NEW ZEALAND GOVERNMENT RAILWAYS

LOCOMOTIVE CORRESPONDENCE COURSE

ENGINEDRIVERS

LESSON NO. 15

GENERAL MOTORS DIESEL ELECTRIC Da AND Db LOCOMOTIVES

The Da and Db locomotives are similar so it is intended to cover them both in the next three lessons. These locomotives are diesel electric locomotives and work on the same principle as those previously described. The lessons will cover the actual apparatus fitted, operation, circuits, and fault finding on these locomotives. The ends of the locomotive are referred to as the short hood end or long hood end and are often called front and rear ends. The short hood or front end is the cab end and the long hood or rear end is the fan compartment end. No. 1 bogie is placed at the short hood end and No. 2 bogie is placed at the long hood end. Refer to the diagrams issued with this lesson for the layout of equipment and to assist you when learning the operation of equipment. Briefly the operating scheme of each unit is as follows :-

1. The engine drives a main generator which produces direct current at a nominal 600 volts, an auxiliary generator which produces direct current which is held constant at 74 volts, a three cylinder two-stage air compressor, a radiator fan, two traction motor blowers and two roots blowers.

   The engine is started by making the direct coupled main generator operate as a motor. Current from a 64 volt battery system rotates the main generator to start the engine.

3. The main generator changes the mechanical power into high voltage electrical power to move the locomotive when in power and to excite the traction motor field when in dynamic brake.

4. The electrical power is supplied to four traction motors, two of which are located in each bogie. The traction motors are geared to separate axles.

5. The drivers control station includes the control levers, brake levers and switches necessary for operating the locomotive.

6. The electrical cabinet contains various switches, fuses, contactors and relays necessary to control the operation of the locomotive.

7. The load regulator sees to it that the engine sends no more or no less power to the main generator than should be produced for each separate throttle position.

8. The engine governor controls the engine speed as directed by the throttle lever and also controls the load regulator.

9. The air compressor is connected to the main generator's armature shaft by an extension and pumps air only when necessary.

10. Two water pumps circulate water through the engine cooling system. The water temperature is automatically controlled.

11. Lubricating oil is circulated through the engine, oil cooler, filter and strainer by two oil pumps mounted on the engine.

12. Fuel oil, drawn from the fuel tank by an electric motor driven pump passes through two or in some cases three filters before reaching the engine.

13. Dynamic braking is also included on the locomotive.

DIESEL ENGINE

1. Da locomotive :

These locomotives have a 12 cylinder V type two cycle 1050 Kw diesel engine supercharged by two roots blowers mechanically driven from the engine gear train.

The main crankshaft is underslung and the crankcase is a steel fabrication which has included in it air boxes to which the blowers supply air. They duct the air to the cylinders.

Cylinder heads are made separate and are fitted with four exhaust valves.

The valves are operated by overhead camshafts and rocker arms. There is one combined fuel injection pump and nozzle fitted to each cylinder. The pumps are driven by rocker arms operated by the camshafts.

The oil pan is a steel fabrication which supports the crankcase and serves as an engine base.

Incorporated in the oil pan is the engine oil sump. Crankcase and airbox inspection covers arefitted in the oil pan and crankcase.

Air from the airboxes is supplied to the cylinder liners via ports formed in the liner walls. The liners are cast with a water jacket.

The engine is pressure lubricated by two engine driven oil pumps and the oil is cooled in a heat exchanger in the engine water cooling system.

The engine is water cooled and water is circulated by two engine driven water pumps.

The engine is fitted with an overspeed device and the governor controls the engine at eight different speeds.

2. Db locomotive :

These locomotives are fitted with an 8 cylinder V type 750 Kw diesel engine and have the same equipment fitted as the 12 cylinder engine.

ENGINE COOLING SYSTEM

As seen from the schematic diagram of the cooling system issued with this lesson, water is drawn from the cooling water supply tank by the water pumps, and then forced through water manifolds placed inside the airboxes. Branch pipes taken from these manifolds supply water to each cylinder liner. After passing through the water jackets of the liners the water passes out through twelve discharge holes at the top of the liner to the cylinder heads and from here to a return manifold. The water passes along the return manifold to the radiators where it is cooled and then returned to the supply tank to be circulated again.

The engine discharge water is cooled in two banks of tube and fin type radiators laid horizontally in the roof of the locomotive.

These radiators are force ventilated by means of a mechanically driven fan which is controlled by an air operated clutch. Cooling air admission to the radiators is controlled by automatically operated shutters placed on the side of the superstructure of the locomotive. These shutters control the amount of air admitted to the fan compartment. A speed increaser gearbox is placed in this compartment and is fitted with an oil sump and sight glass. The shutter operation is controlled by electro-pneumatic magnet valves which are operated by temperature control switches.

The temperature sensitive bulbs of the control switches are mounted in the water discharge line from the engine to the radiators and control the fan and shutter operation as follows :-

With rising water temperature.

1. At 190°F or 88°C FMV the fan magnet valve is energised which allows air to engage the fan clutch and the fan starts rotating.

2. At 200°F or 93½°C the shutter magnet valve or valves are energised to allow air to the operating cylinders to open the radiator shutters.

Another temperature control switch which closes when water temperature reaches 208°F or 98°C will cause a warning bell to operate and an indicator light to be lit on the drivers control stand to warn the driver that the engine cooling water has reached a temperature above that recommended for safe operation.

As water temperatures drop the shutters will close and the fan will stop in correct sequence on all locomotives.

The supply tank is fitted with a gauge glass to show the water level and level markings are stencilled on the water tank next to the gauge glass to indicate the minimum and maximum water levels, with the engine running or stopped. The engine must not be operated with the water below the low water mark.

Pressure filler pipes are located on each side of the locomotive just below the underframe at the long hood end of the locomotive. A filling cap is also placed on the top of the supply tank. When taking water the engine should be stopped and the overflow valve on the side of the supply tank opened.

A temperature gauge is fitted to the supply tank and the engine speed must not be increased above idle until this gauge shows a reading of 125°F or 51°C.

The entire cooling system can be drained by opening the drain valves. One is located at floor level in front of the engine and the other is on the bottom of the water pump housing.

ENGINE LUBRICATING SYSTEM

The engine lubricating oil system is a combination of three separate systems. The engine lubricating oil system, piston cooling oil system, and scavenging oil system. The engine lubricating system supplies oil for lubrication of the various moving parts of the engine. The piston cooling system supplies oil for the cooling of the pistons and lubrication of the piston pin bearing surfaces. The scavenging oil system serves the purpose of supplying the other two systems with cooled and filtered oil by taking the oil drained into the oil pan or sump and forcing it through the filter and cooler from where it flows to the suction strainer housing from which the lubricating and piston cooling oil pumps draw their supplies. Refer to the schematic diagram.

The piston cooling and lubrication pump is a combination pump, that is two pumps are contained in one housing with separate oil inlet and discharge openings.

The oil strainer housing is a large box-shaped cast aluminium housing mounted on the front right-hand side of the engine. It contains independent strainers for the main oil supply and scavenging oil pump.

Relief valves are placed in three strategic locations in the lubricating oil system -

1. A 420 kPa relief valve is connected into the discharge side of the scavenging oil pumps. When opened, this valve relieves pressure on the oil cooler core and bypasses oil around the oil cooler and filter to the oil strainer box. A sight glass is located in the bypass line to provide a visual indication of the opening of this valve. This valve will often open when the engine is first started and the oil is cold but as soon as the oil heats up the valve will close. If when operating with oil at its normal operating temperature it is noticed that oil is passing through the sight glass it indicates that the oil filter is blocked and this should be entered in the repair book. The locomotive may be worked home but a check should be kept on the engine for overheating.

2. A relief valve is built into the filter to allow the passage of oil to strainer box in excess of the capacity of the oil filter elements.

3. A relief valve is mounted in the discharge side of the lubricating oil pump. The purpose of this valve is to limit the maximum pressure of the lube oil entering the lubricating oil system to approximately 420 kPa.

A pressure gauge placed on the front of the cooling water tank indicates engine lubricating oil pressure. At 835 r.p.m. the oil pressure is normally 280 - 350 kPa but should not drop below 140 kPa. At idle speed 275 r.p.m. the lubricating oil pressure should be at least 42 kPa.

A low oil pressure device located in the engine governor will automatically stop the engine in case of a dangerously low oil pressure condition.

To top up the oil system the square cover on top of the strainer housing box must be removed and oil poured in the opening. Oil from this box will flow through an overflow opening into the sump where it can be checked by the means of a dipstick. The oil may be added and the level checked with the engine running or stopped but when the engine is running the level of oil on the dipstick should show on the full mark and when the engine is stopped the reading on the dipstick should show overfull. The engine lube oil dipstick is located on right-hand side of the engine about halfway along the side.

An oil separator is mounted between the two roots blowers on top of the auxiliary drive housing. It is a cylindrical housing containing a securely held mesh screen element. The housing cover has two openings on top to connect hoses leading to the suction side of each blower. Blower suction draws the hot oily vapour from the oil pan through the gear train housing into the oil separator. The oily vapour collects as oil on the mesh screen of the separator element, drains to a trough at the separator bottom and flows into the gear train returning to the oil pan.

FUEL SYSTEM

Fuel oil is drawn through a suction filter by an electrically driven gear type fuel pump and then forced through a discharge filter to an engine mounted filter. After having passed through the double element engine mounted filter the fuel flows to the injectors. The excess fuel that is not used by the injectors is returned through the return sight glass fitted on top of the engine mounted filter housing. An orifice restricts the flow of fuel into the glass which causes a slight back pressure of fuel on the injectors. By maintaining this back pressure a positive supply of fuel for the injectors is assured as long as the fuel pump is operating.

Normally the fuel pump delivers more fuel to the engine than is burned in the cylinders. The excess fuel which is circulated through the injectors provides cooling and lubrication for the fine working parts of the injector pumps. For this reason the engine should never be allowed to operate without adequate fuel flow showing in the return sight glass.

The suction filter and discharge filter are placed in one housing and on the discharge filter side a 105 kPa relief valve is fitted. This relief valve will open and allow fuel to bypass the discharge filter and pass to the engine mounted filter if the element in the discharge filter becomes clogged.

On Db and the later types of Da locomotives only a suction filter and engine mounted filter are fitted.

FUEL FLOW SIGHT GLASSES

Two sight glasses are mounted on the engine mounted filter housing to provide a visual indication of the condition of the fuel system. For proper engine operation a good flow of fuel, clear and free of bubbles should be indicated in the sight glass nearest the engine and named the 35 kPa fuel return sight glass. The other sight glass called the 315 kPa sight glass is normally empty. When more than a trickle of fuel through the 315 kPa sight glass is seen it indicates that a 315 kPa relief valve is open. This fuel when it passes through the 315kPa sight glass and relief valve bypasses the engine and returns to the fuel tank. It indicates that the engine mounted filter is becoming clogged and the engine will be starved for fuel and will in time shut down. When fuel is noticed in the 315 kPa glass it must be entered in the repair book and reported to the Officer in Charge.

This filter is often called the sintered bronze filter but does not necessarily have sintered bronze elements fitted.

FUEL TANK

A fuel tank is placed under the locomotive frame between the two bogies and may be filled from either side. A short sight level gauge is located next to each filling aperture and must be

observed when refuelling to prevent overfilling. This gauge indicates the fuel level from the top to about 4½ inches (112 mm) below the top of the tank.

Full length fuel level sight gauges are located on each side at the front end of the fuel tank. A valve at the bottom of each full length glass must be opened to obtain an accurate reading on the gauge.

ENGINE GOVERNOR Refer to speed setting diagram

This governor which is known as the Woodward governor is electric-hydraulic in operation which means it uses oil as a pressure medium and electrically controlled solenoid operated plungers which act to vary the engine speed. The flyweights of the governor are driven by the engine and the centrifugal force developed as they tend to fly out is balanced by two concentric springs. The flyweights act on a platform which lowers the governor pilot valve which opens a regulating port and allows oil from a sump formed in the base of the governor to be pumped to one side of a buffer piston. The buffer piston moves across and oil that is already on the other side of the buffer piston is forced up under a spring loaded power piston. The power piston is attached to the operating rod for the fuel racks which move and set the injector pumps to deliver the fuel required for each predetermined speed setting.

Speed setting is done in steps by energising different combinations of four solenoids "A", "B", "C" and "D" commonly referred to as "A" valve, "B" valve, etc. The solenoids provide for engine speed changes as shown on the Engine Speed Chart issued with this lesson which shows the solenoids which are energised in the different notches of the controller. Solenoids "A", "B" and "C" have plungers bearing on a triangular fulcrum plate at varying distances from a set fulcrum point. The fulcrum plate bears on a lever connected to a speed control pilot valve inside a rotating bushing. The "D" solenoid plunger bears on the rotating bushing through its cap and bearing.

AV	increases speed	80 R.P.M.
BV	increases speed	320 R.P.M.
CV	increases speed	160 R.P.M.
DV	decreases speed	160 R.P.M.

To increase or decrease engine speed the speeder spring must be compressed or decompressed by moving the speeder spring piston. This is done by admitting or releasing governor oil above the piston by the use of the solenoids controlling the speed control pilot valve and rotating bushing. When a solenoid or a combination of solenoids "A" "B" or "C" is energised the triangular plate is forced down a certain distance depending on the solenoids energised. This causes the speed control valve pilot valve to go down and uncover the regulator port in the rotating bushing, governor oil is then admitted under pressure forcing the speeder spring piston down and compressing the speeder spring. As the

piston moves down to the desired position the linkage of the fulcrum arm raises the speed control pilot valve which closes the regulating port. Compression of the speeder spring forces the flyweights in allowing the governor pilot valve plunger to lower and permits oil to enter the buffer piston which moves across and causes the oil pressure to raise the power piston to move the fuel racks to supply more fuel to the engine and increase engine speed. When the power piston has been raised enough for the desired speed, unbalanced oil pressure on the compensating land of the pilot valve plunger closes the regulating port and when the selected speed is reached the flyweights return to a balanced position against speeder spring pressure. Oil will flow from one side of the buffer piston to the other via a small compensating needle valve at the same rate as the increase in the centrifugal force of the flyweights and the buffer piston will return to its centre position.

When a solenoid or a combination of solenoids is de-energised the triangular plate rises and the speed control pilot valve moves up & oil from above the speeder piston drains through the regulating port to the oil sump. The speeder spring piston is now raised by its spring and the linkage causes the speed control pilot valve to move down and close the regulating port when the desired piston position is reached. As the speeder spring piston is raised the speeder spring compression is lessened and the flyweights will move out under centrifugal force and lift the governor pilot valve. Oil is now released from one side of the buffer piston which moves across and this decreases pressure under the power piston which moves down decreasing engine speed. When the desired speed is reached the governor pilot valve is closed and the flyweights will move back to their balanced position and the oil pressure will also balance out each side of the buffer piston again via the compensating needle valve.

Energising "D" solenoid in combination with other solenoids lessens their effect on engine speed since it pushes the rotating bushing down and lowers the regulating port. When "D" solenoid is energised by itself it opens the regulating port in the rotating bushing to the sump, allowing oil above the speeder piston to be released. The piston then rises and its extension lifts the shut-down nuts and rod causing the governor to shut off the engine fuel supply.

Under normal operating conditions the flyweights will move in and out to allow more or less fuel to the engine to allow the engine to remain at a constant speed corresponding to the notch the controller is in no matter whether the locomotive is ascending or descending a grade or operating on flat track.

The governor is fitted with an oil level sight glass and the oil level should be between the lines marked on the glass when the engine is running. A filling aperture is placed in the top of the governor to allow the governor oil system to be topped up.

AIR SYSTEM

Compressed air is used for operating the air brakes, sanders, radiator shutters, fan driving clutch, horn and windscreen wipers. On locomotives 1400-1439 a control reservoir is fitted in

the short hood and supplies air at 640 kPa to operate a reversing switch and a transfer switch. This reservoir is fitted with a pressure gauge and has two isolating cocks and a drain cock. Each locomotive is basically equipped with an air cooled or water cooled three cylinder air compressor which consists of two low pressure heads and one high pressure. This type of compressor and its governor control has been explained in Lesson 4.

Locomotives 1400 to 1429 are fitted with 6SL brake equipment and locomotives 1430 on are fitted with 26L brake equipment. These brakes have been fully covered in Lessons 13 and 14.

FUEL PUMP CONTROL GEAR

The governor controls the fuel pump control shafts through a linkage system which incorporates a manual layshaft lever. Under normal operating conditions the lay shaft lever moves with the fuel control shafts but by pulling on this lever the fuel racks can be moved to the 'no-fuel' position and the engine will stop. By pushing this lever in towards the engine the fuel can also be increased to increase engine speed. The layshaft lever can be used to over-ride the governor.

When the engine is very cold and lubricating oil is thick it may be necessary to operate this lever to over-ride the governor to allow the oil pressure to build up and prevent high suction which will automatically shut the engine down after 40 seconds. When using this lever it must not be pushed in too far to cause engine speed to be increased much above idling and a close check must be kept on the oil pressure gauge to see that oil pressure is indicated.

MACHINES

MG : Main generator which is mounted on the rear end of the diesel engine and is driven directly from the main engine crankshaft. This generator nominally produces 600V and supplies the traction motor fields and armatures when in power and the traction motor fields when in dynamic brake. The output of the main generator is controlled by the load regulator and engine speed.

AG : Auxiliary generator which is mechanically driven from the rear gear train of the diesel engine and supplies power at 74 volts for battery charging, lighting, control circuits, running the fuel pump and for exciting the battery field of the main generator.

TMB : Traction motor blowers which are mechanically driven from the diesel engine and supply cooling air to the traction motors, the main generator and a cooling grid to cool main reservoir air. One is driven from the rear gear train of the engine. The other is in the long hood end and is driven through a speed increaser gearbox which also drives the radiator fan.

TM : Traction motors which are hung on the axle on one side by suspension bearings and resiliently suspended from the bogie frame on the other. Each motor drives an axle through gearing consisting of a pinion on the armature shaft and a gear wheel on the

locomotive axle. The gear ratio is 63 : 14 which allows a maximum locomotive speed of 100 Km/h. Speeds higher than this could 'burst' the traction motor armatures.

The motors are all permanently connected in parallel on Da locomotives.

On Db locomotives the motors are connected in series - parallel at low speeds and in parallel at higher speeds (above approximately 20 Km/h.).

The fields of the traction motors in both types of locomotives are arranged for one stage of field diversion which takes place when loading permits.

FP : Fuel pump which is driven by an electric motor through a flexible coupling. The motor is supplied with power from the battery when starting the engine and from the auxiliary generator when the engine is running.

Dynamic Brake Grid Blower which is driven by an electric motor supplied with power from the traction motors when they are operating as generators in dynamic brake. This blower is placed in the roof at the short hood end of the locomotive and supplies cooling air to keep the dynamic brake resistor grid cool.

CONTROL EQUIPMENT

The operating control equipment consists of three levers and two brake valve handles. These are the throttle, reverse and selector levers and the independent and automatic brake valve handles.

THROTTLE LEVER

This lever when placed in notch one sets up the circuit for the excitation of the main generator. The position of the throttle is shown in an illuminated indicator and the lever has 10 positions. STOP. IDLE and operating notches 1 to 8. STOP can be obtained on Da 1400-1439 by depressing the emergency stop button on the end of the throttle lever and then moving it one step beyond the idle position. This stops all engines in the locomotive consists. On locomotives 1440 onwards, the throttle lever has no stop button but the lever can be pulled out away from the controller and then moved into the STOP position. Each running notch after notch one, increases the speed of the engine in increments of 80 r.p.m. That is from 275 r.p.m. in idle and notch one to 835 r.p.m. in notch 8. The throttle may be closed completely in one motion in an emergency but should be closed one notch at a time in normal operation.

REVERSE LEVER

The reverse lever has three positions : Forward, Neutral and Reverse. Directional movement of the locomotive is selected by movement of this lever to the Forward or Reverse position. With the reverse lever in the Neutral position no power will develop if the throttle is opened, even though the engine speed will increase. The reverse lever must only be moved when the locomotive is standing still.

The reverse lever can be moved from the controller only when the lever is in the neutral position, the throttle is in Idle, and the selector lever is in OFF. Removal of the reverse lever locks the operating controls in the controller. The reverse lever must be removed in all non-operating cabs and placed in the electrical cabinet.

The reverse lever controls the operation of an electro-pneumatic reverser switch on locomotives 1400 to 1439 but on locomotives 1440 onwards it controls the operation of large EM contactors which take the place of the reversing switch and control the direction of the locomotive.

SELECTOR LEVER

The position of the selector lever determines whether the locomotive will operate to deliver power or dynamic brake. The selector lever has three positions, "B" (dynamic brake), OFF, and RUN. The OFF position is used when locking the controller. When the selector lever is in "B" position, it partially establishes the braking circuit. On locomotives 1400-1439 by moving the selector lever further to the right of B the circuit is completed and the braking effort is increased. On locomotives 1440 onwards movement of the throttle lever away from OFF towards notch 8 completes the circuit and increases the braking strength.

The RUN position on locomotives 1400-1439 or (1) position on locomotives 1440 onwards, is used to allow the locomotive to develop power.

The selector lever can only be moved one notch at a time and the lever position is shown in an illuminated indicator just above the lever.

All control levers are mechanically interlocked to prevent inadvertent faulty operation except the possibility of reversing while the locomotive is still moving. Care must be exercised at all times to prevent reversing until the locomotive is stationary.

DRIVERS CONTROL PANEL

The drivers control panel contains the following :-

Driving and Brake Ammeter : This ammeter shows the amount of current flowing to one traction motor when in power and also the output of the traction motor when operating in dynamic brake. This ammeter should be carefully watched to ensure that when operating in power the following rating is not exceeded -

Quarter hour rating	490 amps
Half hour rating	455 amps
One hour rating	435 amps
Continuous rating	406 amps

When operating in dynamic brake the ammeter reading must not be allowed to exceed 300 amps on locomotives 1400-1429 and 375 amps on locomotives 1430 onwards.

Air Brake Gauges : These are standard gauges mounted on the drivers control panel. Each gauge is clearly labelled as to its function.

Operating Switches : The panel contains all the switches necessary for the operation of the locomotive. A nameplate below each switch identifies the function of the switch. To start the diesel engine and control its speed from the throttle the Control and Fuel Pump switch and the Engine Run switch must be ON. To move the locomotive the Generator Field switch must be ON.

The automatic sanding feature if used is cut-in with the Sand Automatic switch in the ON position.

Indicator lights : There are five warning lights fitted to this panel as follows :-

WS : Wheel slip light. Flashing of this light during power operation, indicates that wheels are slipping. Automatic sand or the wheel slip brake will operate, whichever is fitted. This light also operates when working in dynamic brake.

GR : Ground relay light. When this light is illuminated it indicates a tripped ground relay. With the ground relay light on, an alarm bell will ring on all locomotives but the light will only show on the locomotive that has the ground relay tripped. When the ground relay is tripped all power will be lost to the traction motors and engine speed will return to idle but if the throttle lever is in notch 5 or 6 the engine will stop.

Loss of power and engine speed, etc. will only occur on the locomotive with the light up.

ET : Hot engine light . The hot engine light, when showing, indicates that engine cooling water temperature is above 95°C. The hot engine light will show on the locomotive affected but an alarm bell will ring on all locomotives. Engine speed or load is not affected.

PC : Switch and light. The P.C. or pneumatic control switch is often called the power cut-off switch and is located in the short hood. This is a normally open electric switch which is operated by brake pipe pressure. During an emergency automatic brake application this switch opens and automatically reduces power output of the locomotive to notch one. When tripped open this switch immediately reduces all engines in the consist to idle but if the throttle lever is left in notch 5 or 6 the engines will stop. The white PC switch open indicating light will show when the switch is open.

The PC switch will automatically reset itself provided that the brake pipe pressure is recovered.

BW : Dynamic Brake Warning Light The brake warning light is used to indicate an excessive braking current. Generally the overcurrent is only temporary and the dynamic brake regulator will automatically reduce the braking current to the maximum permissible value, depending on the type of traction motors used. Under no circumstances should the light be allowed to stay on.

Ground Relay Reset Button or Switch. This button or switch placed on the drivers panel is provided to reset the ground relay if it should trip but before operating the button or switch the throttle lever must be in idle and the isolating switch in Start.

Head Light Switches. There are three head light switches two for allowing a dim headlight to be used and one for allowing a bright head light on either end of the locomotive.

A gauge light dimming rheostat control and a cab heater control are also placed on the drivers control stand.

ENGINE CONTROL PANEL

This panel is mounted on the front of the electrical cabinet and contains the following :-

IS : Isolating Switch. This switch has two positions START (handle vertical) and RUN (handle horizontal). In the start position the power plant is isolated from the control circuits and the engine speed is reduced to idle. The engine will remain at idle speed and will not respond to throttle control. The main generator will not supply power to the traction motors even with the throttle lever in an operating notch.

The engine start button is only effective with the isolation switch in Start position and on locomotives up to 1461 the Stop button is also only effective when the isolation switch is in Start position.

The isolation switch must be in Run position for the unit to develop power and for engine revolutions to be increased.

The isolation switch should be moved only with the engine at idle or stopped. Use the manual layshaft lever to bring the engine to idle or stop when the locomotive is in power or in dynamic braking. If the isolation switch is in the Start position, do not place it in Run while operating in dynamic brake.

Engine Stop and Start Buttons These buttons are placed on the control panel and the Start button is only effective when the isolation switch is in the Start position. On locomotives 1462 onwards and Db locomotives this button is replaced with a two way switch marked Prime and Start. This switch when placed in the Prime position allows the fuel pump to be supplied with power from the battery and it will run to charge the fuel system. When the switch is placed in the Start position the fuel pump will stop but the circuit will be made to enable the engine to rotate and start. The switch is spring loaded and will return to its centre position when released.

The Start button or switch must not be held in the start position for any longer than 15 seconds. If the engine does not start within this time check for fuel faults before operating the button or switch again.

The Stop button on locomotives 1400 to 1461 is only effective with the isolation switch in Start position but on locomotives 1462 onwards the button is effective with the isolation switch in Start or Run positions. The isolation switch must always be placed in Start position when the diesel engine is to be stopped except in an emergency. Pressing the Stop button energises D valve in the governor which causes the governor to shut down the engine by putting the fuel racks to 'no-fuel'.

Battery Charge Ammeter. This ammeter shows the rate of charge or discharge of the batteries.

ELECTRICAL CABINET

This cabinet is placed between the cab and the short hood and contains the various contactors, relays, circuit breakers, fuses, and knife switches necessary for the electrical and electro-pneumatic control of the units. The cabinet is accessible from both cab and short hood sides. This cabinet differs on the several types of Da locomotives as far as equipment is concerned and although all equipment will be named and its purpose stated in the following the driver or Student should, when working on these locomotives, make himself conversant with the different types and learn what equipment is placed on them.

The following are the types of equipment which may be found in the electrical cabinet :

Knife Switches. Battery isolating switch, main lighting switch, auxiliary generator switch, control switch and ground relay by-pass switch. The ground relay bypass switch must not under any circumstances be opened by a driver.

Circuit Breakers.

1. Outside lights
2. Inside lights
3. Gauge lights
4. Headlights
5. Auxiliary generator field
6. Control
7. Local control
8. Fuel pump
9. Hot point

On some of the locomotives the circuit breakers are placed on the engine control panel.

Fuses

1. Main start fuse, 400 amp.
2. Auxiliary generator (battery charging fuse) 250 amp.

3. Battery charging fuse, 100 amp.
4. Auxiliary generator field fuse, 30 amp.
5. Battery field fuse, 80 amp.
6. External battery charge fuse, 60 amp, and ammeter.
7. Tail light fuses (4)

For proper locomotive operation all fuses must be in good condition and securely in place. All knife switches must be closed and all circuit breakers should be in the ON position in all units of the locomotive consist.

GR : Ground Relay. This relay is provided to protect the high volt circuits when a gound fault occurs - see under indicating lights. When it trips it also opens the ER relay.

ER : Engine Run Relay. This relay when energised allows the governor A, B and C valves to be energised by placing the throttle in the speed notches. When de-energised by the opening of the PC switch, tripping of ground relay or opening of the engine run switch, the engine will return to idle or if throttle in notch 5 or 6 the engine will stop.

PCR : Pneumatic Control Relay. This relay, controlled by the PC switch, will de-energise the ER relay if the PC switch is opened through low brake pipe pressure.

FPC : Fuel Pump Control Contactor. This relay when energised closes and connects the fuel pump motor to the battery.

BF : Battery Field Contactor. This contactor closes when the throttle is moved from idle to notch one and connects the low voltage excitation through the load regulator to the main generator battery field. The battery field contactor remains closed as long as the throttle is in an operating notch but will open automatically on locomotives fitted with automatic sanding when wheel slip occurs. On DB locomotives this contactor opens during transition from series-parallel to parallel.

BC : Battery Charging Contactor. This contactor closes after the engine has started and run up to speed when the auxiliary generator is able to give an output. It connects the battery to the auxiliary generator so that the battery can be charged.

BK : Dynamic Brake Contactor. . This contactor, when it closes, connects the traction motor fields in series with the main generator provided that the brake transfer switch has thrown to the 'brake' position. On later locomotives not fitted with the brake transfer switch, provided that BKB contactor has closed.

BKP : Magnetic power and brake switchgear. These are large EM contactors used to make high voltage connections in the circuits of the main generator, traction motors and dynamic brake grids as required during power operation and dynamic braking. The brake contactors are energised as soon as the battery isolating switch is closed and remain energised for all power operation.

They are de-energised when operating in dynamic bfake to connect the motor armatures to the resistor grids.

BKB. This contactor is energised when operating in dynamic brake and connects the traction motor fields in series with the main generator provided that BK is closed.

B.K.T. : Dynamic brake transfer switch. This is a large electro-pneumatic operated switch fitted to locomotives 1400-1439. It is operated by an air engine controlled by two magnet valves BKT-M and BKT-B. When the selector is placed in Run BKT-M motor magnet valve is energised which throws the transfer switch to the power position provided that the reverse lever is in a direction of travel. With the transfer switch in the 'power' position the main generator supplies power to the four series wound traction motors connected in parallel.

When the selector is placed in B position, BKT-B brake magnet valve is energised and after a 10 sec. delay the brake transfer switch will throw to the brake position. In this position it connects the traction motor armatures to the resistor grids and also connects the traction motor fields in series with the main generator provided that BK is closed.

When the engine is shut down the isolation switch must be placed in start position and the control switch left on until the transfer switch throws to the brake position. If this is not done the transfer switch will stay in the power position and the engine will not rotate when the Start button is pressed. To complete the start circuit when the Start button is pressed the transfer switch must be in the brake position, that is, its topleft hand contacts must be making. When towing a dead locomotive its brake transfer switch must be in the brake position so that any output from the traction motors can be fed to the brake resistor grids.

BR : Dynamic brake relay. This relay is energised when the selector is placed in B position and allows some of the dynamic brake circuits to be completed and at the same time isolates some of the power circuits. When the dynamic brake is increased it also allows C valve in the Governor to be energised and the engine speed is increased to 435 R.P.M.

BWR : Brake warning relay. This relay will be energised if the maximum braking current is exceeded while operating in dynamic brake. When energised it brings up the brake warning light.

DBI : Dynamic brake interlock. This is a magnet valve which is energised when the locomotive is operating in dynamic brake and prevents an automatic application of the locomotive brakes when a automatic brake application is made. Locomotive brakes will automatically apply if dynamic brake is suspended and an automatic application has been made. This valve is placed on the distributor in the short hood.

FOR : Reverser - Forward magnet valve. This valve when energised allows the air engine on the reverser to move the reverser to the forward position. On later locomotives FOR is Forward Relay which when energised closes large EM contactors which allow for forward direction of travel.

FS : Traction motor field shunting contactor. This contactor is energised when loading permits and closes a bypass shunt circuit around each traction motor field which causes a weakening of the fields.

FSR : Field shunt relay. This relay when energised energises FS to provide field weakening.

FTR : Field transition relay. This relay when energised allows FSD relay to close and energises FS.

GS1 and GS2 : Generator starting contactors. These contactors are energised when the start button is pressed and when they close they connect the battery to the main generator which acts as a series motor to crank the diesel engine.

RCR : Reverse current relay. This relay protects the auxiliary generator from a reversal of current from the battery.

RER : Reverse Relay. This relay is energised when the reverse lever is placed in the reverse position. When closed it sets up the circuit to allow large EM contactors to close to allow the traction motors to operate in a reverse direction.

REV : Reverser - reverse magnet valve. When energised it allows the air engine on the reverser to move the reverser to the reverse position on Da 1400-1439.

RVF : Magnetic switchgear. These are large EM contactors which allow the locomotive to operate in the forward direction when they are energised.

RVR : Magnetic switchgear. These are large EM contactors that allow the locomotive to operate in the reverse direction when they are energised.

SF : Shunt field contactor. This contactor when energised completes the main generator shunt field circuit.

SFT : Shunt field transfer relay. This relay when energised in dynamic braking closes and the shunt field is paralleled to the grid resistance of the traction motors 3 and 4, it also completes some LV circuits in brake.

LRP : Load regulator positioner. This relay controls the ORS over-riding solenoid in the engine governor so that the load regulator is positioned to correspond with the position of the brake control rheostat arm when operating in dynamic brake.

DBR : Dynamic brake regulator. This regulator automatically controls the strength of the dynamic brake.

WS12 : WS14: WS34 : Wheel slip relays. These relays are energised when wheel slip takes place in power and brings up the wheel slip light. At the same time if locomotive is not fitted with wheel slip brake TDS time delay sanding relay will operate and allow sand to be applied to the rails. At the same time BF will be opened and the main generator battery field will be de-energised. The opening of BF will cause the over-riding solenoid to be energised and the load regulator will move back to minimum field. When wheel slip stops power will be returned to the locomotive gradually. The wheel slip relays will also operate in dynamic brake if one motor has a greater output than other.

P12 - P34 : Parallel Contactors. These contactors are energised when the reverser contactors close for the correct direction of travel. When closed they connect the traction motors to the main generator for parallel working.

This now covers the equipment in the electrical cabinet but remember only certain locomotives have certain equipment and it is not always placed in the same place in the electrical cabinet.

REVERSER :

The reversing switch on locomotives 1400 to 1439 is operated by an air engine and operates in the same manner as the one described in lesson 8. On locomotives 1440 onwards the reversing is done by large EM contactors which act as a reversing switch.

The air operated reversing switch can be operated by hand and then locked in its neutral position. This must be done whenever the locomotive is to be towed dead.

It is most important that the reverse lever must not be placed in the opposite direction of travel while the locomotive is in motion. The locomotive must first be brought to a stop and then the reverse lever operated, otherwise serious damage may result. If by mistake the reverse lever is moved to opposite direction of travel while the locomotive is in motion, it must be left there and the locomotive brought to a stand and then the reverse lever operated for the direction of travel required; this may save some of the damage being caused. It must be remembered at all times the reverse lever must be in the correct direction to correspond with the movement of the locomotive except when the locomotive has been prepared for towing.

MAIN RESERVOIRS :

There are two main reservoirs on the locomotive. No. 1 is placed under the frame of the locomotive between the bogies and No. 2 is placed in the short hood. Air can pass from No.1 main reservoir to No.2 but air cannot pass back from No.2 to No.1 as a non-return valve is fitted between the two

reservoirs. Each reservoir is fitted with a drain cock and when No.2 main reservoir is to be reduced the drain on this reservoir must be used.

MANUAL CONTROL OF COMPRESSOR :

A manual unloader valve is fitted in the pipe line from the governor to the compressor unloader valves. If it is desired to keep an air compressor unloaded, irrespective of the compressor control system, this valve should be moved to the unloaded position as marked on the wall next to the cock. This allows main reservoir air to bypass the governor and pass straight to the unloader valves which now hold open the intake valves and the compressor works to the atmosphere. Another valve placed in the pipe from the main reservoir to the governor, if altered from its normal position, will cut off the air to the governor and the compressors will remain on load. The excess pressure which will be pumped into the main reservoirs will be relieved through the safety valves. These valves must be checked to see that they are in their correct position when the locomotive is being prepared.

AIR BOX DRAINS :

Air box drains are fitted to all locomotives but only some are fitted with drain cocks. While the engine is running air box air will blow from these drains all the time. These drains give a visual indication of any leaks that may occur in the internal parts of the engine. The drain cocks if fitted must be opened when the locomotive is put away and closed when the engine is started when preparing. At all times a close check must be kept on these drains and if there are signs of any excessive water or oil discharge the engine must be stopped if running and the fact reported to the Assistant Locomotive Supervisor or Senior Driver.

CYLINDER TEST VALVES :

Each cylinder is equipped with a test valve for the purpose of testing for liquid accumulation in the cylinders prior to starting an engine that has been shut down for 12 hours or more.

To make the test proceed as follows :-

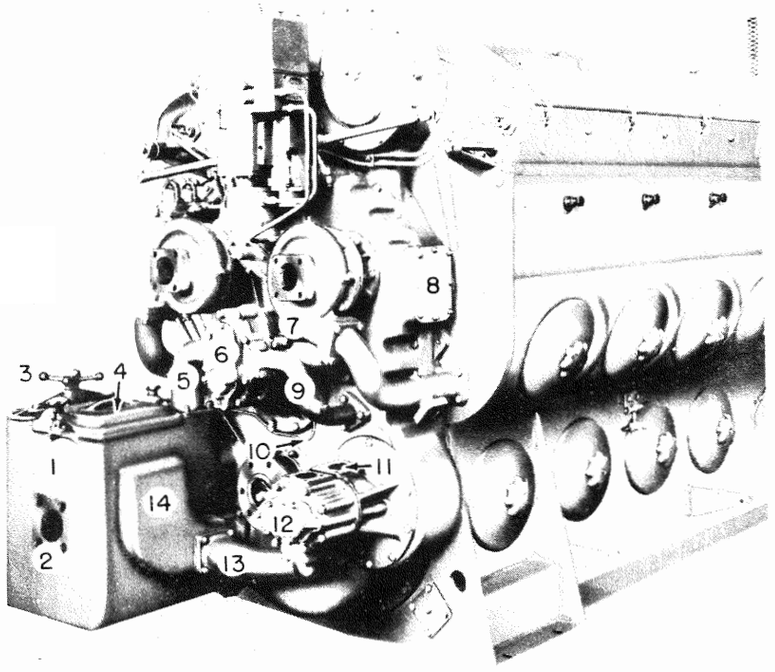
1. Remove the 400 amp starting fuse so that the engine cannot be started.
2. Open all cylinder test valves approximately three full turn
3. Use the engine barring-over jack to rotate the engine one complete revolution.
4. Check the cylinder test valvew for any discharge.
5. If liquid is discharged from any test valve report the fact to the Assistant Locomotive Supervisor or Senior Drive
6. If no discharge, close all test valves firmly.
7. Replace the 400 amp fuse and start the engine.
8. Check all test valves to see if any are leaking.
9. If any valves are leaking, stop engine at once and tighten valve or valves.

NOTE :

The hot gases blowing past a cylinder test valve seat will soon burn the seat and make it necessary to replace the entire assembly.

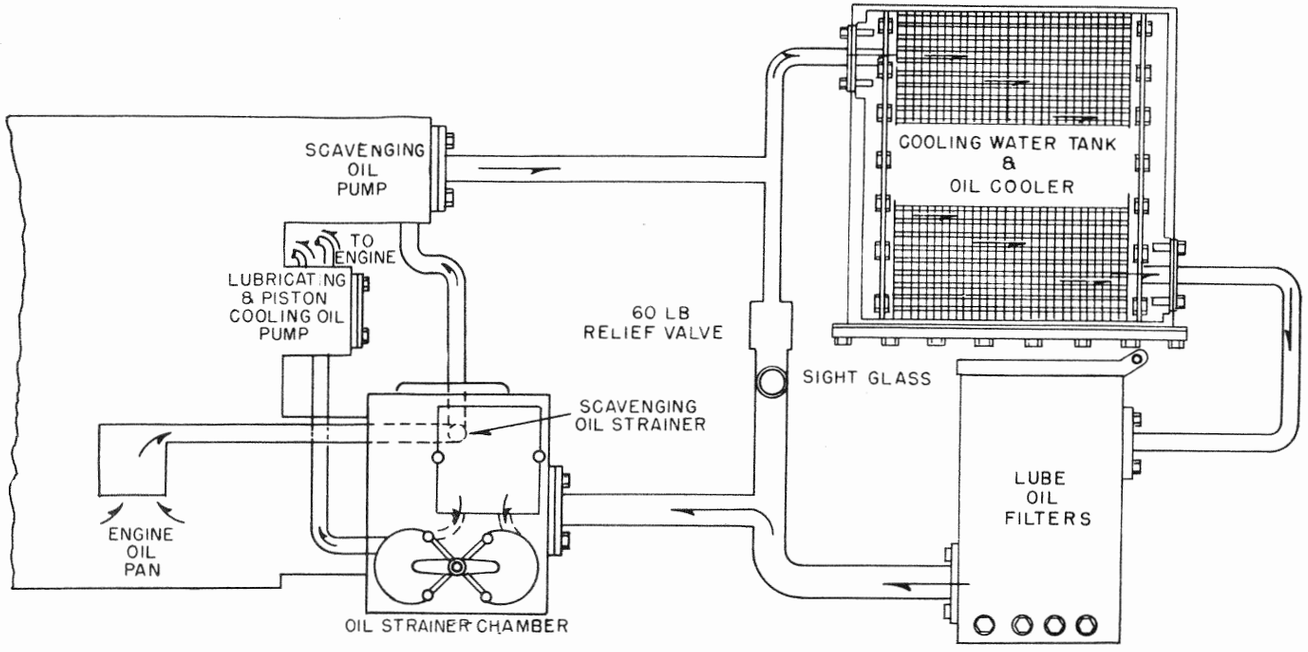
LIST OF QUESTIONS

1. Briefly describe the diesel engine fitted to a Da locomotive.
2. Describe the engine water cooling system on a Da locomotive.
3. Describe the lubricating oil system on a Da locomotive.
4. Describe the fuel oil system on a Da locomotive.
5. What is the purpose of the two fuel oil sight glasses?
6. Briefly describe how the diesel engine speeds are varied.
7. Briefly describe the three positions of the selector lever.
8. What will cause the Pneumatic Control Switch (PC) to open and explain what occurs when it opens ?
9. What is the purpose of the Battery Field Contactor
10. What is the Dynamic Brake Interlock (DB1) provided for?
11. Why are air box drains fitted and if fitted with drain cocks when should these cocks be opened?
12. What are the (BKP) contactors provided for?
13. What will cause the Engine Run Relay (ER) to open?
14. There are three ways to stop a diesel engine on a Da locomotive; name them and describe what occurs with each method.
15. How is the temperature of the cooling water controlled on a Da locomotive?

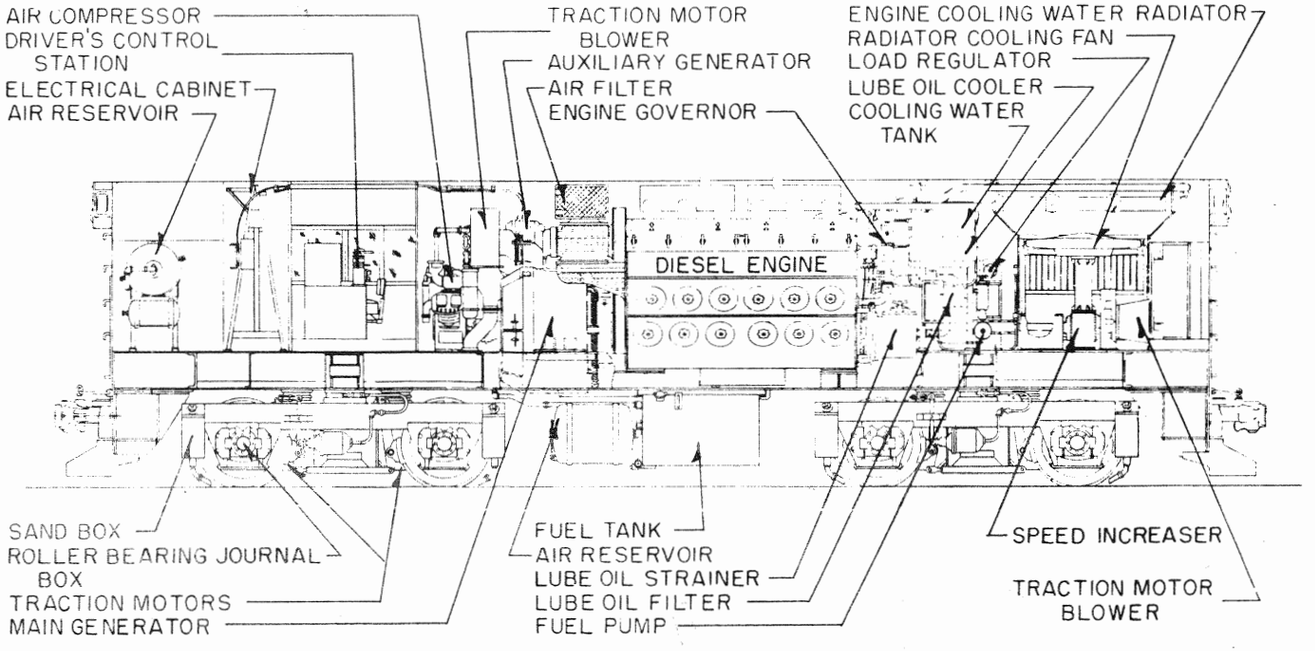


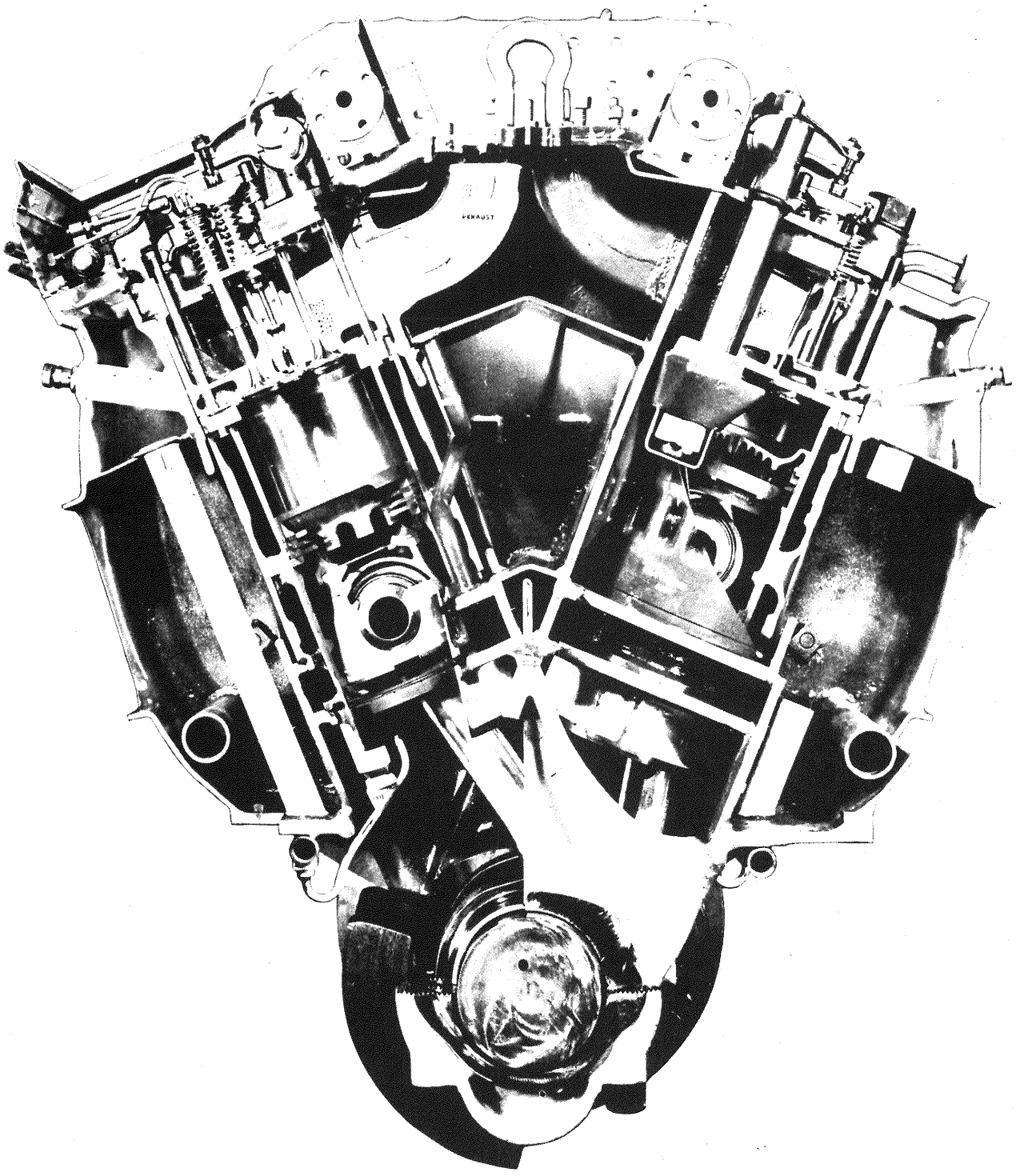
1. Strainer Housing
2. Cooler Oil Inlet to Housing
3. Lube Strainers Hold Down Crab
4. Filler Opening Cover
5. Lube Oil Suction to Lube and Piston Cooling Pumps
6. Lube and Piston Cooling Pumps
7. Lube Oil Discharge
8. Oil Manifold Relief Valve Cover
9. Piston Cooling Discharge
10. Strainer Seal Oil Supply Line
11. Scavenging Pump Outlet
12. Scavenging Oil Pump
13. Scavenging Oil Pump Suction Line From Strainer Housing
14. Scavenging Suction Strainer Oil Outlet Channel

Lubricating Oil System Components

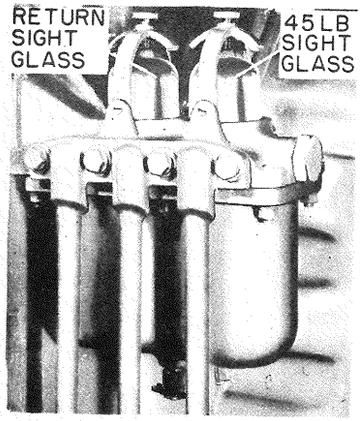


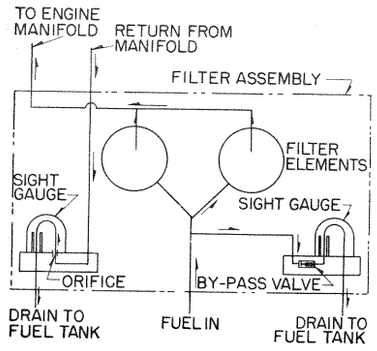
Schematic Lube Oil System

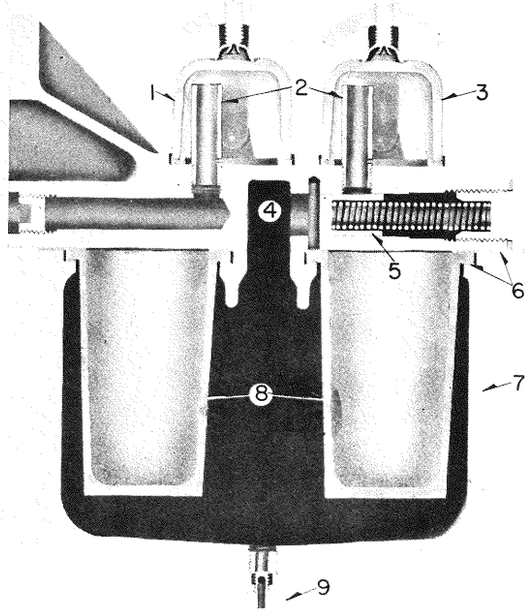




Two Stroke 567 Series Engine Cross-Section

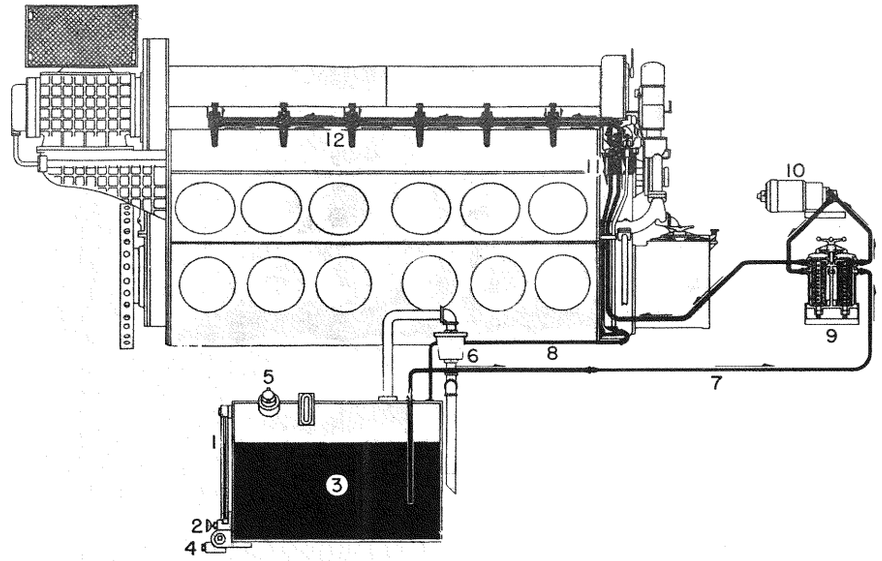






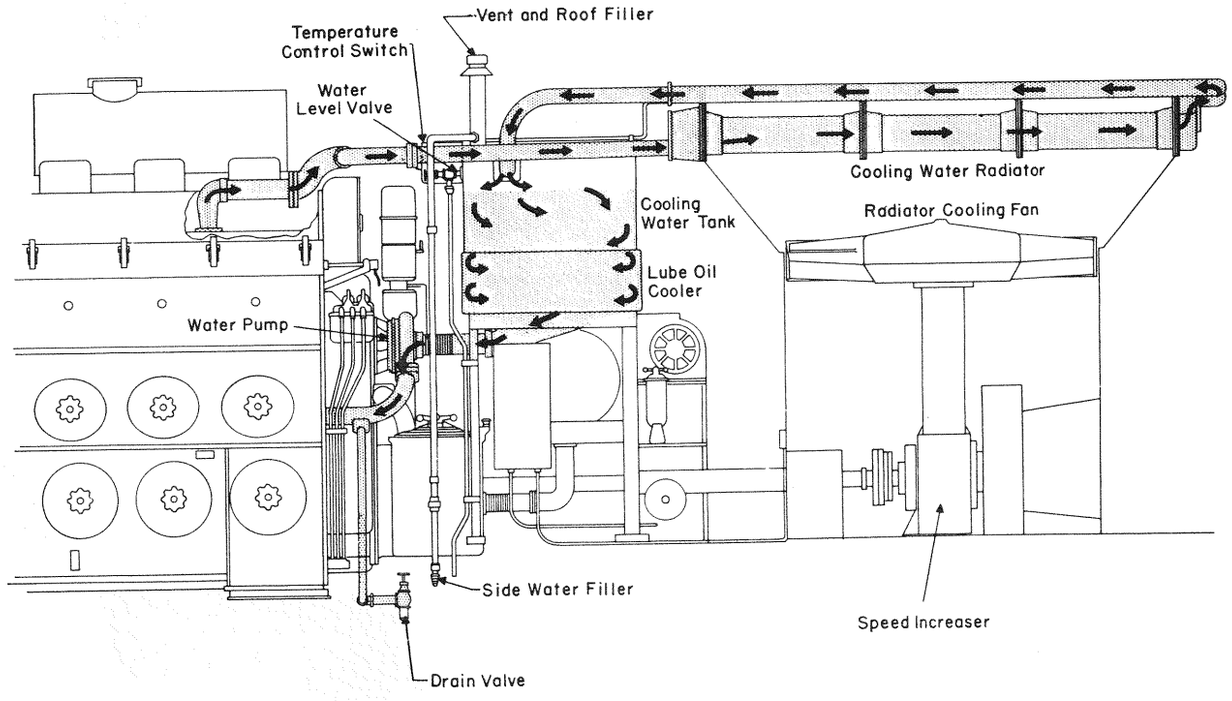
1. Return sight glass-5 lb.
2. Stand pipe
3. By-pass sight glass
4. Fuel inlet passage
5. Relief valve
6. Gaskets
7. Case
8. Elements
9. Drain

Sintered Bronze Fuel Filter

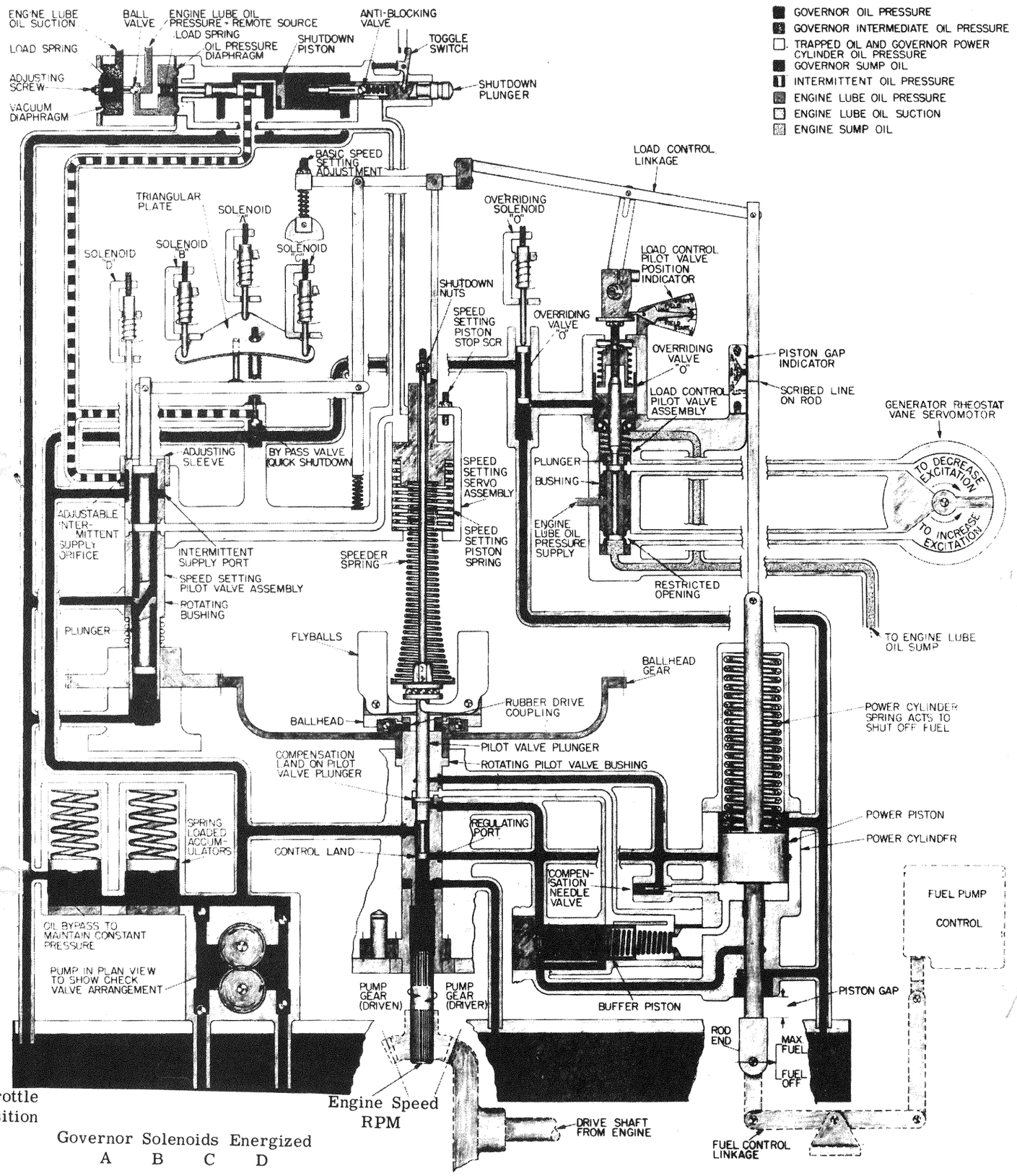


1. Fuel Level Sight Glass
2. Gauge Shutoff Valve
3. Fuel Tank
4. Fuel Tank Drain Plug
5. Fuel Filler
6. Vent And Flame Arrestor
7. Fuel Supply Line
8. Fuel Return Line
9. Dual Fuel Filter
10. Fuel Pump
11. Sintered Bronze Filter And Sight Glass Assembly
12. Injector

Fuel Oil System — Schematic



Schematic Cooling System



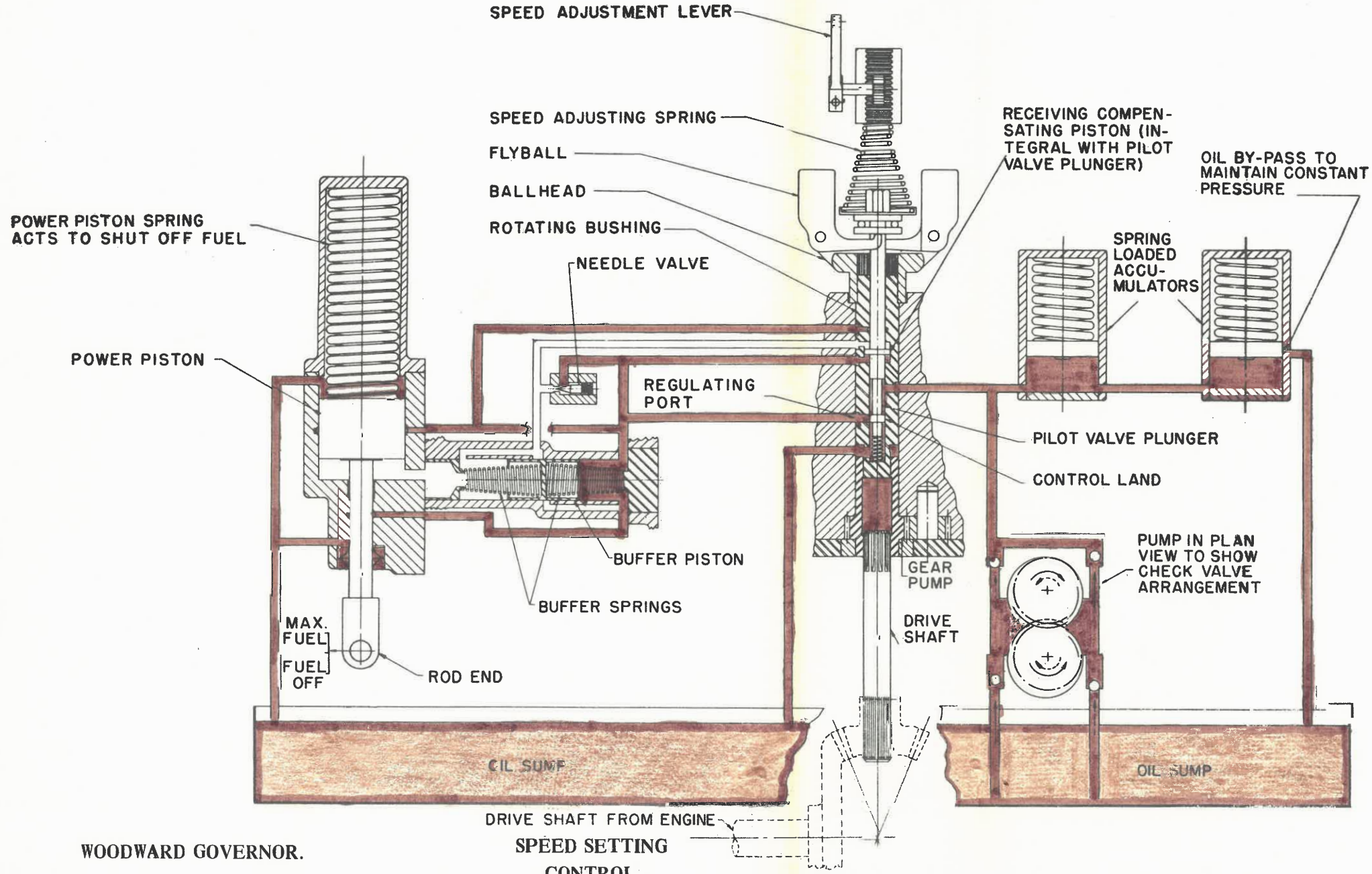
Throttle Position	Governor Solenoids Energized A	B	C	D	Engine Speed RPM
STOP				*	0
IDLE					275
1					275
2	*				355
3			*		435
4	*		*		515
5		*	*	*	595
6	*	*	*	*	675
7		*	*		755
8	*	*	*		835
Effect of Solenoids on Engine RPM	+80	+320	+160	-160 (or stop)	

Engine Speed Chart

DA

Governor with Electro-Hydraulic Control

SPEED SETTING CONTROL AND LOAD REGULATOR



WOODWARD GOVERNOR.

SPEED SETTING CONTROL

66/444