

AIR SYSTEMS

2. Remove the cylinder mounting bolts on the two elbows attached to the section to be removed. Also, remove the elbow mounting bolts from the cylinder just ahead of the section to be removed. Remove these elbows.

3. Remove the clamp rings from both ends of the section to be removed.

4. Carefully lift out the section, rotating it to clear the water discharge header.

5. Install the new section in reverse order, being careful to align the section to the mounted elbows before torquing the clamp rings.

B. To replace the manifold-turbocharger inlet section (when the turbo inlet casing is of the current short nose design), proceed as follows:

The short nose design can be observed by removing the elbow at cylinder IL or 1R and looking into the manifold towards the turbocharger. The short nose inlet casing has a center vertical vane.

1. Remove the top six socket head bolts holding the turbo inlet casing to the turbo housing. (To permit sliding the transition section straight up.)

2. Unbolt the elbow clamp rings and the elbows for cylinders 1L and 1R, and remove the elbows.

3. Remove the clamp ring at the forward end of the first main pipe section.

4. Remove the bolts mounting the manifold — turbocharger inlet section to the turbocharger.

5. Lift this section up and out toward the left side of the engine.

6. Reverse these procedures to install the new section.

C. To replace the manifold-turbocharger inlet section (when the turbo inlet casing is of the earlier long nose design), follow the procedure in B above, except as noted:

1. Omit Item B1.

2. Remove the elbows to cylinders 2L and 2R, also.

3. a. Remove the clamp ring at the rear of the first main section also.

b. Lift out the first main section.

4. Same as Section B.

5. Same as Section B.

6. Same as Section B.

NOTE: *Be careful to obtain the correct alignment of the main-pipe section by installing elbows, then rotating the main section.*

DATA

OIL BATH AIR FILTER

*CLEANING COMPOUNDS (Non-Caustic Types Recommended for Galvanized Steel, Plastic and Paint)

Name of Manufacturer	Name of Product
Oakite Products, Inc.	Oakite Composition No. 111
Pennsalt Chemicals Corp.	Pennsalt Delchem Super CR Pennsalt Cleaner 44
Magnus Chemical Co., Inc.	Magnusol
Turco Products, Inc.	Turco Mulsirex

AIR CLEANER

*CLEANING COMPOUNDS (Non-Caustic Types Recommended for Aluminum)

Name of Manufacturer	Name of Product
Oakite Products, Inc.	Oakite Composition No. 111
Pennsalt Chemicals Corp.	Pennsalt Delchem Super CR Pennsalt Cleaner 44
Magnus Chemical Co., Inc.	Magnusol
Turco Products, Inc.	Turco Mulsirex

* Use the above cleaners according to directions supplied by the cleaner manufacturer. Equivalent cleaners made by other manufacturers may also be used.

AIR SYSTEMS

INTERCOOLER

**CLEANING COMPOUNDS (Non-Caustic Types Recommended for Aluminum and Galvanized Steel)

Name of Manufacturer	Name of Product
Oakite Products, Inc.	Oakite Composition No. 111
Pennsalt Chemicals Corp.	Pennsalt Delchem Super CR Pennsalt Cleaner 44
Magnus Chemical Co., Inc.	Magnusol
Turco Products, Inc.	Turco Mulsirex

EXHAUST MANIFOLD

**HIGH-TEMPERATURE THREAD COMPOUND

Name of Distributor	Name of Product
Surveyor's Inc. 302 So. Olden Avenue Trenton, New Jersey	FEL-PRO- C-5 COMPOUND
General Electric Company Transportation Systems Division Locomotive and Parts Department Repair and Renewal Parts Section Erie, Pennsylvania	NEVER-SEEZ NS-1

****NOTE:** *Equivalent compounds made by other manufacturers may also be used.*

TORQUE VALUES

Exhaust Stack Clamping Bolts. . . 3/8 in. Bolt 8-10 lb-ft
5/8 in. Bolt 15-18 lb-ft
Exhaust Manifold Mounting Bolts ....50-55 lb-ft
Main Pipe Clamping Bolts ....70-75 lb-ft
Elbow Clamp Bolts..70-75 lb-ft
Manifold Elbow Bolts to Cylinder
Exhaust Port ....105-115 lb-ft
Exhaust Manifold to Turbo Inlet Clamp............. 70-75 lb-ft

OVERSPEED SYSTEM

DESCRIPTION AND OPERATION

The function of the overspeed system is to protect the locomotive power plant by preventing excessive rotational speed.

The overspeed system consists of the following principal components:

1. Overspeed governor.

2. Two overspeed shutdown butterfly valves, each with a hydraulic actuator connected by mechanical linkage.

3. Diaphragm-operated fuel cut-off actuating valve.

4. associated interconnecting lines.

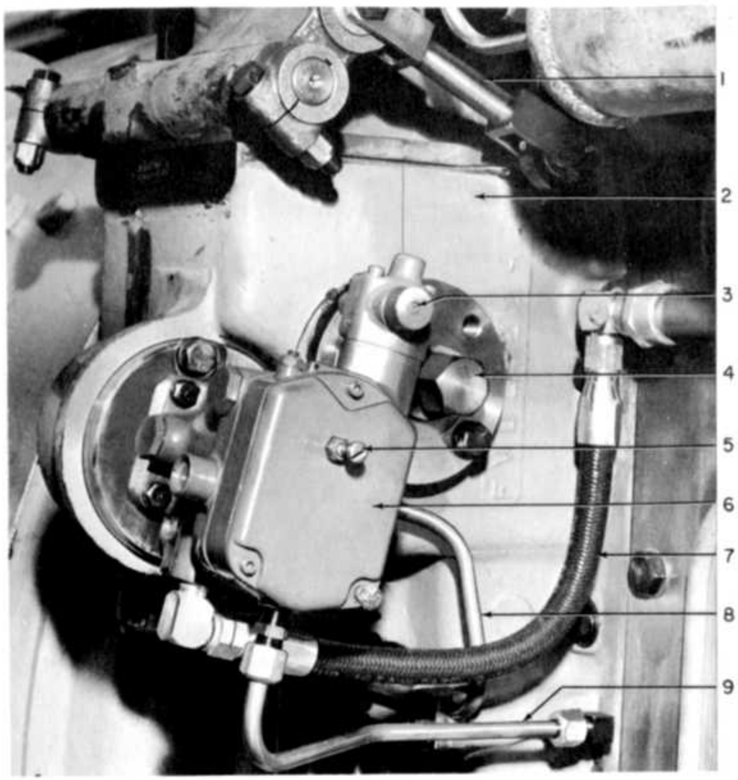
The overspeed governor is located on the right side of the engine, below the speed control governor. Like the speed control governor, it is driven from the right-bank camshaft gear through the governor drive gearing. (See Fig. 8-1.)

During normal engine operation, the overspeed governor delivers engine lubricating oil, at regulated pressure of 200 psi, to the actuators of the two overspeed shutdown butterfly valves.

These valves are mounted, one on each side of the engine, between the air outlets of the intercoolers and the first sections of the intake manifolds. (See Fig. 8-2.)

The overspeed shutdown butterfly valves are shown in cross-section in Fig. 8-3. When open, they permit air to flow from the intercoolers into the intake manifolds. When closed, air supply to the engine is cut off.

The actuators of the butterfly valves are constructed very much like an air-brake cylinder. Oil, under pressure

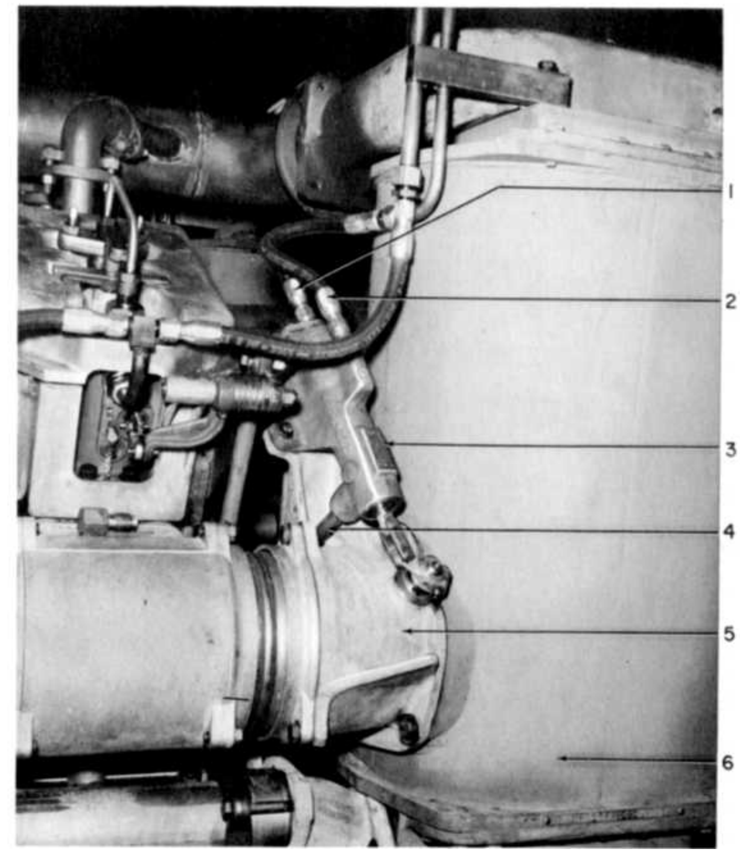


1 Engine control governor linkage
2 Governor drive gear case
3 Overspeed governor reset button
4 Tachometer drive (capped)
5 Overspeed trip adjustment
6 Overspeed governor
7 Oil line to butterfly actuators
8 Overspeed governor oil supply line
9 Overspeed governor oil drain line

Fig. 8-1. ***Overspeed-governor arrangement***

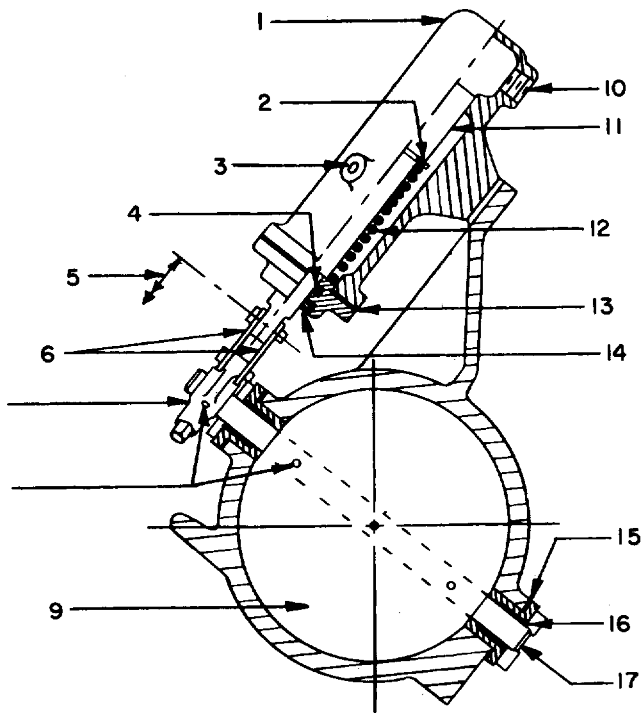
Fig. 8-1 (E-13455)

Fig. 8-2 (E-13456)



1 Oil inlet line to actuator
2 Oil line to butterfly actuator left side
3 Butterfly actuator cylinder
4 Actuator drain line
5 Butterfly valve housing
6 Right bank intercooler

Fig. 8-2. ***Butterfly-valve arrangement—right side***



1 Butterfly valve actuator
2 Piston washer
3 Oil drain connection
4 "O" ring
5 1-3/8 in. travel
6 Lever links
7 Lever
8 Roll pins
9 Butterfly valve
10 Oil supply connection
11 Piston
12 Piston spring
13 Gasket
14 Oil seal
15 Shim
16 Bearing
17 Butterfly valve shaft

Fig. 8-3. Overspeed-shutdown butterfly valve and actuator (shown in closed position)

from the overspeed governor, causes the actuator pistons to advance, opening the butterfly valves.

When engine overspeed is detected by the overspeed governor, the governor quickly cuts off oil pressure to the butterfly valve actuators and permits the lines to drain. The actuator springs then return the pistons, closing the butterfly valves, and cutting off air supply to both cylinder banks.

During operation, the overspeed governor draws the lubricating oil, which it delivers to the actuators, from a small reservoir inside the governor drive gear housing. While the engine is running, oil in this reservoir is constantly replenished from the main lube oil header.

The oil connections to the actuator bodies are marked in cast, raised letters "IN" and "OUT." Oil flows from the overspeed governor, through a pipe mounted along the right side of the engine, to the "IN" connection of the right-bank actuator. (See Fig. 8-1.)

When the oil pressure moves the piston in the right-bank actuator to the FULL OPEN position, oil flows from the "OUT" port, through a crossover pipe, to the "IN" port of the left-bank actuator. (See Fig. 8-2.)

When the left-bank actuator piston is fully open, oil flows from its "OUT" port, through a pipe mounted along the left side of the engine, to the connection on the overspeed fuel shut-off valve on the main control governor.

Pressure from the overspeed system applied to the fuel shut-off valve causes a bypass port in the governor's speed setting servo system to close, allowing the governor to function normally in supplying fuel to the cylinders.

Care should be used in connecting the oil lines to the actuators, to be sure the hoses are connected to the proper "IN" and "OUT" ports. Check that the actuator pistons move smoothly to the open position, and in the proper sequence when the engine is cranked.

To prevent overheating of the oil being pumped to the butterfly actuators by the overspeed governor and to cool components of the overspeed system, the actuators are built intentionally "leaky" so that a small amount of oil circulates through them to the crankcase. At the same time, this feature also hastens "dumping" of oil which is in the actuators, and closing of the butterfly valves when overspeed is detected.

The overspeed system is "failsafe" in operation. A broken oil line, loss of engine oil, or governor failure will stop the diesel engine.

NOTE: *If an engine shutdown occurs due to or' et--speed, inrestigate the cause and make the neces-sary repairs before attempting to start the en - gine. Reset the orerspeedgorernor by depress - ing the reset button.*

OVERSPEED GOVERNOR

DESCRIPTION

The governor main body contains the following components:

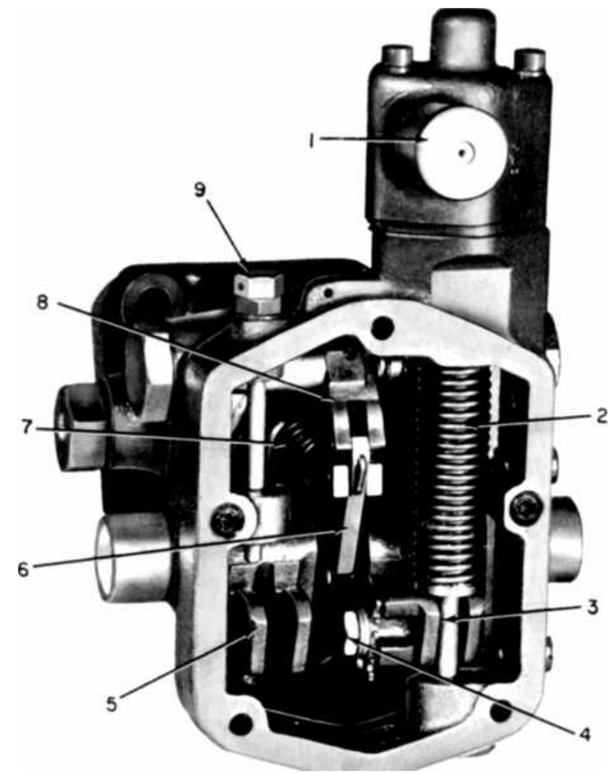
1. A pilot valve plunger with speeder spring and linkage.

2. A pair of flyweights mounted on the end of the drive shaft.

3. A power piston, at the end of which is mounted the terminal lever.

4. An oil pressure relief valve, mounted in the side of the governor case.

The base portion contains a positive displacement gear pump. The outer case portion contains the lock-out and latching mechanism. (See Fig. 8-4.)



1 Reset button
2 Reset spring
3 Overspeed lockout rod
4 Speed droop adjustment (set at 50% position)
5 Terminal lever
6 Floating lever
7 Speeder spring
8 Speed adjusting lever
9 Terminal lever stop screw

Fig. 8-4. Overspeed governor with cover removed

OVERSPEED SYSTEM

OPERATION

Engine Running (normal speed range). (See Fig. 8-5.)

NOTE: *On the engine, the overspeed governor is mounted with its drive shaft horizontal. In Fig. 8-5 and Fig. 8-6 the governor is shown with the drive shaft vertical. The following test refers to the governor as it is shown in the FIGURES, NOT AS IT IS MOUNTED ON THE* ***ENGINE.***

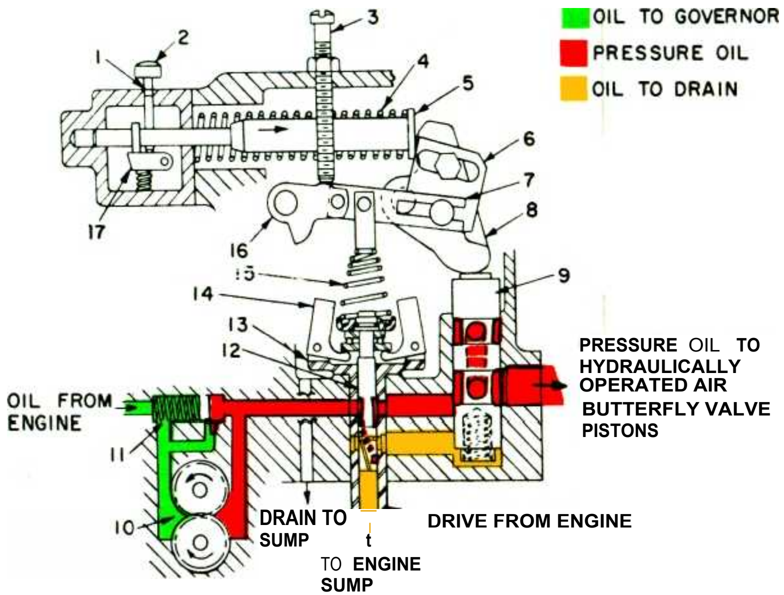
1. The reset spring and overspeed lockout rod will position the terminal lever to hold the power piston down in its bore (lockout latch released).

2. Downward pressure of the speeder spring, as set by adjustment of the trip-speed setting screw, will hold the flyweights in and the pilot plunger down.

3. In these positions, the bottom of the power piston is connected to drain to the engine sump through ports in the pilot valve bushing to a groove in the pilot valve plunger, and through a slanting hole drilled from the groove to the lower end of the pilot valve plunger.

4. Oil under pressure (200 psi) from the pump is delivered through porting in the pilot valve bushing, around the pilot valve plunger, and out to the power piston. With the piston down, the oil can flow around the lower groove and out of the governor case through connecting lines to the butterfly valve actuators.

NOTE: *The upper groove in the power piston will also contain oil under pressure by means of drilled holes connecting to the lower groove. Also, a slot in the pilot valve plunger, below the port connecting to the power piston, is connected to the pressurized oil in the pilot valve bushing through a second diagonally drilled hole.*



1 Trip indicator
2 Reset button (press to reset)
3 Trip speed setting screw
4 Reset spring
5 Overspeed lockout rod
6 Speed droop bracket (set at 50% position)
7 Floating lever
8 Terminal lever
9 Power piston (down)
10 Gear pump
11 Relief valve
12 Pilot valve plunger (down)
13 Flyweight head
14 Flyweight
15 Speeder spring
16 Speed adjusting lever
17 Lockout latch (released)

Fig. 8-5. Operating condition—engine running at normal speeds

Fig. 8-6 (E-9708)

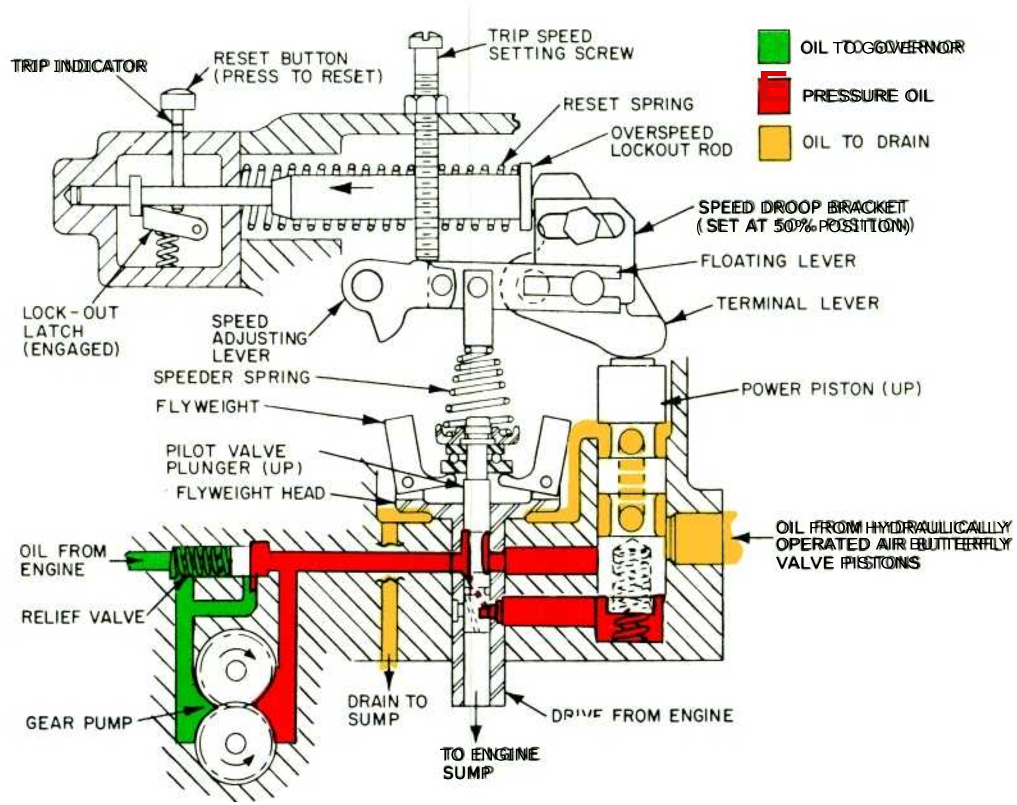


Fig. 8-6. Tripped condition—result of engine overspeed

OVERSPEED SYSTEM

Engine Overspeed (Tripping Action) Piston-Type Valves (See Fig. 8-6)

1. As engine speed increases to the overspeed setting, the flyweights will move outward and raise the pilot valve plunger, bringing the pressurized oil slot in line with the port connected to the power piston.

2. Pressurized oil flowing under the power piston will force the piston up to close-off the supply of pressurized oil to the butterfly valve actuators. This will position the upper groove in the piston above the top of the power piston bore.

3. This allows oil from the butterfly valve actuators to flow back through the holes connecting the two grooves in the power piston, over into the flyweight head cavity in the governor case, and down through a drain hole to the engine sump.

4. This releases the spring-loaded butterfly valve pistons, and the butterfly valves close, shutting off the engine air supply.

5. Upward movement of the power piston to the tripped position also rotates the terminal lever, raising the end of the floating lever at the speed droop bracket pin. This reduces the pressure of the speeder spring, and allows flyweights to move out quickly. Rotation of the terminal lever also pushes the overspeed lockout rod back until the lockout latch engages and raises the reset button.

TRIP INDICATOR AND RESET

Visual indication that the unit is in tripped position is provided by a red band below the reset button, visible when the button is up. To reset the governor following an overspeed trip, push down on the reset button.

ADJUSTMENTS

CAUTION: *ONLY QUALIFIED PERSONNEL SHOULD BE PERMITTED TO MAKE ADJUST - MENTS TO THE OVERSPEED GOVERNOR.*

The governor has two points of adjustment:

1. The speed droop bracket, located inside the governor on the terminal lever, must be set at midposition.

2. The trip-speed setting screw in the governor cover must be adjusted to provide trip action at the specified overspeed for the engine.

TRIP ADJUSTMENT PROCEDURE

A direct-reading, accurately calibrated tachometer is necessary to read engine crankshaft speed when adjusting the trip speed. The tachometer may be applied to the tachometer drive opening located on the governor drive gear case just behind the overspeed governor. See DATA for proper governor trip speed.

CAUTION: *UNDER NO CIRCUMSTANCES CAUSE OR ALLOW THE DIESEL ENGINE CRANKSHAFT SPEED TO EXCEED SPECIFIED TRIP RPM. IF THIS WARNING IS NOT HEEDED, EXTENSIVE DAMAGE COULD RESULT.*

ONLY QUALIFIED PERSONNEL SHOULD BE PERMITTED TO CONDUCT AN OVERSPEED TEST AND MAKE NECESSARY ADJUSTMENTS TO THE OVERSPEED GOVERNOR MOUNTED ON THE DIESEL ENGINE.

1. Check the overspeed system for proper operation. While running the engine at Notch 6, no load, back out the trip adjusting screw, noting the number of turns required to cause engine shutdown. If shutdown does not occur, investigate and correct the cause before proceeding.

2. Return the trip adjusting screw to its original position.

3. Return the throttle handle to idle; then, reset the overspeed governor and start the engine.

4. Run the engine at Notch 8, no load.

5. Using a pry bar under the governor power piston link, increase the engine speed to a maximum 1130 rpm.

6. Note the speed at which the overspeed governor trip action occurs. It must never be allowed to exceed 1130 rpm.

   a. To lower the trip speed, back out the trip adjustment screw.

   b. To raise the trip speed, screw in the trip adjusting screw.

When tests and adjustments have been completed, the governor is ready for service. Lock the trip-speed setting screw, using sealing wire, to prevent misadjustment by tampering.

OVERSPEED SYSTEM

DATA

SYSTEM

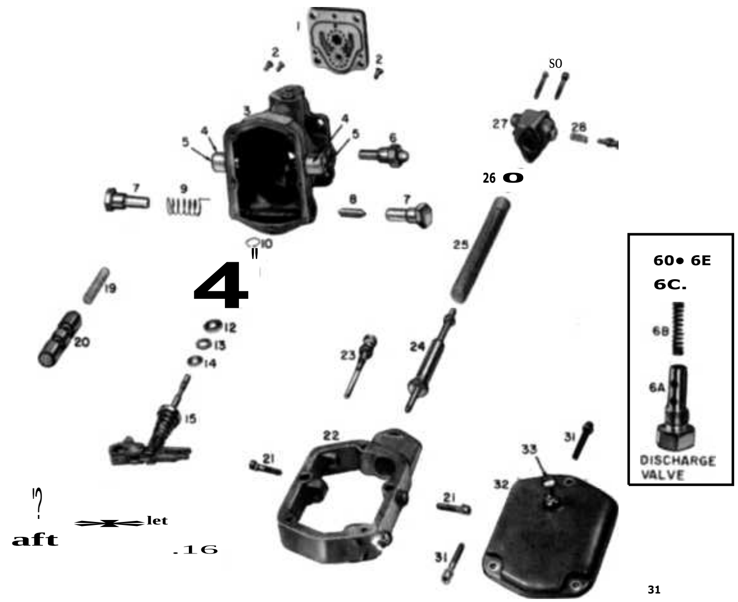
Hydraulic Oil .... Engine Lube Oil
Pressure During Normal Operation .... 200 psi

GOVERNOR

Governor to Crankshaft Speed Ratio .... **3.465 to 1**
Pressure Relief Valve Setting
(Non-Adjustable) .... 200 psi
Governor Trip Speed

Crankshaft Rpm	Tachometer Drive Rpm
1130 10	1677±10

OVERSPEED SYSTEM



1 Governor **base and** pump **gears**
2 Slotted screws (base)
3 Governor case
4 Terminal sleeve
5 Welch **plug**
6 Relief valve
   a sleeve
   b spring
   c **plunger**
   d **bushing**
   e pin
7 Spacer cap
8 Pin
9 Torque spring
10 Drive **shaft** snap **ring**
11 **Drive shaft and ball head** assembly
12 Thrust bearing lower race
13 Thrust bearing ball cage
14 Thrust bearing upper race
15 Pilot valve, speeder spring and floating lever assembly
16 Cotter pin
17 Terminal shaft
18 Terminal lever
19 Spring
20 Power piston
21 Socket head screw (outer case)
22 Outer case
23 Stop screw
24 Lockout rod
25 Reset spring
26 Spring seat spacer
27 Latch housing
28 Spring
29 Reset plunger
30 **Socket head screw (latch housing)**
31 Socket head screw (cover)
32 Governor cover
33 Screw (trip speed adjusting)

Fig. 8-7. Exploded view of governor assembly

ENGINE CONTROL GOVERNOR

DESCRIPTION

The engine control governor is an electro-hydraulic device used to regulate speed and horsepower output on the diesel engine. It also includes a number of auxiliary devices to protect and provide the power plant with characteristics desirable for railway locomotive service.

The governor is a self-contained unit which is mounted on and driven by the diesel engine. It is equipped with its own oil supply and oil pressure pump, and is remotely controlled by the locomotive throttle.

During operation, the governor performs two basic functions. Primarily, it control the speed of the diesel engine by regulating the amount of fuel supplied to the engine cylinders. At any speed setting of the governor, speed control is isochronous; that is, the governor maintains constant engine speed regardless of changing conditions of load. The secondary function of the governor is to maintain a constant pre-determined horsepower output of the engine for each specific speed setting, by accurately controlling the engine load. Control of the engine load is accomplished by adjusting the strength of the generator field to compensate for electrical load changes on the generator and those resulting from variable auxiliary loads such as the air compressor, battery charging generator, etc. Thus, while the primary function of the governor is to maintain speed of the engine, by controlling both speed and load, a condition of balance can be established which results in a constant, single horsepower output for each speed setting of the engine.

AUXILIARY FUNCTIONS

The governor also has the following auxiliary functions:

ENGINE CONTROL GOVERNOR

1. Remote electrical throttle control for eight notch speeds, from 400 to 1000 rpm, plus a shutdown position.

2. Overriding of the normal load control operation to aid in controlling wheel slip and, in some applications, dynamic braking functions.

3. Automatic shutdown of the diesel engine in the event of failure of the lubricating oil pressure or failure of the cooling water pressure. Two switches in the governor provide lights and/or bell warnings in the operator's cab when either of the devices is tripped. At idle speed, a time delay is provided on the safety shutdown devices, to permit starting the engine while still providing shutdown protection if the pressures fail to develop within the allotted time.

4. An overspeed fuel shutoff valve to automatically shut off fuel to the engine in case of an engine overspeed.

5. Limiting of fuel supplied to the engine during starting, to provide improved starting characteristics.

INSPECTION AND MAINTENANCE

SOLENOID SEQUENCE TABLE

THROTTLE NOTCH	GOVERNOR SPEED CONTROL SOLENOIDS ENERGIZED			
Stop				D
Idle - 1				
2	A			
3	–		C	
4	A	-	C	-
5		B	C	D
6	A	B	C	D
7		B	C	
8	A	B	C	

ENGINE CONTROL GOVERNOR

SOLENOID SEQUENCE TEST

1. With the diesel engine shut down:

   a. Position the reverse handle in OFF.

   b. Move the selector handle to POSITION 1.

   c. Move the throttle handle to IDLE.

2. Have the air system charged and the locomotive brakes applied.

3. Remove the electrical connector from the governor with a twist, pulling outward from the governor. Remove the top cover, taking care to keep dirt and foreign matter from dropping into the governor. Reinstall the electrical connector.

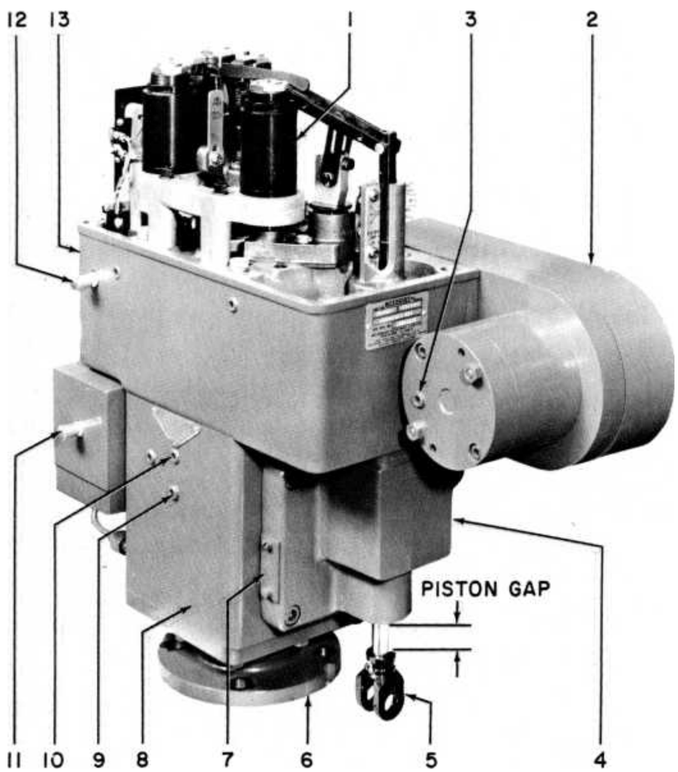
4. Close the battery switch, negative circuit breaker, fuel pump circuit breaker, and the control circuit breaker. Move the EC switch to RUN. Make sure the power limit switch is in NORMAL.

5. Depress the safety control foot pedal (if used), and advance the throttle handle from IDLE, checking the governor solenoid pickup in each numbered notch. Solenoid operation may be checked either by feeling the solenoids as the throttle is moved from notch to notch, or by observing the short visible length of the solenoid plunger which can be seen below the solenoid support. See SOLENOID SEQUENCE TABLE.

6. Move the throttle handle back to IDLE. Move the EC switch to START. Depress the engine stop button. The "D" solenoid should be energized.

7. If any solenoids fail to operate, check the internal governor wiring and also the connections to the governor electrical connector.

ENGINE CONTROL GOVERNOR



1 Electric solenoid pack
2 Load control and servomotor assembly
3 Vane servomotor pressure test opening
4 Power cylinder
5 Power piston rod
6 Governor base
7 Compensating needle valve (under cover)
8 Power case
9 Accumulator pressure test opening
10 Air vent opening
11 Low water pressure shutdown reset button
12 Low oil pressure shutdown reset button
13 Column

*Fig. 9-1. Left side **of governor with cover removed***

ENGINE CONTROL GOVERNOR

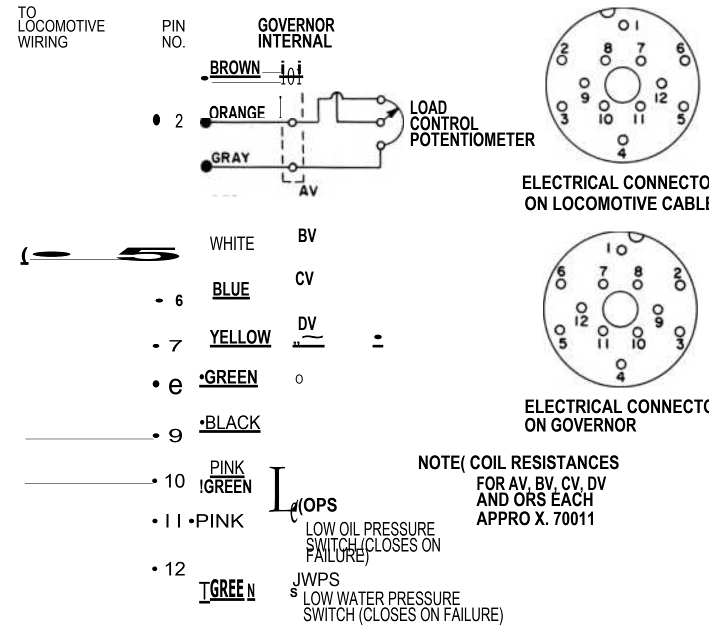


Fig. 9-2. PG governor—wiring connections

8. After checking the sequence, carefully remount the governor cover and reinstall the electrical connector.

CHECKING GOVERNOR WIRING
(See Fig. 9-2)

To check the internal wiring of the governor, with the engine shut down, proceed as follows:

1. Disconnect the electrical connector from the governor.

2. Using an ohmmeter, check from pin 9 to pins 4, 5, 6, 7, and 8, in turn. See DATA sheet for solenoid resistance values.

ENGINE CONTROL GOVERNOR

3. Connect the ohmmeter from pin 10 to pin 11. If the oil safety shutdown plunger is OUT, the ohmmeter should indicate a closed circuit (zero resistance). Push the oil safety shutdown plunger IN. The circuit should read "open" (infinite resistance). With the ohmmeter connected from pin 10 to pin 12, repeat the test, moving the water safety shutdown plunger OUT and IN.

4. Using the ohmmeter, check the resistance of the load control potentiometer by measuring between pins 2 and 3 and from pins 1 to 2 and 1 to 3. The latter two readings will vary, depending on the position of the rheostat brush arm. If, after long service, an unusually high or erratic resistance reading is noted between the rotating brush and the resistor unit, it may be caused by the formation of oxides on the surface of the rheostat commutator and contact brushes. See instructions, CLEANING AND INSPECTION OF GOVERNOR PARTS.

GOVERNOR OIL

The type and weight of oil to be used in the governor should agree with that given in the FUEL AND LUBRICANT SPECIFICATIONS for the particular locomotive application. In most cases, engine lubricating oil is recommended for ordinary conditions of temperature. If conditions of operation are extremely hot, it may be desirable to use SAE 40 or SAE 50 weight oil, or if extremely cold, SAE 10. In any case, the oil must not contain additives which are used to free-up rings, remove carbon, etc., unless a non-foaming additive is also present. The oil should not foam or sludge when agitated, or form gummy deposits when heated.

CAUTION: *MOST GOVERNOR TROUBLES ARE CAUSED BY DIRTY OIL. THEREFORE, ALWAYS USE CLEAN, NEW, OR WELL FILTERED OIL. NEVER MIX OILS WHICH ARE INCOMPATIBLE. ALL CONTAINERS USED FOR HANDLING OIL MUST BE CLEAN AND SHOULD BE RINSED USING LIGHT GRADE FUEL OIL OR KEROSENE BEFORE USING.*

ENGINE CONTROL GOVERNOR

Oil Level

The governor oil level must be maintained between the lines on the oil gage while the engine is running. Oil should be added slowly through the filler cap in the top cover. Oil level, if above or below the lines in the gage, when running, will cause aeration of the oil, resulting in a hunting condition.

Changing Oil and Flushing Governor

Governor oil should be changed at intervals according to recommendations given in the locomotive LUBRICATION AND SERVICING instruction.

To change the governor oil, proceed as follows:

1. With the engine stopped, open the oil drain cocks on the side of the governor case and on the under side of the load control potentiometer housing. Apply a container to catch the used oil.

2. Close the drain cocks and fill the governor with clean, new oil through the filler cap.

3. Start the engine and allow it to operate at IDLE speed. Cause the load control vane servomotor to move through its full travel several times, by removing and re-connecting the governor electrical connector. More oil must be slowly added to the governor until the load control potentiometer housing has become full and the oil level remains between the lines in the oil gage.

4. After refilling the governor with oil, trapped air must be bled from the governor oil system. See COMPENSATION ADJUSTMENT.

5. If it is desired to flush the governor system after filling the governor as described above, operate the engine at IDLE speed until the oil becomes warm and com-

ENGINE CONTROL GOVERNOR

pletely circulated. Then, shut down the engine and repeat steps 1, 2, 3, and 4, using clean new oil.

NOTE: *Flushing the governor with materials such as fuel oil or kerosene is not recommended, because, with the governor mounted on the engine, this material cannot be completely drained and, therefore, will cause dilution of the governor oil and contamination of the governor valves with dirt.*

CAUTION: *WHEN CHANGING GOVERNOR OIL, IT IS IMPORTANT THAT THE GOVERNOR BE SURGED ENOUGH TO COMPLETELY FILL THE LOAD CONTROL POTENTIOMETER HOUSING BEFORE APPLYING POWER TO THE LOAD CONTROL CIRCUIT. THIS IS REQUIRED BECAUSE THE OIL SERVES TO DISSIPATE HEAT GENERATED IN THE RESISTOR ELEMENT.*

GOVERNOR ADJUSTMENTS

COMPENSATION ADJUSTMENT

When the engine has been started for the first time, or after the governor oil has been changed, the governor oil system must be purged of trapped air.

To purge the system, loosen either of the vent plugs on opposite sides of the governor power case, just far enough to establish a leak. (See Fig. 9-1.) (These plugs are identified by instruction plates.) Start the engine and allow it to operate at IDLE speed. Open the compensating needle valve five turns to cause the engine and governor to hunt. Thus, the alternating movements of the governor parts will force all trapped air from the governor oil passages and out through the vent plug.

ENGINE CONTROL GOVERNOR

Allow the engine to hunt at idle speed long enough to bleed all trapped air from the governor, as evidenced by solid oil, without bubbles, draining from the vent plug. Tighten the vent plug. If necessary, add oil to the governor to restore the correct level. Close the compensating needle valve slowly until the engine hunting condition is minimized or eliminated. Then, allow the engine to run at idle speed until the engine and governor reach normal operating temperature (governor oil approximately 180 F).

When operating temperature has been reached, open the compensating needle valve again several turns to cause the engine to hunt. Slowly close the needle valve until the hunting is completely eliminated. This will usually occur when the needle valve is open between one-quarter turn and three full turns. The correct setting will depend on the characteristics of the particular engine.

Test the stability of the governor by disturbing the engine speed. Move the throttle to a higher notch and back to IDLE, or press down lightly on the governor shutdown rod. If the engine returns to a steady speed, the adjustment is satisfactory. If it continues hunting, close the needle valve slightly and test again.

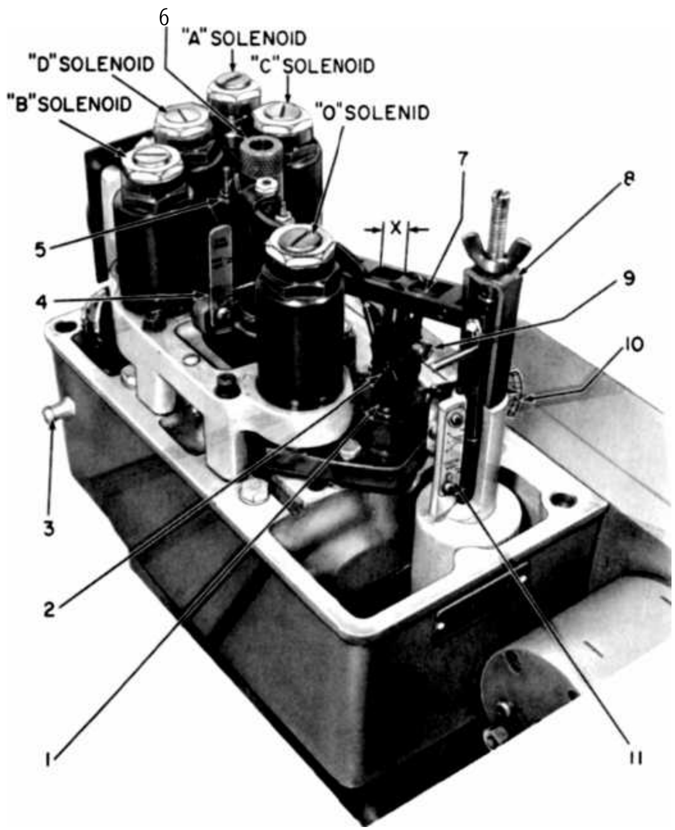
Keep the needle valve as far open as possible to prevent sluggishness and still obtain stability. Once it is correctly adjusted for the engine, no further adjustment should be required except at time of oil change, or, if a large permanent temperature change takes place, affecting the viscosity of the governor oil.

MATCHING ENGINE PUMP RACKS TO GOVERNOR

With the diesel engine shut down and the start contactors blocked open or insulated, adjust the engine fuel pump racks to match the governor piston gap as follows:

1. Remove the governor top cover. Install the power piston, jack tool on top of the power piston tail rod. (See

ENGINE CONTROL GOVERNOR

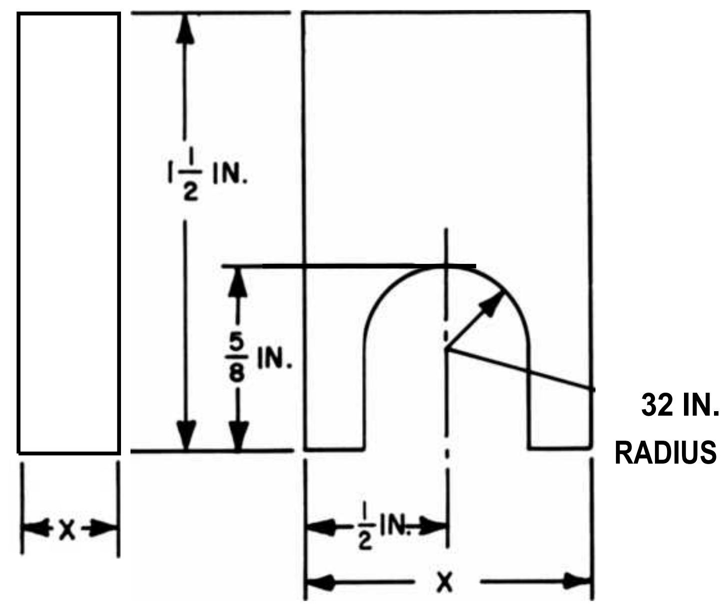


1 Load control pilot valve umbrella
2 Load control pilot valve eccentric adjustment
3 Oil pressure shutdown reset button
4 Speed setting indicator scale and pointer
5 Base speed setting nut
Manual speed setting tool
7 Floating lever ratio adjustment screw
8 Power piston jack tool
9 Load control pilot valve eccentric clamp screw
10 Load control indicator scale and pointer
11 Built-in power piston gap indicator

Fig. 9-3. ***Engine control governor with adjusting tools in place***

9-4 (E-10008A)

ENGINE CONTROL GOVERNOR



X- FOR DIMENSION REFER TO GOVERNOR

Fig. 9-4. ***Power-piston gap gage***

Fig. 9-3.) (Do not install manual speed setting tool.) Install the portion of the power piston gap gage marked for FULL LOAD piston gap, and turn the nut on the jack screw to raise the power piston and firmly clamp the gage. (A pry bar may be used under the power piston clevis to assist in raising the power piston.) Each pump rack should now read millimeters travel as specified in the DATA sheet for the full load fuel setting.

2. If the travel of any pump rack is not properly set at the FULL LOAD piston gap, adjust the individual rack link at the pump rack to obtain the correct setting. (See Fig. 9-6.) To make the adjustment, loosen the locknut and release the spring clip. Disengage the link and turn the threaded portion in or out to lengthen or shorten it.

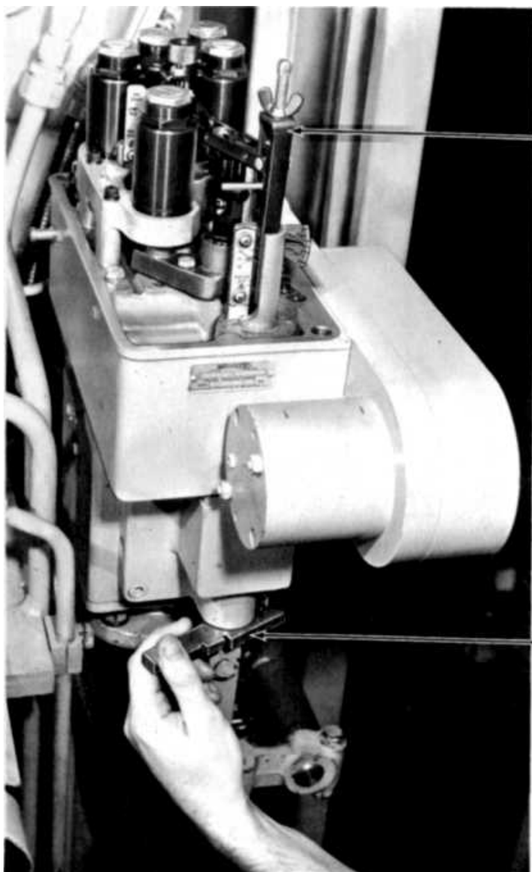


Fig. 9-5. Measuring piston ciao

3. After adjustment of all racks to obtain the correct full load setting, back off the power piston jack tool and clamp the portion of the gage marked for IDLE piston gap. The pump racks should now read millimeters as specified in the DATA sheet for the idle fuel setting.

4. Back the power piston jack tool off completely. The pump racks should now read 0 to 3 millimeters, which in all cases, is shutdown position.

NOTE: *When making the adjustments described above, always approach the rack setting from a lower setting. If by accident the desired setting is exceeded, back off the power piston to the next lower setting, then reapproach the desired setting. This is necessary to eliminate errors in rack readings which would otherwise result from lost motion in rack linkage.*

a

5. Check that all adjustable rack links have been secured. Remove the power piston jack tool and restore the governor cover.

CAUTION: *DO NOT ATTEMPT TO START TILE ENGINE WITH **THE** POII'ER PISTON JACK TOOL INSTALLED, AS THE GOVER-NOR WILL BE UNABLE TO CONTROL THE ENGINE FUEL RATE. THUS, ENGINE DAMAGE MAY RESULT FROM OVERSPEEDING.*

ENGINE SPEED SETTINGS

Before any attempt is made to check or reset engine speeds, the governor piston gap and engine fuel pump racks must be correctly matched as described above. For the following speed checks and adjustments, an accurately calibrated tachometer must be attached to the engine to determine crankshaft speed.

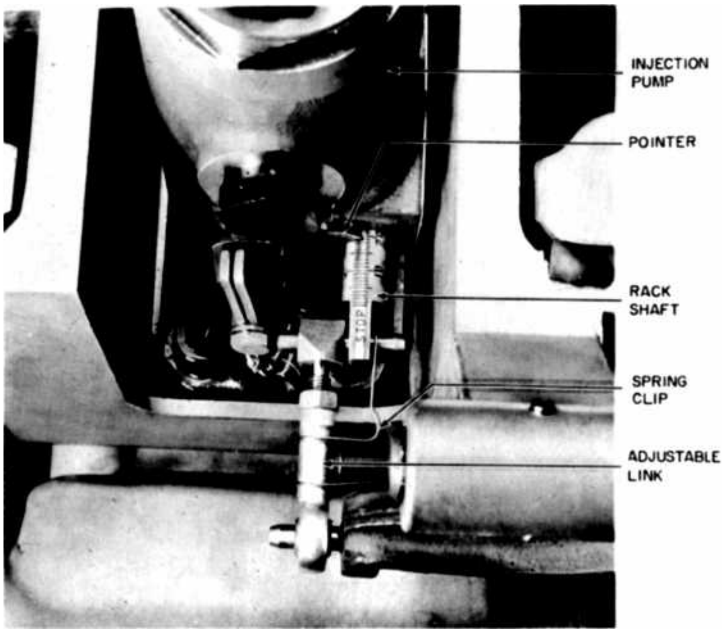


Fig. 9-6. Fuel-pump-rack shaft and linkage

Engine Speed Check

1. Start the engine and allow it to warm-up to normal operating temperature.

2. With the throttle at IDLE, the reverser handle in NEUTRAL, and the selector handle in POSITION No. 1, check the idle speed of the engine, using the tachometer.

3. Advance the throttle handle, checking speeds at each numbered notch. Speeds should be within the limits given on the DATA Sheet. If speed readings are out of limits, they should be reset.

ADJUSTING ENGINE SPEEDS
(See DATA Sheet for Correct Engine Speed Schedule)

1. With the reverser handle in the NEUTRAL position and the selector handle in POSITION No. 1, advance the throttle handle to the 6th notch which is the base speed setting. Read the engine speed and, if necessary, adjust this speed using the base speed setting nut. (See Fig. 9-3.) Turn the nut counterclockwise to increase speed. (Re-adjustment of the base speed nut will change all other speeds by an equal amount.)

2. Advance the throttle handle to the 8th notch, and read the speed. If necessary, adjust this speed by loosening the locknut on top of solenoid D. Using a screw driver, turn the adjustable screw-plug to set the speed. On solenoid D, turning the adjustable screw clockwise will increase speed. Tighten the locknut after each trial adjustment.

3. Move the throttle handle to the 7th notch. Check the speed reading. If necessary, readjust the speed, using the adjustable screw plug on top of solenoid A. Secure the locking nut.

4. Move the throttle handle to the 4th notch. Check the speed reading. If necessary, readjust the speed, using the adjustable screw on top of solenoid B. Secure the locking nut.

5. Move the throttle handle to IDLE. Check the idle speed. If necessary, readjust the speed, using the adjustable screw on top of solenoid C. Securethe locking nut.

6. Recheck each speed setting to assure that the final settings are correct. If the settings are not within the limits given, repeat steps one through five above.

ENGINE CONTROL GOVERNOR

NOTE: *When setting the engine speed, if all speeds are found to be high or low by an equal amount, it may only be necessary to adjust the base speed setting nut to raise or lower all speeds.*

Readjustment of the engine speed settings will affect the adjustment of the governor shutdown nuts, the low oil pressure shutdown bypass valve, and the speed setting piston stop screw. Therefore, after making any speed adjustments, check the adjustment of the shutdown nuts, speed setting piston stop screw, and the bypass valve. See adjustment of these items previously described in this section.

LOAD CONTROL ADJUSTMENT

Although all governor adjustments are important and should be made only by experienced service men, it is extremely important that the load control adjustments be properly set, as they directly affect the horsepower output of the power plant.

A number of malfunctions of the power plant system will be detected and automatically compensated for by the load control mechanism. This will be indicated by the load control potentiometer brush arm indicator (white dot visible through the load control window) operating near or at its minimum field position while the engine is operating on load. In some instances, this condition may be mistaken as malfunction of the governor. Therefore, before making any adjustments to the governor, investigate the following items:

1. Check to see that all cylinders are firing properly.

2. See that the generator excitation system is functioning properly and that the auxiliary governor voltage is correct.

ENGINE CONTROL GOVERNOR

3. Be sure the engine fuel racks are free to move and are properly matched to the governor power piston travel. The fuel racks and linkage must be free to move somewhat beyond their normal full fuel positions to permit proper functioning of the load control mechanism.

To adjust the load control mechanism, proceed as follows:

1. See that engine speeds are correctly set and that the speed indicator scale in the governor is calibrated so that the STOP, IDLE, and FULL SPEED scribed lines on the indicator plate coincide with the indicator pointer for each of these speeds. (See: ENGINE SPEED SETTINGS.)

2. Operate the engine at IDLE speed.

3. De-energize the overriding "0" solenoid by disconnecting the electrical connector from the governor. Loosen the locknut on the top of the "0" solenoid and turn the adjusting screw to position the plunger at least two and one-half turns off the bottom. This is necessary to assure that the overriding solenoid does not affect the operation of the load control pilot valve while making the following adjustments.

4. With the engine operating at IDLE speed, check the calibration of the load control pilot valve indicator as follows:

   a. Apply the bit of a long screwdriver under the head of the eccentric clamp screw, to raise or lower the load control pilot valve. Observe the position of the brush arm indicator (white dot in window). Continue to position the pilot valve until the brush arm indicator remains stationary or barely creeps in either direction when positioned near its mid-point. When this condition is reached, the pilot valve is centered. If properly calibrated, the pilot valve indicator pointer should exactly coincide with the ZERO mark on the indicator scale.

ENGINE CONTROL GOVERNOR

NOTE: *If the load control pilot valve is adjusted for "Minimum Field Start," it will be necessary to loosen the eccentric adjustment clamp screw to permit the pilot valve to be manually centered.*

b. If the indicator is not correctly calibrated, loosen the indicator mounting screw, and shift the indicator scale plate up or down to cause the pointer to exactly coincide with the ZERO mark while the pilot valve is centered. Then, tighten the mounting screw.

NOTE: *If the indicator scale plate is doweled in position, the indicator should be calibrated as follows:*

Loosen the locknut under the umbrella, on the pilot valve stem, using a thin, 1/2 inch open-end wrench. Then, thread the valve plunger in or out of the adjusting block to position the pointer exactly on ZERO with the pilot valve centered.

After each adjustment, check the calibration of the pilot valve indicatoras described in Step 4a. When the adjustment is .correct, tighten the locknut.

5. Shut down the engine. Block open or insulate the starting contactors to prevent the engine being accidentally cranked and started during the following adjustments.

6. Install the manual speed setting tool on the stud provided. (See Fig. 9-3.) Turn the tool down until the speed indicator pointer exactly coincides with the IDLE mark on the indicator scale.

ENGINE CONTROL GOVERNOR

7. Install the power piston jack tool on the power piston rail rod. (See Fig. 9-3.) Install the portion of the power piston gap gage to obtain the correct piston gap for idle speed. Refer to the governor DATA Sheet. Clamp the gage firmly, by turning the wing nut on the tool. To assist in raising the power piston, apply a prying force to the rack linkage near the governor.

8. Loosen the eccentric adjustment clamp screw and adjust the eccentric to position the pilot valve indicator pointer to exactly coincide with either the "Maximum or Minimum Field" start mark on the indicator scale. Refer to the governor DATA Sheet for the specified setting.

9. Turn the manual speed setting tool down until the speed indicator pointer exactly coincides with the FULL SPEED mark on the indicator scale.

10. Install the portion of the power piston gap gage to obtain the correct power piston gap for full speed-full load. Refer to the governor DATA Sheet. Clamp the gage firmly by tightening the wing nut on the tool. The pilot valve indicator pointer should now exactly coincide with the ZERO mark on the indicator scale.

11. If in Step 10, the indicator pointer does not coincide with the ZERO mark on the scale, adjust the screw in the floating lever over the load control pilot valve to cause the pointer to move one half the distance toward the ZERO mark. Then, adjust the eccentric to bring the pointer the remaining distance and exactly in line with the ZERO mark.

12. Repeat Steps 6 and 7, and observe that the pointer position as set in Step 8 has not changed. Continue adjustments as described in Steps 6 through 11, until the indicator pointer moves to the correct position at both the idle and full speed settings.

13. Remove the governor tools and make sure all adjustments are locked.

ENGINE CONTROL GOVERNOR

CAUTION: *EXT* ***ENSIVE ENGINE*** *!)1.11:1 GE CAN RESI'L7' FROM 0 1'ER SP E ED ING IF THE ENGINE IS STARTED WITH TIIE GOVERNOR TOOLS APPLIED.*

14. Readjust the Overriding Solenoid. See: OVERRIDING SOLENOID ADJUSTMENTS.

START-FUEL LIMITING DEVICE (See Fig. 9-7)

The start fuel limiting device consists of a control lever positioned directly above the speed setting cylinder, with one end pivoted at the upper end of the restoring link. The other end, at the idle speed setting, is positioned approximately 1 ⁄ 8 inch off the floating lever between the speed setting piston and the power piston tail rod. Near the center of the control lever is an adjustment screw upon which the governor shutdown nuts rest. When cranking the engine to start, the device will limit the governor power piston opening, and thus the fuel to the engine, by lifting the governor shutdown rod to effect a governor turn-off signal. The device, when properly adjusted, has no affect on the governor operation after the engine has been started.

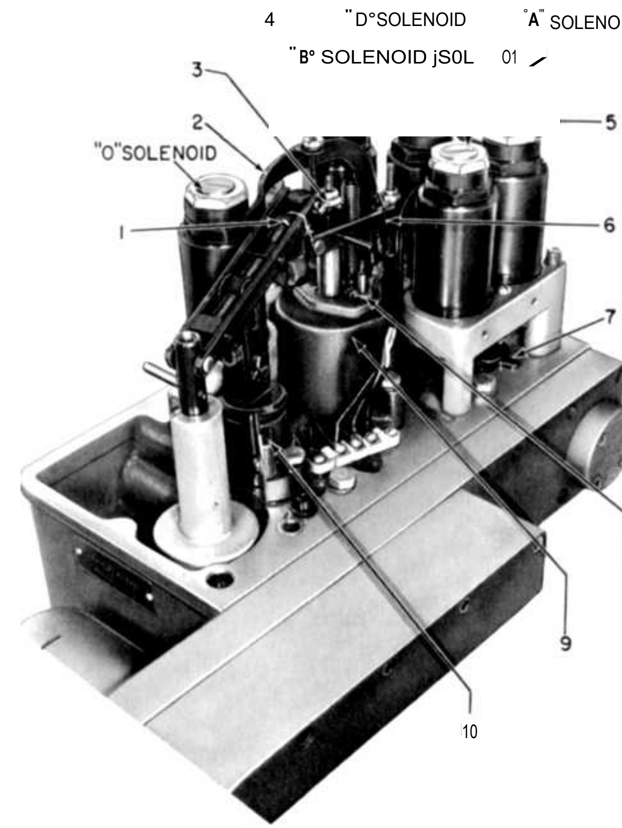
To adjust the start fuel limiting device, proceed as follows:

1. Operate the engine at IDLE speed setting and at normal operating temperature.

2. Loosen and back off the shutdown nuts to near the top of the shutdown rod.

3. Loosen the locknut on the lift screw in the control lever. Turn the screw down until it contacts the fulcrum assembly over the speed setting piston rod and lifts the free-end of the control lever approximately 118 inch off the floating lever assembly. Then, tighten the locknut.

ENGINE CONTROL GOVERNOR



1 Floating lever ratio adjustment screw
2 Start fuel limiting device control lever
3 Shutdown rod and nuts
9 Adjustable lift screw and locknut for start fuel limiting device
5 Adjusting screw and locknut for solenoid
0 Pin and lock **spring** clip for start fuel li miting device
7 Oil pressure shutdown time delay adjustment
8 Speed setting piston stop screw and locknut
9 **Speed** setting servo assembly
10 Load control pilot valve assembly

Fig. 9-7. ***Engine-control governor—top-right side with cover removed***

ENGINE CONTROL GOVERNOR

4. Turn the speed setting piston stop screw IN slowly until it touches the top of the piston; back it off 1 1/2 turns, and tighten the locknut. This provides a 3/64-inch clearance between the piston and the stop screw with the engine operating at its lowest normal speed.

5. Turn the shutdown nuts on the shutdown rod enough to enable lifting the rod lightly with the fingers. This action takes out any slack or lost motion at the inner end of the rod.

6. With the slack out, adjust the lower shutdown nut to have a 1/32-inch clearance over the head of the lift screw and lock into position with the upper nut.

If the above adjustments are correct, when starting the engine, the fuel racks should open to approximately 10 to 12 mm.

CHANGING GOVERNORS ON ENGINE

CAUTION: *TAKE PRECAUTIONS AGAINST THE DIESEL ENGINE BEING ACCIDENTALLY CRANKED WHEN CHANGING GOVERNORS. ENGINE DAMAGE CAN RESULT IF THE ENGINE IS STARTED WITH GOVERNOR REMOVED.*

REMOVING GOVERNOR FROM ENGINE

1. Have the diesel engine stopped and the engine starting contactors blocked open or insulated.

2. Remove the electrical connector plug from the governor.

ENGINE CONTROL GOVERNOR

3. Remove the cotter pin from the power piston clevis and remove the clevis pin to disconnect the fuel rack linkage.

4. Disconnect the external piping attached to the governor.

5. Install an eyebolt in the governor top cover and attach a hoist supported from the engine hood. Lift the governor straight up until its splined shaft clears the governor drive gear case. Then, lower the governor to the locomotive platform.

GOVERNOR INSTALLATION

1. Make sure the governor drive shaft and mounting surfaces are clean. Install a new gasket on the governor mounting surface.

2. Hoist the governor into position over the governor drive housing, aligning the spline drive, and lowering the governor into position. No force should be required to properly seat the governor.

3. Assemble the nuts and lockwashers to secure the governor in position. Then, reconnect the fuel rack linkage, making sure the linkage is properly aligned to prevent binding.

4. Attach the external governor piping and tighten the fittings securely.

5. Check the governor oil level and add oil as required. See **GOVERNOR OIL.**

6. Match the fuel racks to the governor power piston gap.

7. Attach the electrical connector to the governor. Remove the blocking from the engine starting contactors and prepare to make an operational test of the governor. Review the governor adjustments previously discussed.

FUEL RACK LINKAGE

DESCRIPTION

The fuel rack linkage connecting the governor power piston to the individual cylinder pump racks consists of a series of levers, shafts, and push-rods of fixed lengths, which move on oil bronze bushings. An adjustable link at each fuel pump rack is the only adjustment in the linkage system.

MAINTENANCE

Bearings in the fuel rack linkage are equipped with oiler buttons, and should be lubricated periodically according to instructions given in the locomotive LUBRICATION AND SERVICING SCHEDULE. The linkage parts should also be inspected periodically for binding and excessive lost motion caused by worn bearings.

NOTE: *When assembling the fuel rack linkage, tighten the elastic stop nuts on all spherical bearings to 20-25 lb-ft torque. To overtighten these nuts will distort the bearing, thus causing the linkage to bind.*

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DATA

Woodward Model No.
8550305

Governor oil — Use engine lube oil .... 2 qt
Governor operating temperature*(approx) .... 180 F
Governor accelerating time from
443 to 1107 rpm .... 25-32 sec

* Temperature at which all final settings should be made or checked.

SPEED SCHEDULE

SPEED SCHEDULE

Control Position**	Engine Crank-shaft RPM	Tachometer Drive RPM	Governor RPM	Speed Adjustment
Idle & Notch 1	390-410	579-609	**439-447**	C Sol.
Notch 2	470-510	698-758	**527-559**	-
Notch 3	560-600	832-892	626-659	-
Notch 4	660-680	962-1010	738-746	B Sol.
Notch 5	739-779	1098-1058	**824-857**	-
Notch 6	838-858	1246-1276	**935-943**	Base speed nut
Notch 7	927-947	1378-1408	1032-1040	A Sol.
Notch 8	1020-1030	1515-1530	1131-1139	DSol.

** Only full throttle notches listed affect engine speed settings.

GOVERNOR PISTON GAP AND FUEL PUMP CONTROL RACK SETTINGS

GOVERNOR PISTON GAP AND FUEL PUMP CONTROL RACK SETTINGS

Engine Operation	Governor Piston Gap (Inches)	Rack Position, mm		Nominal HP	Governor Link	
		Running	***Stopped		Cat. No.	Lever Arm
Shutdown	1 **5/32**		0-3			
Idle	1	5 (approx)				
Full Load	0.344	21 1/2-22 1/2	**21-22**	**3280**	**132X1243-1**	2 47/64

***Rack readings reached when the power piston is jacked to "Full Load" position are approximately 1/2 mm lower than whenthe engine is running. Settings should be rechecked with the engine running.

LOAD CONTROL SETTINGS

1. Adjust the load-control pilot valve for maximum field. Start at 1.000 inch power piston gap and at Idle Speed setting.

2. The pilot-valve indicator pointer must come to zero (servomotor balanced) at 0.344 inch power piston gap at Full Speed setting.

3. Servomotor timing rate maximum field to minimum field (fixed) 18-22

4. Servomotor timing rate minimum field to maximum field (fixed) 25-32

5. Servomotor timing rate maximum field to minimum field overriding solenoid energized. . less than 2 sec

6. Servomotor pressure (vane stationary). . 37 to 47 psi

7. Potentiometer resistance (total)................44 ohms

8. Solenoid resistance, A, B, C, D, and 0 (approximate) 700 ohms at 68 F

ENGINE OIL PRESSURE FAILURE SHUTDOWN

Trip pressure IDLE and First Notch . . Between 7 to 10 psi

Trip pressure FULL SPEED..............Between 45 to 52 psi

Triptime delay IDLE and First notch
(adjustable).. **35 to 45 sec**

Trip time-delay Second notch to
FULL SPEED.. Osec

ENGINE WATER PRESSURE FAILURE SHUTDOWN

Trip pressure - Second notch..................Between 0 to 3 psi

Trip pressure - FULL SPEED . . . . Between 14 to 18 psi

Trip time-delay IDLE and First notch (See ENGINE OIL PRESSURE FAILURE SHUTDOWN).

GAGES AND MEASURING DEVICES

During scheduled inspection periods and when performing light maintenance, the following gages and measuring devices are used in specific work operations.

ENGINE-LUBRICATING-OIL DIP STICK – one located on each side of engine near filler pipe. The stick is marked HIGH and LOW (Fig. 10-1). Proper level with the engine idling is between HIGH and LOW.

FUEL-OIL SIGHT GLASSES – mounted on both sides of the main fuel tank, to indicate level of fuel in the tanks.

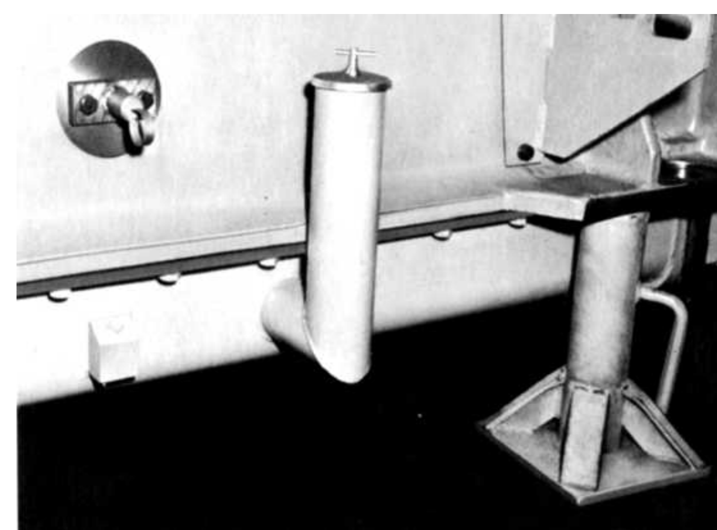

Fig. 10-1. Lube-oil fill pipe and oil-level dip stick

LIGHT MAINTENANCE FEATURES

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COOLING WATER - a sight glass mounted on side of cooling water supply tank indicates the level of cooling water in the system. Markings on the tank indicate the proper level for conditions. (Fig. 10-2)

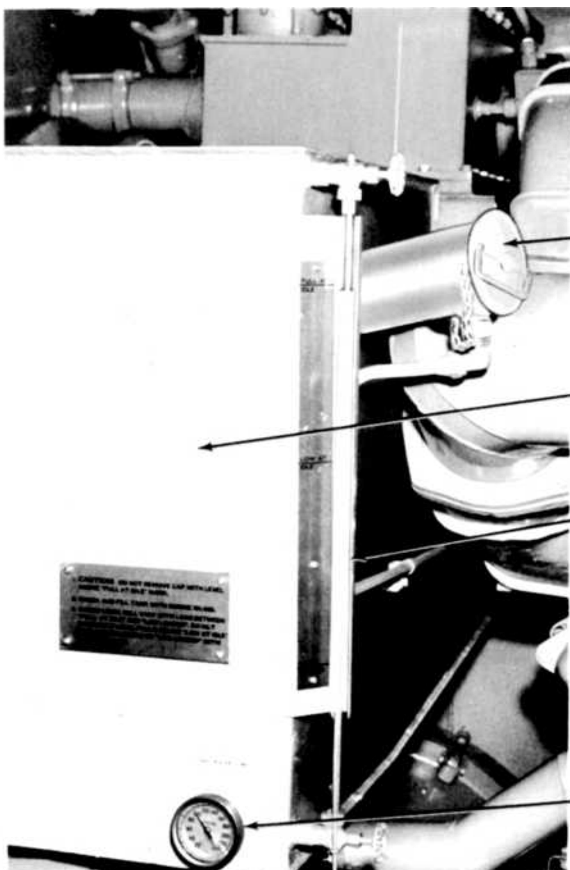

Fig. 10-2. Water storage tank

LIGHT MAINTENANCE FEATURES

COMPRESSOR LUBE OIL (Gardner-Denver Compressor) - a gage mounted on the compressor frame indicates oil level. The gage scale is marked ADD (lower red scale), RUN (green scale), EXCESSIVE (upper red scale). See Fig. 10-3. Take the reading with the engine shut down. (Westinghouse Compressor) — maintain oil supply to RUN level on gage.

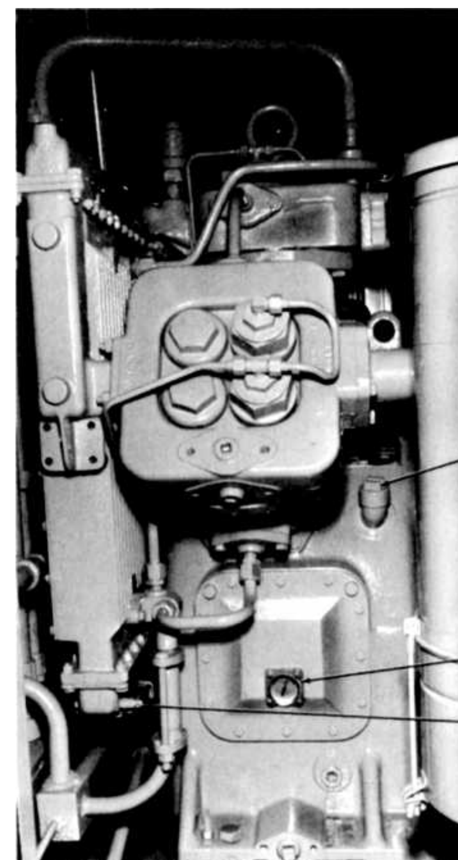

Fig. 10-3. Air compressor

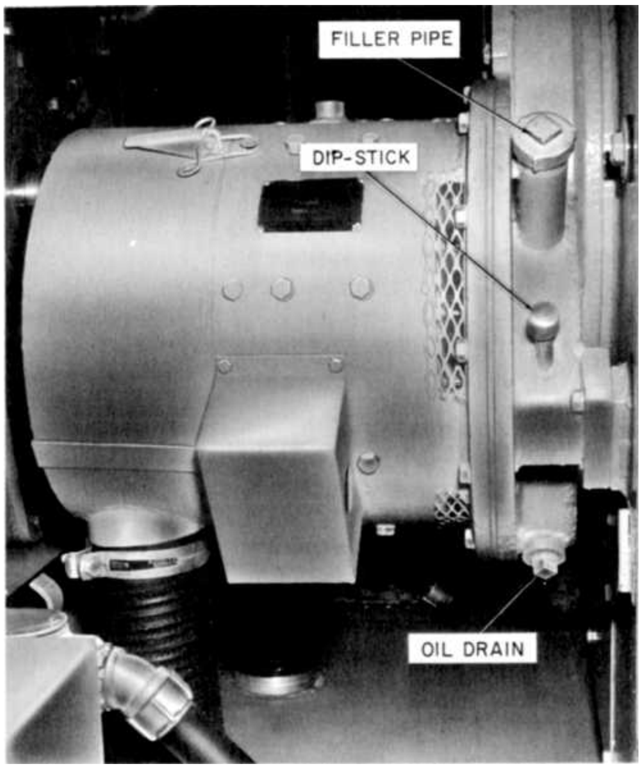

Fig. 10-4. Traction-generator gear unit

TRACTION-GENERATOR GEAR BOX — has a dip stick marked EMPTY-ADD-FULL. Proper level is between ADD and FULL, with the engine stopped. See Fig. 10-4.

OIL-BATH AIR-FILTER SIGHT GLASS – there are six filters, three located on the right and three on the left side at rear of locomotive unit. A sight glass is mounted on each filter. Oil must be visible between lines on the sight glass, with engine idling. See Fig. 10-5.

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FAN-GEAR-UNIT OIL-LEVEL PLUG – maintain the oil level near spill over. See Fig. 10-6.

GOVERNOR-OIL-LEVEL SIGHT GLASS – located on the left side of the engine, near the traction generator.

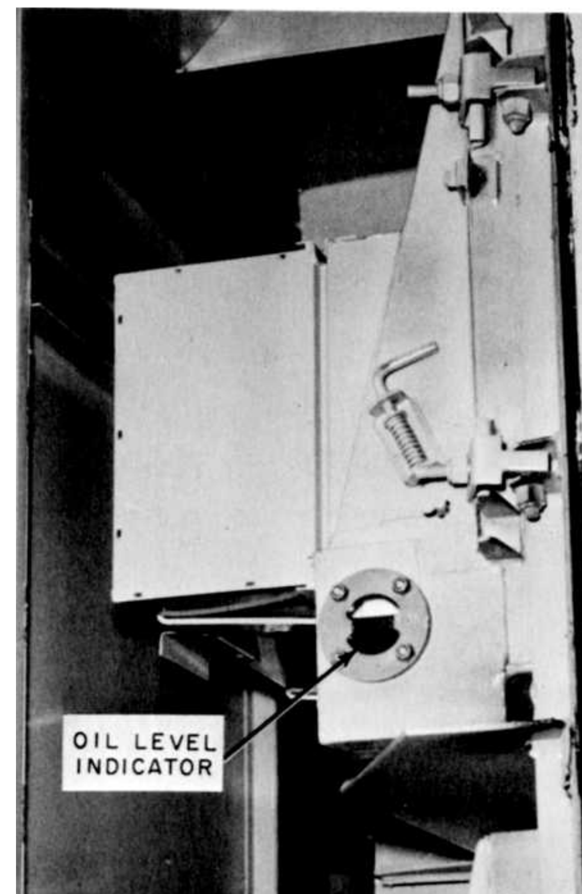


Fig. 10-5. Engine air filter

LIGHT MAINTENANCE FEATURES

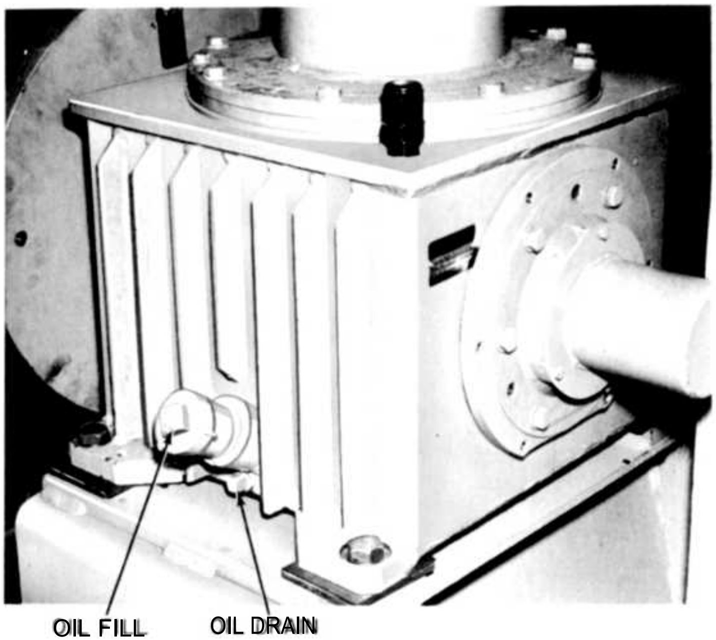


Fig. 10-6. Fan gear unit service points

See Fig. 10-7. The oil level must be visible between the marks on the sight glass when the engine is running.

NOTE: *Refer to Fig. W-10 JOY locations of the locomotive equipments and all other lubrication and service points.*

LIGHT MAINTENANCE FEATURES

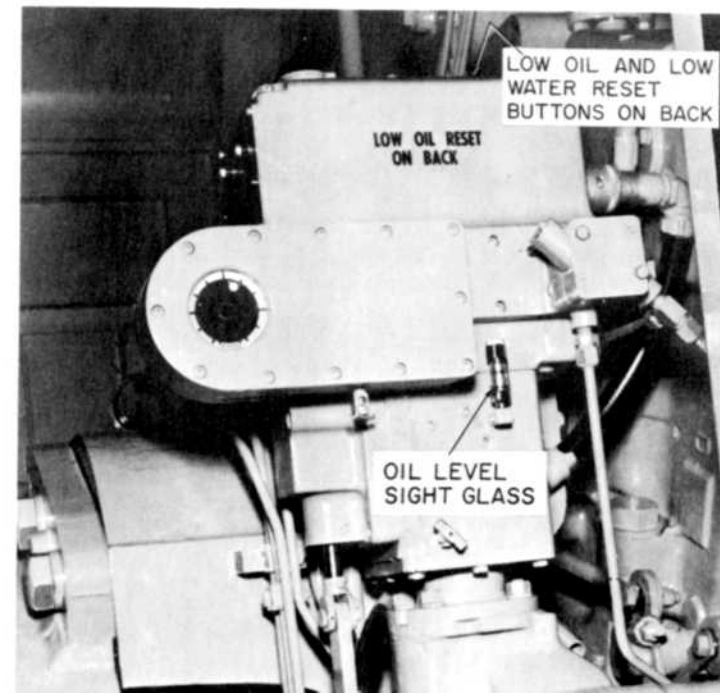


Fig. 10-7. Engine-control governor

BRAKE RIGGING

ADJUSTMENT (See Fig. 10-8)

1. Exhaust air from the brake cylinders.

2. Loosen the jam nut on the piston pushrod, and turn the adjusting nut. To reduce piston travel, turn the nut to move the shoes closer to the wheels; to increase, move the shoes away from the wheels. After adjustment, tighten the jam nut.

3. Piston travel should be held as close as possible to low limit of 3/4 inch. Travel should not exceed 3 1/2-inch maximum.

4. When piston travel cannot be adjusted with slack adjuster movement alone, a coarse adjustment becomes necessary. To make a coarse adjustment, reconnect the lower end of the live lever to another set of coarse adjustment holes in the live lever, and reconnect to the cylinder pushrod.

BRAKE SHOE RENEWAL

1. Exhaust air from the brake cylinder.

2. Move the shoes as far as possible from the wheel tread, by adjusting the manual slack adjuster and/or picking up the coarse adjustment.

3. Hammer the keys out of the brake shoe head.

4. Knock the shoes loose from the brake head and remove them by sliding them up the wheel and out.

5. Insert new shoes in the brake heads and line up the keyways.

6. Drive the keys in place and check the shoes for tightness.

Fig. 10-8 (E-13505)

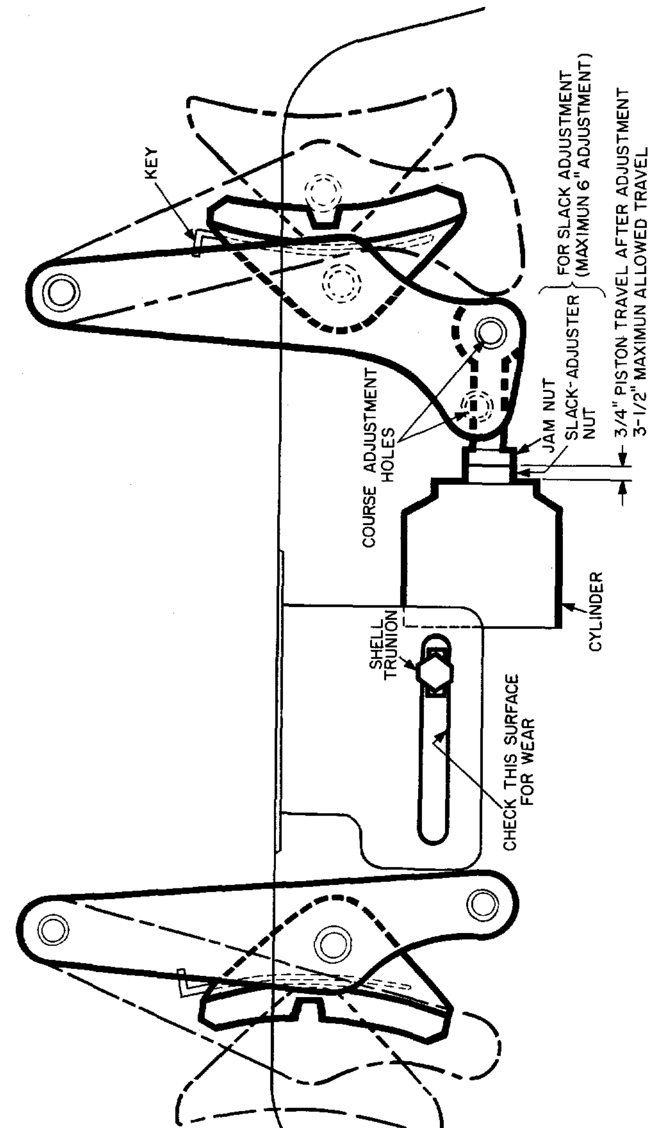


Fig. 10-8. Clasp brake rigging

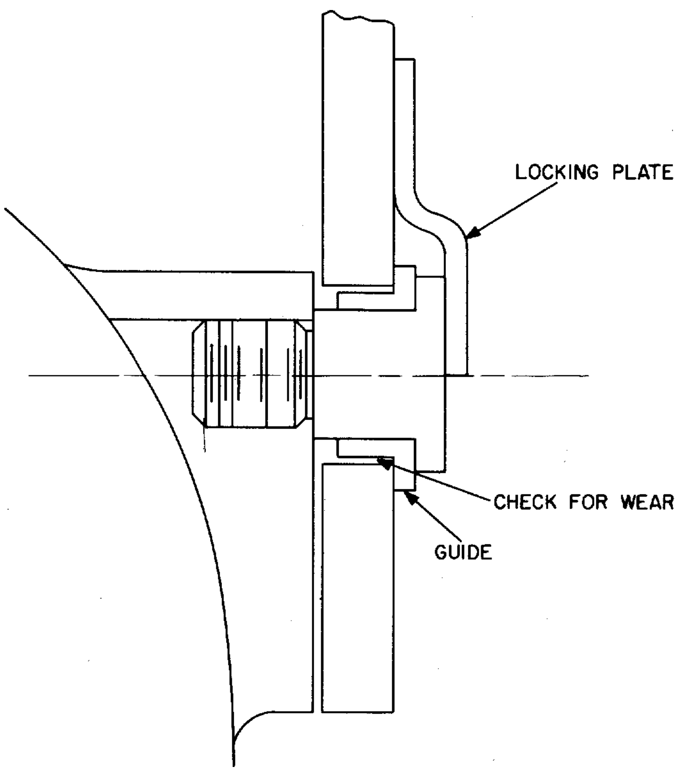
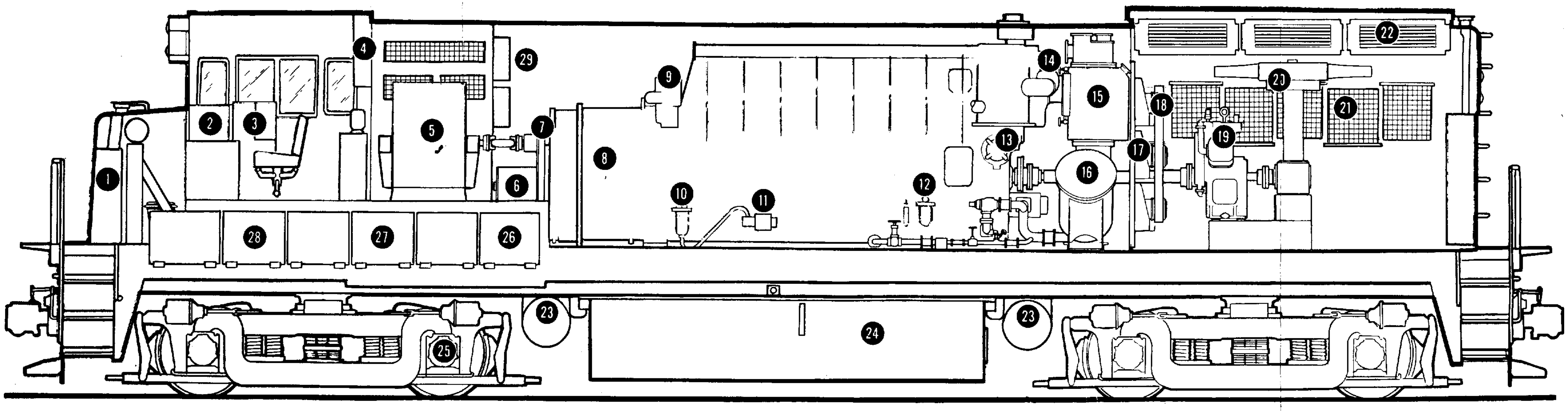


Fig. 10-9 (E-13506)

Fig. 10-9. ***Slack-adjuster and brake rigging details***

7. Adjust the manual slack adjuster to obtain 3/4-inch brake cylinder piston travel.

8. Make sure the brake cylinder cutout cocks are open when the work is finished.



1 Sand box
2 Operating controls
3 Air brake controls
4 Engine control panel
5 Equipment blower
6 Auxiliary generator (left side)
7 Traction alternator gear case
8 Traction alternator
9 Engine control governor
10 Fuel strainer
11 Fuel booster pump
12 Lube oil fill
13 Lube oil strainer
14 Turbocharger
15 Water storage tank
16 Lube oil filter
17 Oil bath air filters
18 Engine primary air cleaners
19 Air compressor
20 Radiator fan
21 Dynamic brake grids (when equipped)
22 Radiator
23 Air reservoir
24 Fuel tank
25 Axle generator (one per axle)
26 Batteries (right side)
27 Air brake compartment (right side)
28 Control compartment (left side)
29 Power rectifier panels

Fig. 10-10. Apparatus location (low-nose locomotive)