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600 HP & 1000 HP
SWITCHING LOCOMOTIVE

OPERATING MANUAL
NO. 2303

MODELS SW-1 & NW-2
567 & 567A Engines

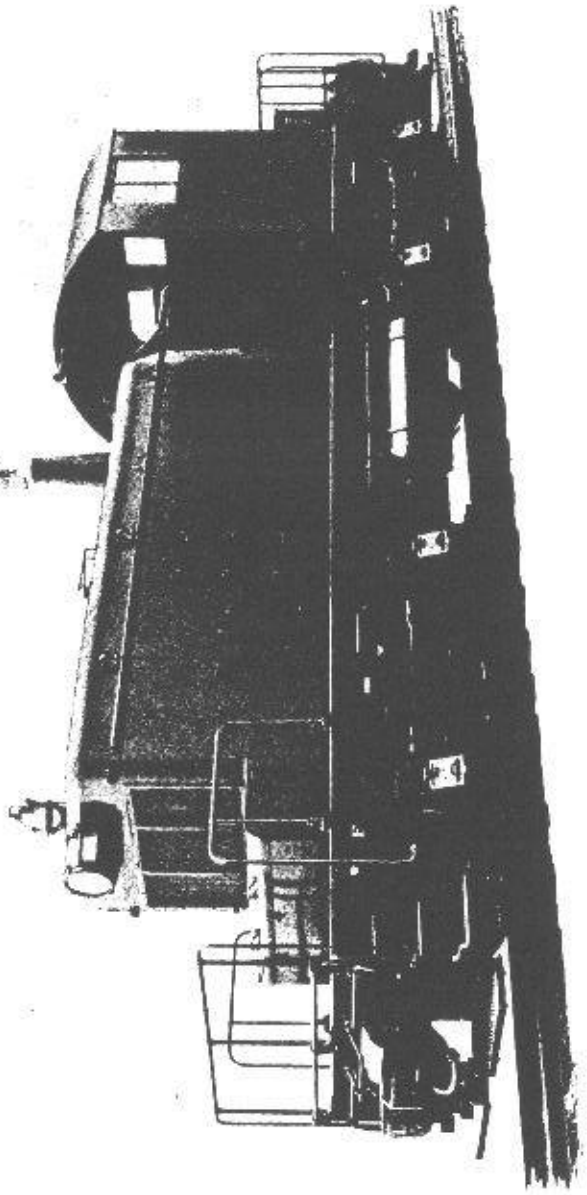
GENERAL MOTORS LOCOMOTIVES

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS CORPORATION • LA GRANGE, ILLINOIS, U. S. A.

INTRODUCTION

The purpose of this manual is to furnish enginemen with information essential for the operation of EMD Diesel switching locomotives. Details of construction are described sufficiently to provide the engineer and fireman with a basic working knowledge of the locomotive and its equipment.

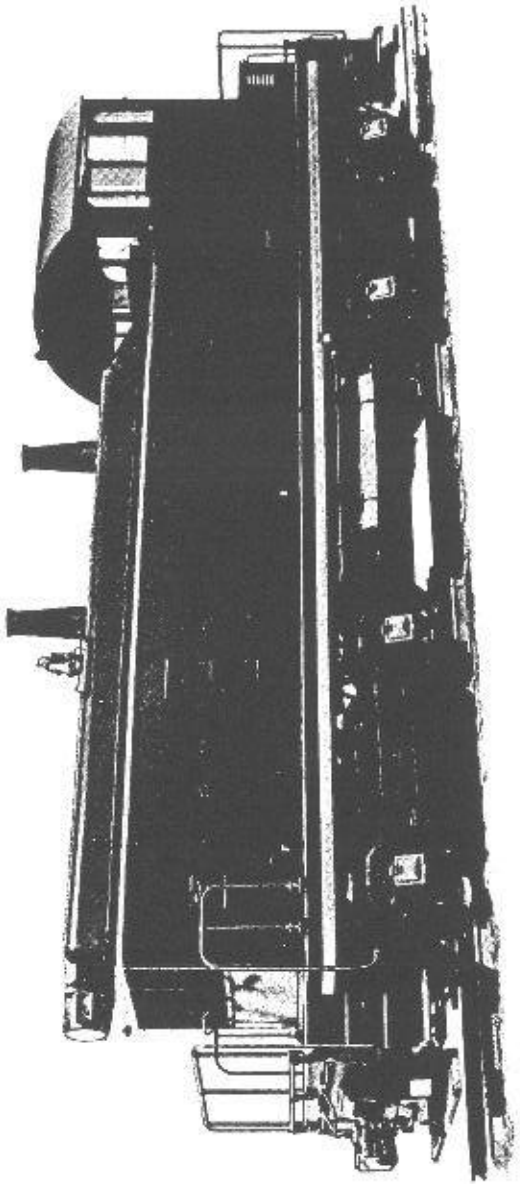
The manual is divided into sections, with the section number and designation shown at the top of each page. Section 0 contains an index to the manual, a list of illustrations and charts, general data and illustrations of the 600 HP and 1000 HP switching locomotives. Section 1 and succeeding sections cover the Description, Instruments and Controls, Operation and Location of Difficulties for the various models. These sections are loose-leaf in form so that revised pages may be inserted in the manual should changes in procedures and equipment be made.



600 HP Switching Locomotive
Fig. 1

TABLE OF CONTENTS

Continued on Page 6



1000 HP Switching Locomotive
Fig. 2

TABLE OF CONTENTS (Con't)

Continued on Page 8

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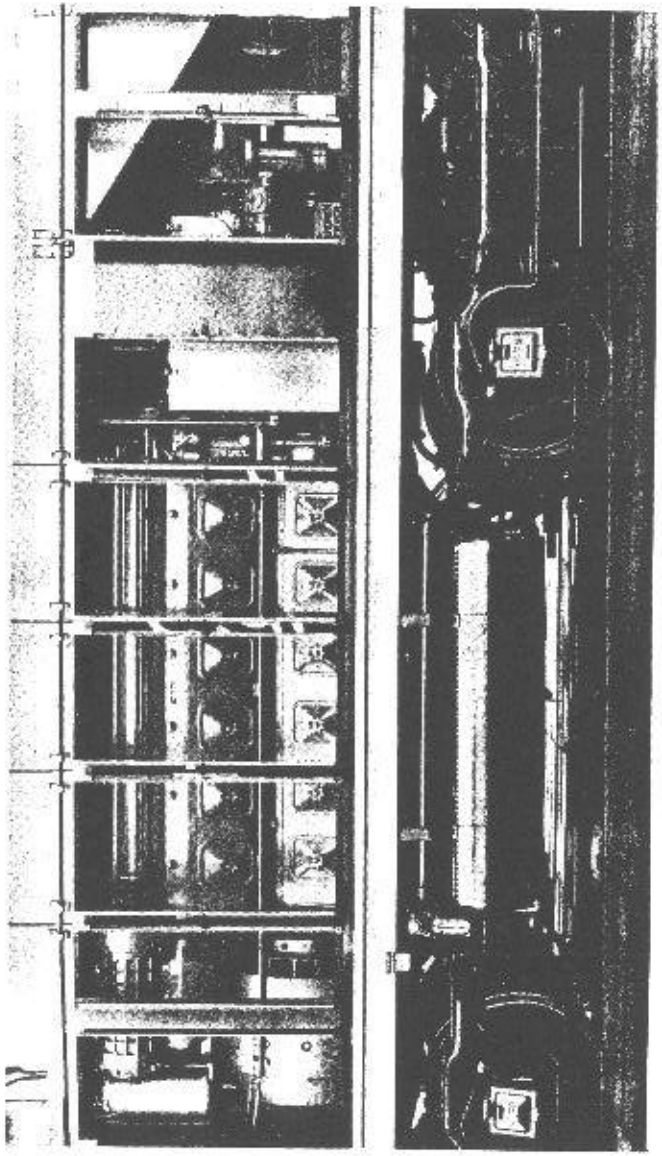
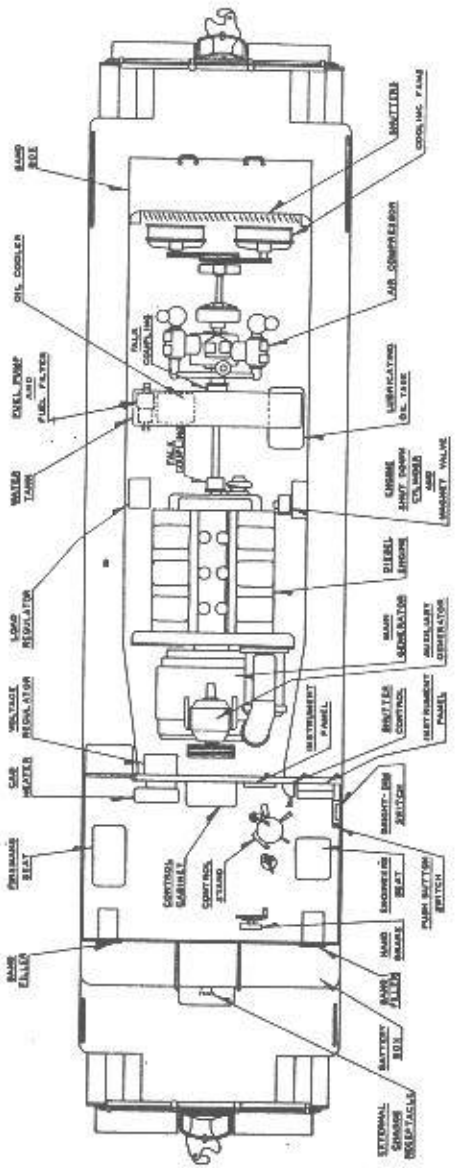


Right Side — 1000 HP Switching Locomotive
Fig. 3

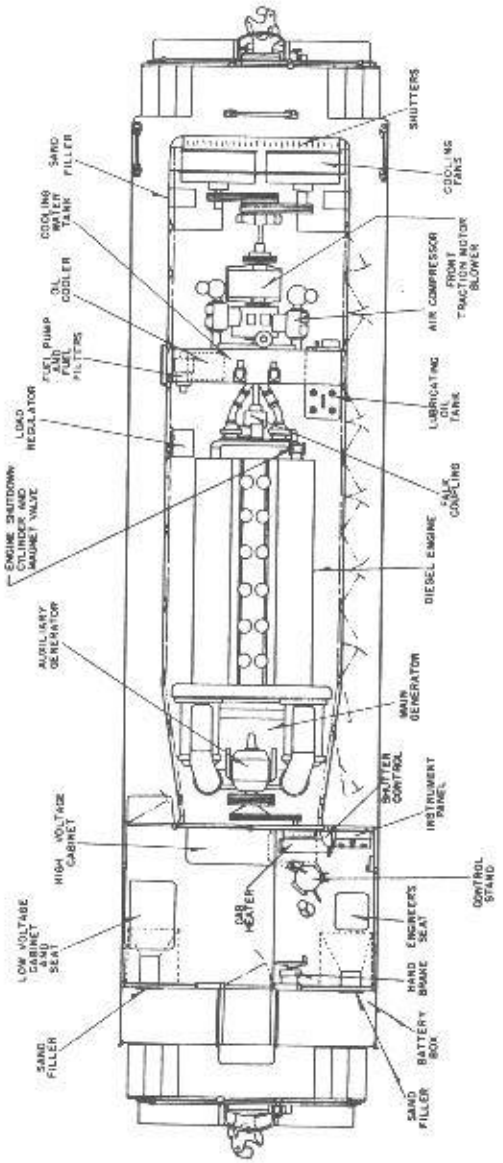
TABLE OF CONTENTS (Con't)

Continued on Page 10



General Arrangement — 600 HP Switching Locomotive
Fig. 4

TABLE OF CONTENTS (Con't)



General Arrangement — 1000 HP Switching Locomotive
Fig. 5

LIST OF ILLUSTRATIONS

GENERAL DATA	SW-1—600 HP Built Prior To January, 1946	SW-1—600 HP Built After January, 1946	NW-2—1000 HP Built Prior To January, 1946	NW-2—1000 HP Built After January, 1946
Model	SW-1	SW-1	NW-2	NW-2
Type	0-4-4-0	0-4-4-0	0-4-4-0	0-4-4-0
Engine	6-567	6-567A	12-567	12-567A
Generator	D-4A, D-4, D4D	D-4-D	D-4, D-4-D	D-4-D
Traction Motors	D-7	D-7	D-7	D-7
Weight—Fully Loaded	198,000 lb.	198,000 lb.	250,000 lb.	250,000 lb.
Weight On Drivers	100%	100%	100%	100%
Starting T.E. at 25% Adhesion	49,500 lb.	49,500 lb.	62,500 lb.	62,500 lb.
Number of Drivers	4 pr.	4 pr.	4 pr.	4 pr.
Wheel Diameter	40"	40"	40"	40"
Journal Size	6½" x 12"	6½" x 12"	6½" x 12"	6½" x 12"
Gear Ratio	62/15	62/15—65/12 *	62/15	62/15—65/12
Maximum Permissable Speed	45 MPH	45 MPH-50 MPH	60 MPH	60 MPH-50 MPH
Minimum Curve Radius	100 ft.	100 ft.	100 ft.	100 ft.
Fuel Oil Capacity	600 gal.	600 gal.	600 gal.	600 gal.
Lubricating Oil Capacity	85 gal. wet sump 65 gal. dry sump	124 gal. wet sump	125 gal. wet sump 100 gal. dry sump	165 gal. wet sump
Cooling Water Capacity	135 gal. full	181 gal. "G" valve 159 gal. full	200 gal. full	223 gal. "G" valve 253 gal. full
Sand Capacity	24 cu. ft.	24 cu. ft.	24 cu. ft.	24 cu. ft.
Length Over Coupler Pulling Faces	44' 5"	44' 5"	44' 5"	44' 5"
Height Over Cab	14' 5"	14' 4⅝"	14' 6¼"	14' 6¼"
Width Over Side Sills	10' 2"	10' 0"	10' 0"	10' 0"
Platform Height Above Rail	4' 7½"	4' 7⅛"	4' 8¼"	4' 8¼"
Truck Centers	22' 0"	22' 0"	22' 0"	22' 0"
Wheelbase—Truck	8' 0"	8' 0"	8' 0"	8' 0"

LIST OF CHARTS

The charts listed below will be found grouped in numerical order following the text of the Manual

NOTES

SECTION 1

DESCRIPTION

GENERAL

The Diesel-electric switching locomotive has a Diesel engine which drives an electrical generator to supply electricity to four traction motors. The motors are geared to the axles to move the locomotive. Various controls and auxiliary equipment are provided as described further in this manual.

MODELS OF LOCOMOTIVES

Switching locomotives built by the Electro-Motive Division of General Motors Corporation are built in two sizes or types:

1. The SW-1 having a six-cylinder, 600 HP engine.
2. The NW-2 having a twelve-cylinder, 1000 HP engine.

For data on switching locomotives, see GENERAL DATA table preceding this section. Figs. 4 and 5 show the general arrangement of the two types. In both cases, late model locomotives are illustrated. The differences between the 600 and 1000 HP locomotives will be described in the following pages.

The production of switching locomotives was suspended between April 1, 1943, and January 1, 1945, by government orders which directed Electro-Motive to concentrate on Diesel freight locomotives. During the interim, changes and improvements were made in the design of the engine and other parts of the locomotive. Where these changes affect the handling or operation of the locomotive, they will be covered in this manual. For

this purpose, locomotives built between February, 1939, and April, 1943, are designated as "earlier locomotives," and those built after January, 1945, as "later locomotives."

Locomotives built prior to February, 1939, were equipped with Model 201A Diesel Engines and are not specifically covered in this manual. The construction and operation of these locomotives are similar in many respects and this manual may be used for general instruction.

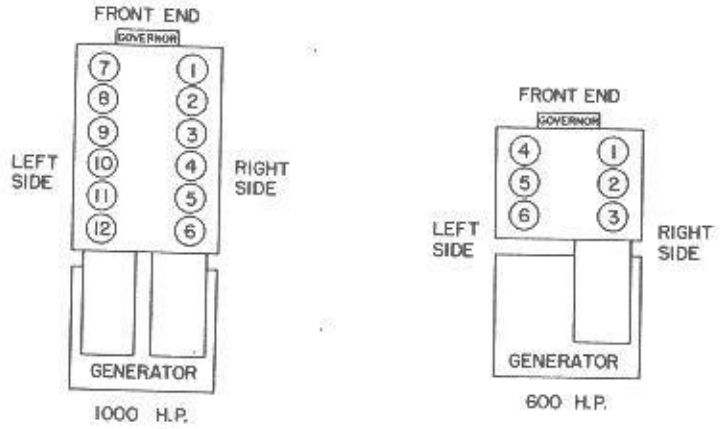
ENGINES

GENERAL

The engines in all switchers are two-cycle, solid injection type, with cylinders $8\frac{1}{2}$" bore by 10" stroke, arranged in banks at 45-degree angle. The engines in earlier locomotives were designated 6-567 (600 HP) and 12-567 (1000 HP). On switchers built in 1945 and later, the respective engines are 6-567A and 12-567A. The engines are basically the same in operation except for such differences noted later in the manual.

Diagrams of the engines are shown in Figure 6. Note that the front of the engine is toward the front of the locomotive. The front end of the engine is also called the "accessory end," since the water pumps, lubricating oil pumps, governor, etc., are located at that end. The diagram can be used to identify the various cylinders by number in making work reports.

The engine is started by using the main generator as a starting motor. Current from storage batteries is utilized, causing the main generator to rotate the Diesel engine.



Engine Cylinder Arrangement
Fig. 6

FUEL SYSTEM

See Charts I and II for schematic illustration of the fuel oil system of the 600 HP and 1000 HP locomotives, late model. Differences in the fuel oil systems of other locomotives are pointed out below.

Fuel oil is drawn from the storage tank under the locomotive and passes through a suction filter to the motor driven fuel pump. The suction filters on the earlier locomotives are Purolator type, having a handle which should be turned periodically to clean the filter. Later locomotives have wastex or screen filters which require no attention by the enginemen. The fuel pumps are located at the left-hand side of the engine compartment, near the front end of the engine. An emergency fuel cut-off is provided in the line between the tank and the suction fuel filter, as described under "Locomotive Protective Devices."

The fuel pump delivers the fuel to the first discharge fuel filter. On earlier locomotives, the Nugent filter is used. It consists of two filter elements with a handle by

which the flow may be directed through either element. Later locomotives have Ful-flo filters with no control handle. After passing through the Nugent or Ful-flo filters, the fuel enters a second discharge filter. This filter contains two sintered bronze elements with a control handle. The sintered bronze filter is used on all models except some early 600 HP locomotives on which "finger strainers" were used.

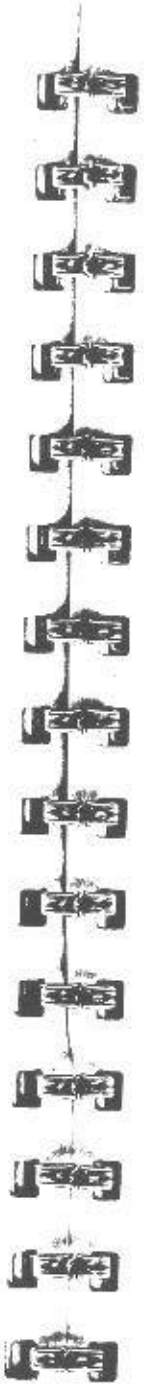
Normally, the control handles of the filters need not be changed except under circumstances outlined in Section 4 when difficulty is encountered.

After leaving the sintered bronze filter, the fuel passes through manifolds along each cylinder bank. Branches go to the injectors in each cylinder head where small sintered bronze filters provide final protection for the injectors. Excess fuel, not used by the injector, returns to the fuel tank through a fuel return manifold and a relief valve set at 5 lbs. pressure.

A relief valve is provided, set at 60 lbs., which by-passes the fuel back to the tank if either or both of the discharge filters become clogged. Two pressure gauges connected to the fuel lines are used to check the condition of the filters as described in Section 4. A third pressure gauge is connected to the return flow pipe from the injectors. This gauge is located in the cab and indicates whether the engine is getting sufficient fuel.

Two direct reading sight level gauges are located at each side of the fuel tank. The upper gauge located in the fuel tank filler casting will indicate the fuel level from a full tank down to approximately 4 inches below the full mark on the gauge.

The lower sight level gauge will indicate the amount of fuel in the tank when the level is approximately 4 inches or less above the bottom.



LUBRICATING OIL SYSTEM

See Charts III and IV for the schematic diagrams of the flow of lubricating oil in the 600 HP and 1000 HP switchers. The illustrations cover later type locomotives using 567A engines with wet sump operation.

Oil is drawn from the oil pan of the engine by the scavenging pump and forced through the oil cooler and lube oil filters to the oil tank strainer chamber. The oil then passes through the suction strainers and goes to the pressure pump, which consists of two pumps in one housing. One section forces oil to the main bearings, gear train, blowers, etc. The second section supplies oil under pressure to cool the pistons. Gauges are provided in the cab which show the pressures of lubricating and piston cooling oil - see Section 2.

The foregoing description covers "wet sump" engines. Some of the earlier locomotives have engines of the dry sump type where the oil reservoir is a separate oil tank rather than the engine oil pan. The oil level gauge or "dipstick" is found on the oil pan of the wet sump engine, while the dry sump engines have the dipstick in the oil tank. A number of these engines have been converted to wet sump operation.

In case of failure of the lubricating oil system, the engine will shut down to idle speed as described under "Locomotive Protective Devices."

COOLING SYSTEM

Charts III and IV also contain schematic diagrams of the engine cooling systems of the late model 600 HP and 1000 HP locomotives.

Water from the water tank is pumped through the engine cooling water passages in the engine to the radiators at the front of the locomotive, where it is cooled and returned to the water tank.

Two cooling fans are located directly behind the shutters. The fans are Vee belt-driven through sheaves and jackshafts and their speed is proportional to the speed of the engine.

The temperature of the water leaving the engine is shown by a temperature gauge in the cab. Earlier locomotives have two gauges, one being connected to the outlet of each cylinder bank, while later models have but one gauge in the cab.

The temperature of the engine cooling water is controlled by radiator shutters. On the early Switchers these are operated by a lever in the cab. Automatically controlled shutters are furnished on the latest Switchers. See Section 3 for normal operating temperatures.

The cab heaters are part of the engine cooling water system as water from engine banks passes through them. For operation of cab heater controls, see Section 2.

The cooling system of the engine is filled either through the filler pipe located on the roof of the locomotive above the water tank, or through the side filler pipe located underneath the locomotive frame, to the left front of the fuel tank. This filler pipe can be identified by a cone-shaped fitting on the end of the pipe. When filling the system, the engine is stopped, the "G" valve opened and water added until it runs out the "G" valve drain. See Section 4, "Low Water Level."

In colder weather, during a layover, the engine cooling system may be heated by steam from an outside source. A connection is provided for such steam supply. If heating is not available and the locomotive must be drained, refer to Charts III and IV which show the drain valves. Also see "Freezing Weather Precautions," Section 3.

ELECTRICAL SYSTEMS AND CIRCUITS

GENERAL

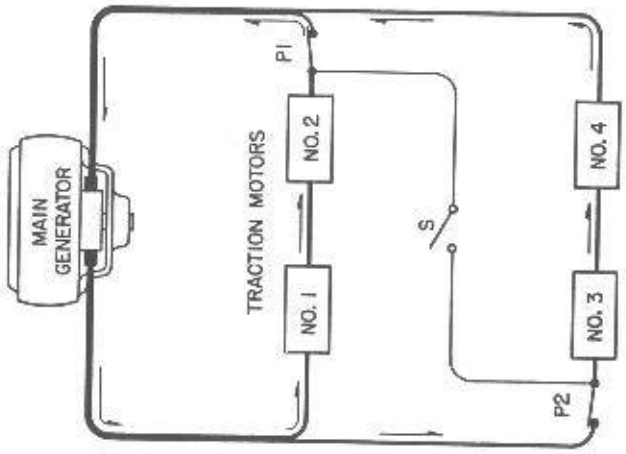
For schematic wiring diagrams of the electrical systems of the late model 600 HP and 1000 HP locomotives, see Charts VI, VII, and VIII. To assist in tracing the circuits described below, a table of electrical symbols is given in Chart V.

The Diesel engine drives the main generator which produces direct current electricity for operation of the traction motors. The voltage of the main generator is nominally 600 volts, but varies with the conditions of operation of the locomotive. The Diesel engine also drives an auxiliary generator, through belts, which produces low voltage electricity (approximately 74 volts) for various purposes such as charging the storage battery, operating the control circuits, lighting, etc.

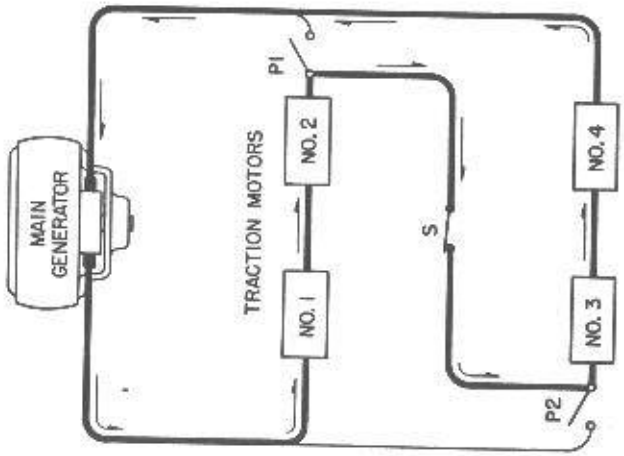
The current from the main generator flows to four traction motors, two mounted on each truck. The motors are connected in series for low speed and heavy traction operations or in series-parallel for higher speed operation. In series, the current passes through each motor in turn before returning to the main generator, as illustrated in Fig. 7.

In series-parallel, the current from the main generator divides and follows two paths. Each branch consists of two traction motors in series. The current paths then reunite and return to the main generator. The diagram in Fig. 8 shows the current flow when the motors are connected in series-parallel. On 600 HP switchers, (before Serial #4582), the motors are operated in series at all times, and no provision is made for series-parallel hookup.

On 1000 HP locomotives, the traction motors are cooled by blowers, one for each truck. The blowers are



Traction Motor Connections
Series-Parallel Operation
Fig. 8



Traction Motor Connections
Series Operation
Fig. 7

belt-driven and turn at approximately three times the speed of the Diesel engine. The blower supplying the two motors of the rear truck is located under the right side of the cab floor. The 600 HP locomotives have no traction motor blowers, but some early traction motors had an impeller type fan attached to the motor shaft.

ELECTRICAL CABINETS

On 1000 HP locomotives, the electrical equipment (contactors, fuses, instruments, etc.) is divided between two cabinets. The high voltage cabinet is located in the forward part of the cab and contains the equipment shown in Fig. 9. The low voltage cabinet, Figs. 10 and 11, serves as the fireman's seat box.

In 600 HP locomotives, both low and high voltage equipment are contained in a single electrical cabinet at the forward end of the cab. Fig. 12 shows the arrangement of this cabinet. In this manual, references are made to certain equipment being located in the low voltage cabinet. On 600 HP locomotives, the items will be found in the electrical cabinet.

TRANSITION

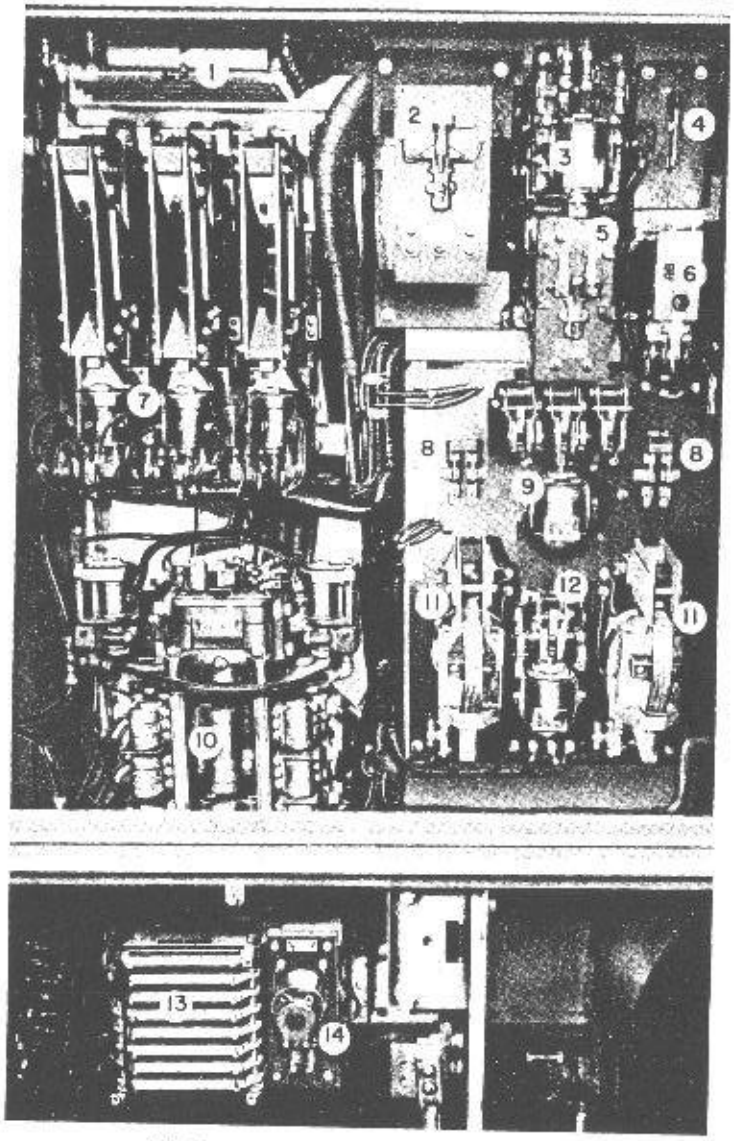
The change-over from series hookup to series-parallel, or vice versa, is called "transition." It is accomplished by opening and closing of "power contactors" designated "P1", "P2", and "S" in Figs. 7 and 8 above and so marked in the high voltage cabinet, Fig. 9. It will be noted that, in series arrangement, "P1" and "P2" are open while "S" is closed. In series-parallel, "P1" and "P2" are closed and "S" is open. The operation and control of the power contactors will be covered later.

REVERSING

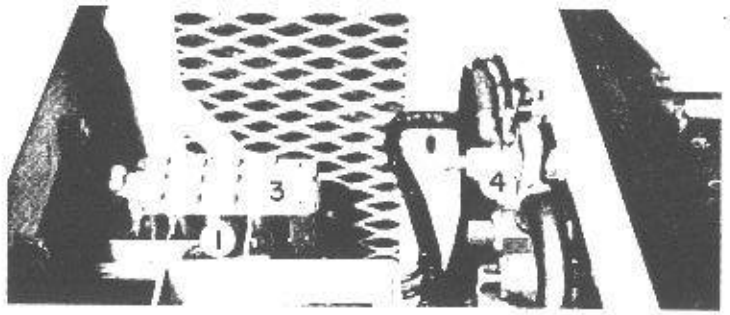
Reversing of the traction motors for forward and

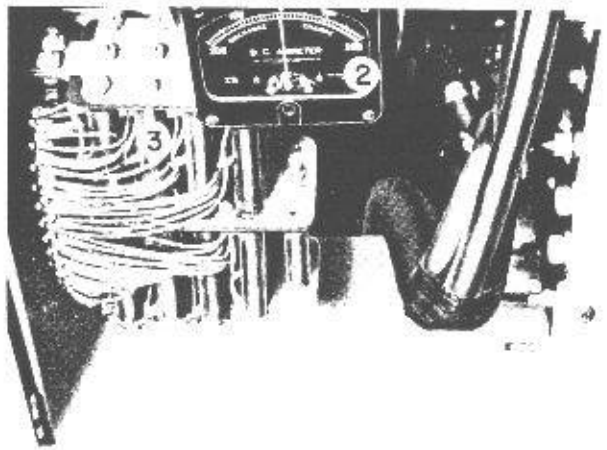
ELECTRICAL EQUIPMENT
HIGH VOLTAGE CABINET - 1000 HP

1	Wheel Slip and Transition Relay Resistors
2	Current Limiting Relay
3	Transition Relay
4	Ground Protective Relay Switch
5	Wheel Slip Relay
6	Ground Protective Relay
7	Power Contactors (P1, S, P2)
8	Motor Cutout Switches
9	Shunt Field Contactor
10	Reverser Drum
11	Starting Contactors
12	Battery Field Contactor
13	Shunt Field Resistor
14	Time Delay Relay



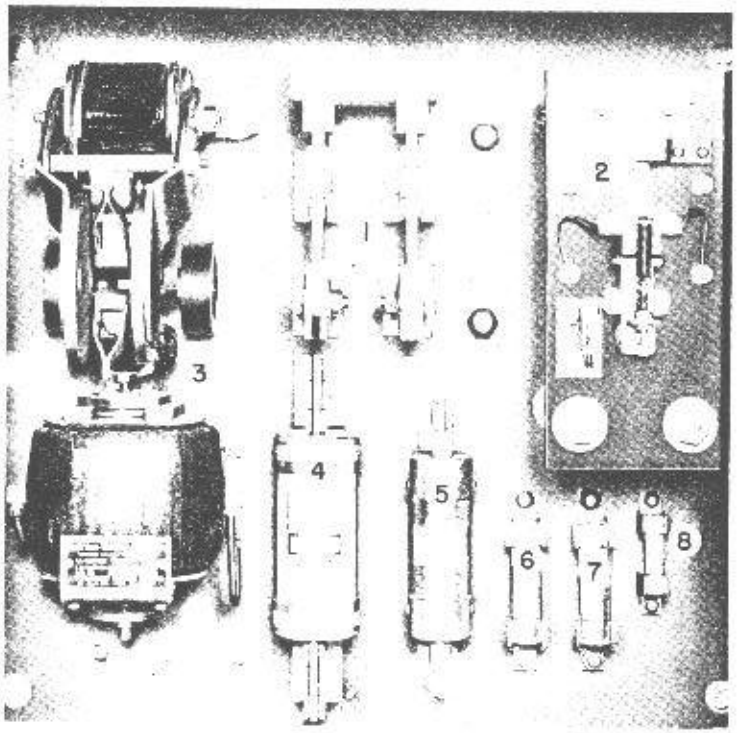
High Voltage Cabinet - 1000 HP
Fig. 9





1 VOLTAGE REGULATOR
2 BATTERY CHARGING AMMETER
3 RESISTORS
4 REAR OF DISTRIBUTION PANEL

Low Voltage Cabinet - 1000 HP
Side and Top View - Door and Cushion Removed
Fig. 10



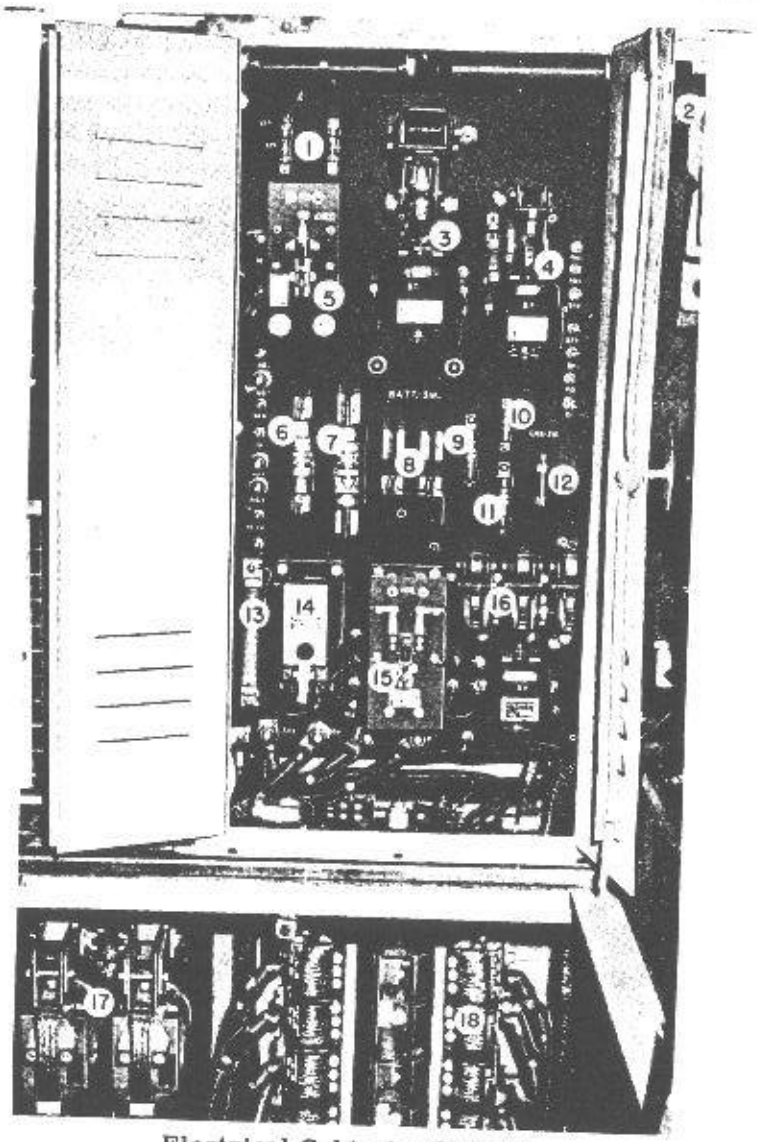
1 MAIN BATTERY SWITCH
2 REVERSE CURRENT RELAY
3 BATTERY CHARGING CONTACTOR
4 STARTING FUSE
5 AUXILIARY GENERATOR OUTPUT FUSE
6 BATTERY FIELD FUSE
7 POSITIVE FUSE
8 AUXILIARY GENERATOR FIELD FUSE

Low Voltage Cabinet - 1000 HP
Front View - Door Removed
Fig. 11

ELECTRICAL CABINET EQUIPMENT - 600 HP

1 Fuses -Outlet and Light Circuits
2 Battery Charging Ammeter
3 Battery Charging Contactor
4 Battery Field Contactor
5 Reverse Current Relay
6 Auxiliary Generator Charging Fuse
7 Starting Fuse
8 Main Battery Switch
9 Battery Field Fuse
10 Auxiliary Generator Field Fuse
11 Battery Positive Fuse
12 Ground Protective Relay Switch
13 Shunt Field Contactor Resistor
14 Ground Protective Relay
15 Wheel Slip Relay
16 Shunt Field Contactor
17 Starting Contactors
18 Reverser Drum

NOTE: Power Contactors (P1, S, P2) Not Illustrated.



Electrical Cabinet - 600 HP
Fig. 12

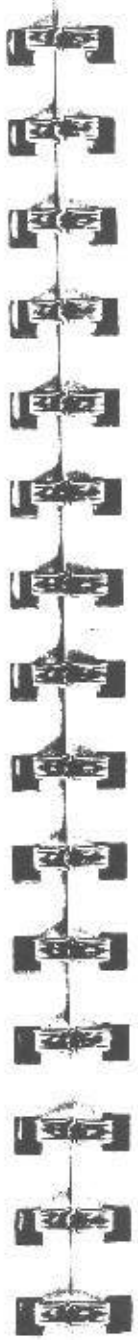
back-up operations is accomplished by changing the direction of the electricity flow through the field windings of the traction motors. The flow through the armature (revolving portion) of the motor remains the same. The reversal of the field current flow is made by a switch called the reverser, controlled by movement of the engineer's reverse lever. Operation of the reverser will be covered later.

LOW VOLTAGE SUPPLY

Electricity for the locomotive control, lighting, etc., comes from either of two sources, the storage battery or the auxiliary generator. The storage battery supplies electricity for lighting while the engine is stopped. The battery also supplies the current necessary for starting the engine, as described under Engine Starting Circuits. With the engine running, the auxiliary generator keeps the battery charged and supplies the low voltage current demands. Should the auxiliary generator supply fail for any reason, the storage battery will supply demands of the low voltage system and allow operation of the locomotive to continue for a limited time.

The storage battery consists of 32 cells and is connected to the low voltage system by the Main Battery Switch located in the low voltage cabinet under the fireman's seat, Fig. 11, on the 1000 HP locomotives or in the electrical cabinet, Fig. 12, on 600 HP locomotives. This switch is kept closed at all times when the locomotive is in operation.

The auxiliary generator is belt-driven from the main generator. The supply from this source is regulated and controlled by the equipment listed below, also contained in the low voltage cabinet of 1000 HP locomotives or the electrical cabinet of 600 HP locomotives, Figs. 10, 11 and 12.



1. Voltage Regulator

Regulates the auxiliary generator output voltage, keeping it approximately constant.

2. Reverse Current Relay (RCR)

Causes the battery charging contactor to open when the output voltage of the auxiliary generator falls below that of the battery.

3. Battery Charging Contactor (BC)

An electrically operated switch which, when closed, connects the auxiliary generator to the low voltage system. When the auxiliary generator voltage drops for any reason (such as stopping the engine), the battery charging contactor opens, due to the function of the reverse current relay. The battery charging contactor and reverse current relay are necessary to prevent a current from the battery from flowing back through the auxiliary generator when the engine is stopped. This would result in very high current being circulated through the auxiliary generator as well as discharging the battery.

4. Auxiliary Generator Output Fuse (150 Amp.)

Protects the auxiliary generator and its discharge circuit against excessive load. A blown auxiliary generator output fuse will cut out the auxiliary generator.

5. Auxiliary Generator Field Fuse (30 Amp.)

Protects the auxiliary generator field windings against excessive current. Blowing of this fuse will also prevent the auxiliary generator from functioning.

6. Battery Charging Ammeter

The ammeter shows whether the battery is charging

or discharging. The ammeter should show zero or a slight "charge" at all times when the engine is running. The amperage will depend on a number of circumstances, and no definite figure can be stated.

7. Voltmeter

On earlier 600 HP and 1000 HP switchers, a voltmeter shows the output voltage of the auxiliary generator.

ENGINE STARTING CIRCUITS

When the "Engine Start" button is pressed, a circuit is completed which energizes the operating coils of the starting contactors (ST- and ST+), causing these contactors to close. With the starting contactors closed, electricity from the storage battery flows through the main battery switch to the armature and starting field windings of the main generator. This causes the main generator to act as a motor and crank the Diesel engine. A 400-ampere fuse is included in the latter circuit.

CONTROL CIRCUITS

The control circuits of the locomotive perform the following functions:

1. Establish circuits which energize the shunt and battery fields of the main generator, thereby enabling it to generate power. These circuits are set up by closing two electrically operated switches or contactors in the high voltage cabinet which are designated "Shunt Field Contactor" (SH) and "Battery Field Contactor" (BF).

   The throttle must be opened at least 1/2" from idle position, the reverse lever in forward or reverse, and the control and generator field push-button switches

closed, to establish the circuit which closes the battery and shunt field contactors.

2. Connect the traction motors in series to start the locomotive. The series hookup of the traction motors is set up by closing of the electro-pneumatic contactor "S" as shown in Fig. 7 (or line switch, LS, on 600 HP locomotives without automatic transition). This is done by energizing a magnet valve in the contactor or line switch which allows air to operate the switch.

   It is necessary to close the control switch and move the reverse lever to forward or reverse position to close the "S" contactor or line switch (whichever is used.)

3. Effect transition from series connection of the traction motors to series-parallel and vice versa. In changeover or transition from series to series-parallel connection, "S" contactor opens and "P1" and "P2" close. The transition occurs when the locomotive speed (at full throttle) reaches approximately 9 to 11 miles per hour. The transition is not under the control of the engineer except that he may prevent or forestall it by pushing the selective transition switch to "IN—SERIES" position (see Sections 3 and 4). At about 9 to 11 miles per hour, the voltage of the generator rises to the point where it causes the transition relay (VI) to "pick up" or close. Closing this relay has three results.

   a. Generator shunt field contactor (SH) opens.
   b. Generator battery field contactor (BF) opens.
   c. Time delay relay (VT) closes (used on 1000 HP only).

   Opening the generator shunt field and generator battery field contactors causes the power output of the main generator to decrease. The time delay relay (VT) does not close instantly when the transition relay closes. It delays closing about one-fifth of a second,

to allow time for the main generator current to decrease before transition takes place. Closing of the time delay relay establishes the circuit which energizes the magnet valve of the "P1" contactor, causing the contactor to close. As this contactor moves to closed position, its mechanism opens an interlock which breaks the circuit energizing the magnet valve of the "S" contactor, causing it to open. When "S" contactor opens, its mechanism closes an interlock which establishes a circuit to energize magnet valve of "P2" contactor, closing it. Completion of the sequence causes the shunt field and battery field contactors to close and the main generator to resume production of power.

The sequence for automatic transition on the 600 HP is the same as for the 1000 HP locomotive except that no time delay relay (VT) is used. The transition relay completes the circuit to close the P1 contactor as soon as the Battery Field (BF) drops out.

For transition from series-parallel back to series, it is necessary to close the throttle to idle. When the throttle is returned to idle, the movement of the lever opens a switch in the control stand which breaks the circuits, de-energizing the "P1" and "P2" contactor magnet valves. When these contactors open, the movement of "P1" closes the circuit to close "S" contactor. Thus the power circuits are again in series arrangement. It is also possible to effect transition from series-parallel to series by pushing the selective transition switch to "IN—SERIES" position. This practice is not recommended.

4. Control of traction motor direction or rotation — accomplished by movement of the reverse lever in the control stand. When placed in either forward or reverse position, the lever closes a contact, completing an electrical circuit which energizes a magnet valve at the reverser in the high voltage cabinet. There are two magnet valves - one energized when the lever is in forward position and the other when the lever is in reverse. When either magnet valve is so energized, it opens and admits compressed air to a cylinder which moves the reverser drum to the corresponding position.

MAIN GENERATOR EXCITATION

The main generator contains five field windings - starting, differential, commutating, battery field, and shunt field. The first is used only when the main generator acts as a starting motor. The second and third are permanently connected and a matter of engineering design of the generator. The last two are of interest since they govern the power output of the main generator.

The battery field of the main generator is excited by low voltage electricity supplied by the battery or the auxiliary generator. The current passes through the battery field contactor (BF), covered under "Control Circuits," and the load regulator.

The load regulator is a device which loads the engine according to the throttle setting in the cab. It automatically maintains a constant horsepower output corresponding to each throttle position within effective limits.

For the purpose of load regulation the means of determining the horsepower output of the engine is based on the rate of fuel consumption. This is determined by the relationship between the speed setting on the governor and the position of the power piston controlling the opening of the injector racks. If the engine demands more fuel than a predetermined setting or balance point, the load regulator reduces the load on the engine by reducing the field excitation of the main generator, thereby reducing its power output.

If the engine requires less fuel than the predetermined setting, the load regulator increases the load on the engine by increasing field excitation of the main generator. In this manner, battery voltage, temperature changes in generator windings, or locomotive speeds do not cause overloading or underloading of the engine.

The load regulator has two components: first, the pilot valve which is attached to the governor, and second, a self-contained unit which consists of an hydraulic rotary vane type motor attached to the commutator type rheostat.

The shunt field is connected across the armature of the generator. When the armature turns and builds up voltage, current flows through the shunt field. The circuit is provided with a shunt field contactor (SH) which must be closed, as described under "Control Circuits," to establish the circuit and make the shunt field effective.

FUEL PUMP OPERATION

The fuel pump motor is operated by low voltage electricity supplied through the fuel pump switch and 15-ampere fuse in the control push-button box.

WHEEL SLIP RELAY OPERATION

The purpose and operation of the wheel slip relay (WSR) are explained under "Wheel Slip Indicator" later in this Section. When the relay picks up on later locomotives, it closes a circuit which allows the shunt field contactor operating current to by-pass the contactor operating coil. This de-energizes the shunt field contactor (SH) operating coil and opens the contactor. When the shunt field contactor opens, it causes the battery field contactor (BF) to open. On earlier locomotives, the wheel slip relay is normally closed. When the wheels slip, the relay opens and breaks the circuit which keeps

the shunt field contactor closed. The contactor opens and, in turn, causes the battery field contactor to open.

LIGHTING

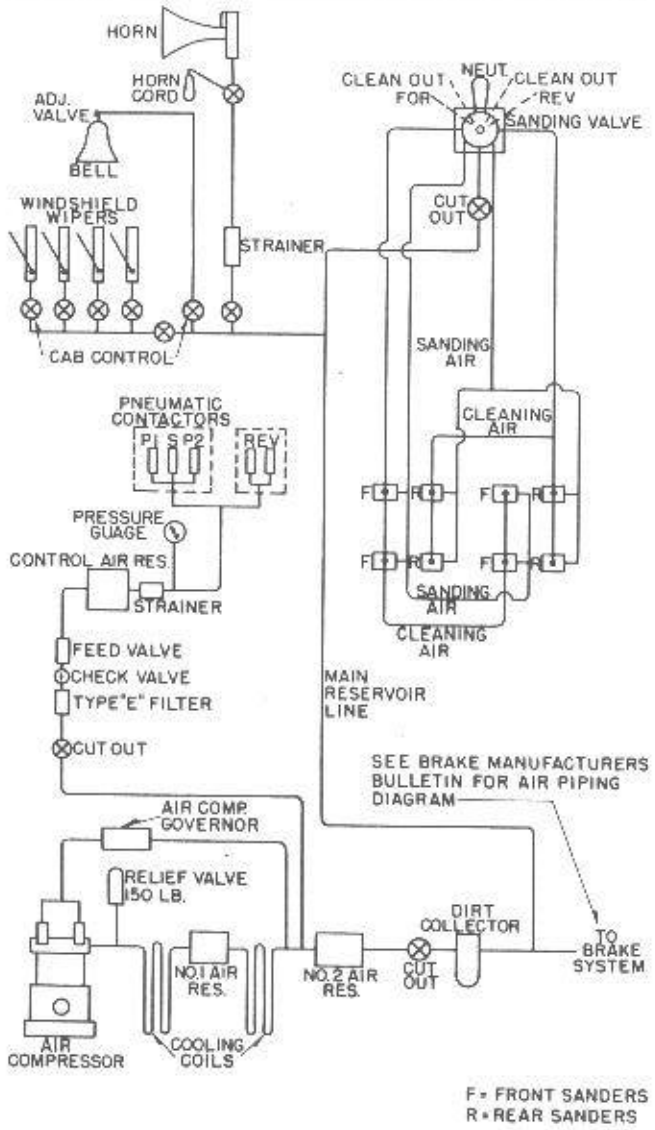
Current for the lighting circuits of the locomotive is supplied through the various switches on the light push-button switch box. Each switch has a corresponding fuse. The operation of the headlight switch is explained in Section 3. Engine compartment lights and plug receptacles are also provided with a 15-ampere fuse in the former and 10-ampere fuse in the latter. These fuses are located in the high voltage cabinet. Blowing of the 15-ampere fuse will also prevent operation of the wheel slip indicator light.

CURRENT LIMIT RELAY (1000 HP Only)

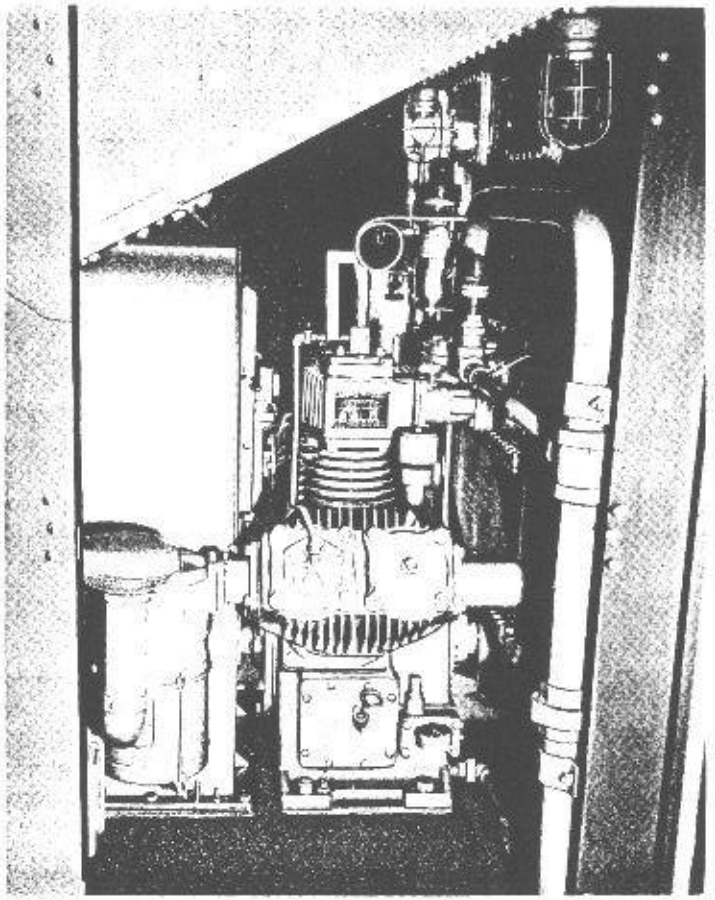
This relay is connected in series with the main generator. It picks up when the main generator current reaches an overload figure. When "picked up," it causes the wheel slip light to burn steady and indicates that backward transition should be made from series-parallel to series. See "Wheel Slip Indicator" under "Locomotive Protective Devices."

MOTOR CUTOUT SWITCHES (1000 HP Only)

Switches (MCO1 and MCO2) are provided in the high voltage cabinet by which the power may be cut off on either truck as desired. This feature is provided to assist in rerailing the locomotive after a derailment (see Section 4) or to enable the locomotive to proceed to the maintenance point in case of traction motor trouble in one truck. The locomotive must not be worked in yard or transfer service with one truck cut out.



Schematic Diagram of Air Piping
Fig. 13



Air Compressor - Side View
Fig. 14

AIR SYSTEM

GENERAL

A schematic diagram of the air system is given in Fig. 13. The side view of the air compressor is shown in Fig. 14.

AIR COMPRESSOR

The locomotive is equipped with a Gardner-Denver 3-cylinder, two-stage, type WXE air compressor, which is driven by the crankshaft of the Diesel engine through a flexible coupling. The compressor has its own oil pump and pressure lubricating system. Oil level in the crankcase can be checked on the bayonet type gauge located on the left side of the compressor. The oil level in the compressor crankcase can be accurately checked only when the engine is stopped. With hot oil, lubricating oil pressure should be from 12 to 15 pounds at 800 RPM and not less than 5 pounds at idle.

The compressor is equipped with an unloading device which is operated by a governor connected to the main reservoir. When main reservoir pressure reaches 130 pounds, the governor actuates the unloader which holds the intake valves open in the compressor, preventing it from pumping air. When the main reservoir pressure falls to 120 pounds, the governor cuts off the air supply to the unloader and the compressor resumes delivery of air.

CONTROL AIR PRESSURE

The control air pressure is taken from the main air reservoir through a reducing valve, located in the cab under the right-hand cab window. The valve is adjusted to maintain a pressure of 80 pounds, which is used to operate the reverser and main power contactors. The

control air gauge is located on the right side of the high voltage cabinet, and should this gauge show main reservoir air pressure, it is an indication that the reducing valve is stuck open. There is no harm in operating the locomotive temporarily with the control air gauge showing main reservoir air pressure, but it should be reported to the maintenance point as soon as possible.

LOCOMOTIVE PROTECTIVE DEVICES

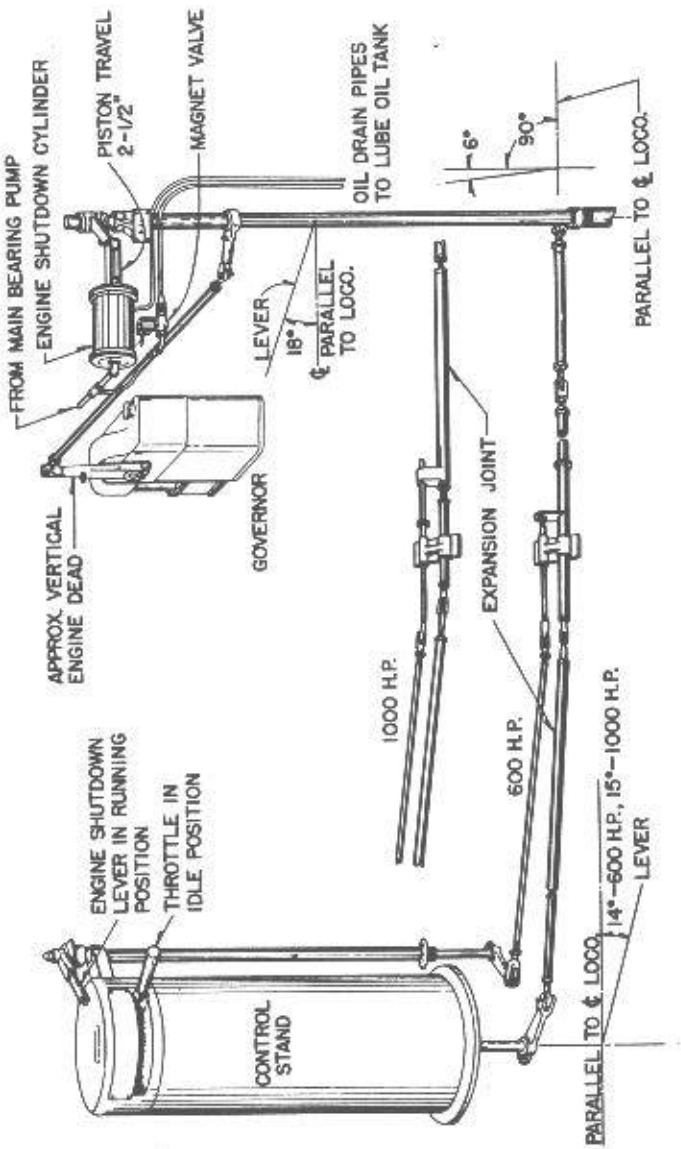
GROUND PROTECTIVE RELAY (GR)

The ground protective relay is located in the high voltage cabinet. If a ground occurs in the high voltage system, the ground protective relay will trip and cause the shunt field contactor and battery field contactors to open. The locomotive will lose all power and come to a stop. In case of a ground in the low voltage circuits, the ground protective relay will trip when the engine is started. For action in case of a tripped ground protective relay, see Section 4.

ENGINE OVERSPEED TRIP

If the engine runs overspeed, a trip operates to shut the engine down. The engine speed at which this will occur is approximately 100 to 110 RPM over the rated maximum speed of 800 RPM. Overspeed trip operation may be caused by sudden loss of electrical load, such as wheel slippage or ground protective relay (GR) tripping.

The overspeed trip resetting lever is located on the front end of the engine directly behind the engine governor. To reset the overspeed trip, the lever is pulled in a counterclockwise direction, as indicated by the arrow painted on the engine.



Throttle Linkage Diagram
Fig. 15

ENGINE SHUTDOWN CYLINDER

While termed a "shutdown cylinder," this device does not stop the engine. It reduces and holds the engine speed to idle in the event of trouble in the lubricating oil system. Opening the locomotive throttle will not speed up the engine under these circumstances. It consists of a cylinder containing a spring loaded piston which is connected to the throttle linkage, as shown in Fig. 15. Lubricating oil pressure acts on one side of this piston, moving it against the action of the spring.

On earlier locomotives, any failure of lubricating oil pressure allows the spring to force the piston back and so bring the engine to idle speed. An electrically operated magnet valve or oil escape valve is also connected to the cylinder. If the piston cooling oil pressure drops below a safe limit, a pressure operated switch opens the oil magnet valve, allowing the oil to escape from the cylinder. The spring moves the piston and brings the engine to idle speed.

On later locomotives, a similar escape valve is provided which is operated somewhat differently. If the main bearing oil pressure drops below a safe limit, a pressure operated switch (low oil pressure switch - LOP) closes the circuit which energizes the oil magnet valve, allowing the oil in the cylinder to escape. Should the vacuum in the suction pipe of the oil pump become excessive, due to clogged suction strainer screens, a second switch (lube oil suction switch - LOS) will close and energize the same oil magnet valve.

EMERGENCY FUEL CUTOFF VALVE

This valve is located in the fuel suction line between the tank sump and the fuel pump. In the event of fire, the valve can be closed by pulling any one of three pull-

rings which are connected by cable to the fuel cutoff valve. One pull-ring is located in the cab on the side of the controller; the other two are located on each side of the locomotive near the fuel filler casting in a small red box with lift cover. The boxes are attached to the locomotive underframe.

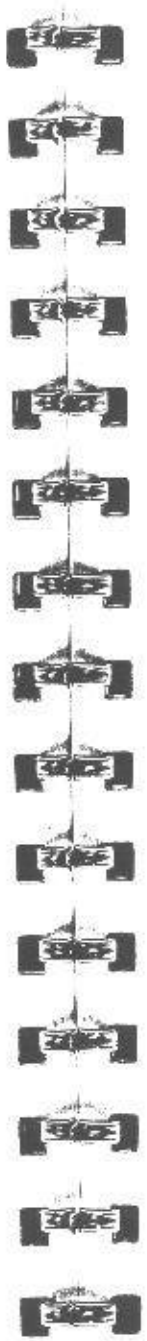
If the fuel cutoff valve is closed, it must be reset to the "open" position by hand.

WHEEL SLIP INDICATOR

1. When wheel slipping occurs, one of the wheel slip relays (WSR) in the high voltage cabinet will pick up. This will light the wheel slip indicator on the engineer's instrument panel in the cab and will open the battery field contactor (BF) and shunt field contactor (SH) in the high voltage cabinet. The power output of the main generator will thus be reduced and the traction motor torque will drop, stopping the slipping. When the slipping stops, the wheel slip relay will drop out. This will cause the battery field contactor and shunt field contactor to close, restoring the power output of the main generator and the traction motor torque. Therefore, the wheels will slip, then stop, slip again and stop, - about once per second.

   If one pair of wheels is locked, due to a broken pinion or axle gear, or the armature shaft is "frozen" in its bearings, the wheel slip indicator will light and stay on as long as current is being supplied to the motors and the other motor in the truck is turning.

   The wheel slip indicator will operate during either series or series-parallel operation.



2. On 1000 HP locomotives only, the wheel slip light has a second function. When the current in the generator rises to the point where transition should be made back to series, the current limiting relay (CLR) will light the wheel slip light causing it to burn continuously. When the current limiting relay operates the wheel slip indicator light, the traction motors should be returned to series operation immediately.

GOVERNOR, GOVERNOR SPEED, SAFETY CONTROL (Pneumatic-Hydraulic and Electro-Hydraulic Controlled Governors)

The engines on locomotives delivered after May 1, 1948, are equipped with a Woodward Governor which includes a pneumatic-hydraulic governor speed control, or an electro-hydraulic control on units equipped for multiple unit operation.

In case of low oil pressure or high vacuum on the suction side of the lube oil and piston cooling oil pumps, the engine governor will stop the engine.

When the governor safety control stops the engine, a push-button on the front of the governor housing moves out approximately 3/8" exposing a red band around the shaft of the button. On these locomotives, the engine shutdown lever is omitted and a "Stop" position included in the throttle. "Stop" is obtained by pressing the button on the end of the throttle lever and moving the throttle past "Idle" to "Stop" position.

The push-button will not trip if the engine stops due to placing of throttle in emergency "Stop" position, operation of manual layshaft control lever, tripping of ground protective relay when throttle is in Run 5 or Run 6 or use of the "STOP" button for normal shutdown.

When the engine is stopped by governor control action, the push-button must be reset before the engine can be started. When the engine is started and run at idling speed, the governor will stop the engine again after approximately 40 seconds, if the condition still exists which caused the original shutdown. This time delay is provided to allow a check to determine the cause of the shutdown. However, if an attempt is made to run the engine above idling speed during the delay period, the governor will stop the engine at once should the oil pressure be low or the oil pump suction be high.

NOTES

SECTION 2

INSTRUMENTS AND CONTROLS

CAB INSTRUMENTS

AIR GAUGES

The air gauges are located on the engineer's instrument panel and show the main reservoir, equalizing reservoir, brake cylinder, and brake pipe pressures.

TACHOMETER (Where Used)

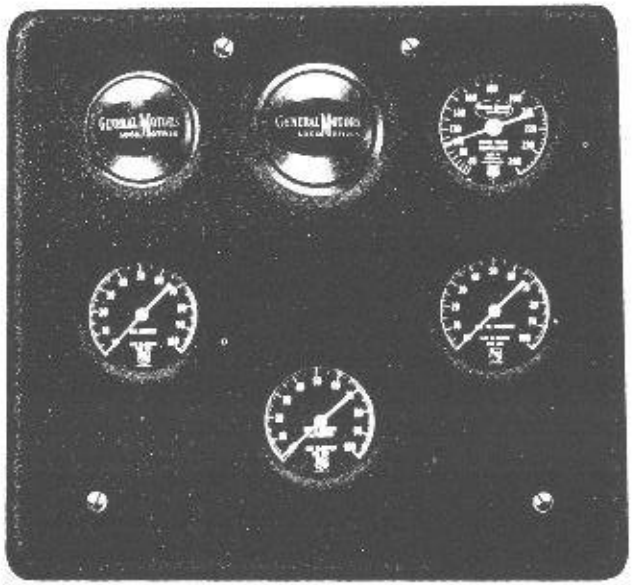
Earlier models of both 600 and 1000 HP locomotives are equipped with a tachometer on the engineer's instrument panel. The reading of the dial shows the engine speed in RPM. The tachometer should show 275 RPM with engine idling and 800 RPM with throttle fully open. Locomotives built after January 1, 1945, have no tachometers.

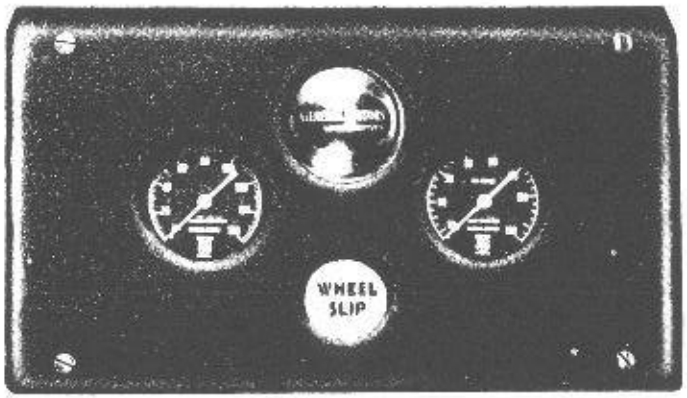
ENGINE TEMPERATURE GAUGE

The gauge shows the temperature of the engine cooling water leaving the engine. Earlier locomotives have two gauges, one for each cylinder bank outlet. Later locomotives have one engine temperature gauge only. Engine temperatures should be kept between 150 and 180 degrees, as described in Section 3.

WHEEL SLIP INDICATOR

When wheels slip, the light will flash on and off. If the locomotive (1000 HP only) is operating in series-parallel and overloaded, the light will burn steadily. Both actions are described under "Locomotive Protective Devices," Section 1.





Engineer's Instrument Panels - 1000 HP
Fig. 16

FUEL OIL PRESSURE GAUGE

The reading shown by the gauge on the engineer's instrument panel is the pressure of the fuel in the line returning from the engine to the main fuel tank. The gauge should read approximately 5 pounds.

LUBRICATING OIL PRESSURE GAUGE

The gauge indicates the pressure of the oil in the lubricating system at the rear of the engine. With hot oil, the reading should be 20 pounds or more at 800 RPM.

PISTON COOLING OIL PRESSURE GAUGE

This gauge shows the pressure of the oil being directed inside the pistons for cooling. With hot oil, the pressure will vary from 5 pounds at idle to 25 pounds at 800 RPM.

CONTROL AIR PRESSURE GAUGE

The gauge is located on the right side of the high voltage or electrical cabinet. Pressure should be maintained at 80 pounds, plus or minus 3 pounds.

BATTERY CHARGING AMMETER

Located in the low voltage cabinet on 1000 HP locomotives or on the side of the electrical cabinet of the 600 HP locomotives, the ammeter shows the charge or discharge current of the battery.

VOLTMETER (Where Used)

The instrument is installed in the low voltage cabinets or electrical cabinets on earlier models only. It shows the output voltage of the auxiliary generator and normally reads approximately 74 volts.

ENGINE ROOM INSTRUMENTS

FUEL OIL PRESSURE GAUGES

Two fuel oil pressure gauges are provided. One is connected to the discharge line of the fuel pump and shows the pressure of the fuel before it enters the first discharge fuel filter (Nugent on earlier locomotives - Ful-flo on later locomotives). The second gauge is connected to the line between the two discharge filters and shows the pressure of the fuel as it enters the duplex sintered bronze filter. The main purpose of the gauges is to provide a check on the condition of the fuel filters. See "Lack Of Fuel," Section 4.

ENGINE COOLING WATER GAUGE GLASS

A water glass is provided on the water tank of the engine cooling water system. The level in the glass, when the engine is running, should be above the line painted on the tank marked "Minimum Water Level."

AIR COMPRESSOR INTERCOOLER GAUGE

A gauge is provided to indicate the pressure in the intercooler of the air compressor. When the compressor is "loaded" or delivering air, the gauge should read approximately 32 pounds.

AIR COMPRESSOR OIL PRESSURE GAUGE

The gauge is located at the left side of the air compressor and shows the lubricating oil pressure. With hot oil, the reading should be approximately 12 to 15 pounds at 800 RPM engine speed.

CAB CONTROLS

THROTTLE

The throttle controls the speed of the Diesel engine. However, if the piston of the engine shutdown cylinder is in the position which holds the engine speed to idle, the engine will not speed up when the throttle is opened.

When the throttle is opened, it closes the throttle switch which is in the circuit operating the shunt and battery field contactors.

Transition from series-parallel back to series operation is accomplished by closing the throttle and re-opening it.

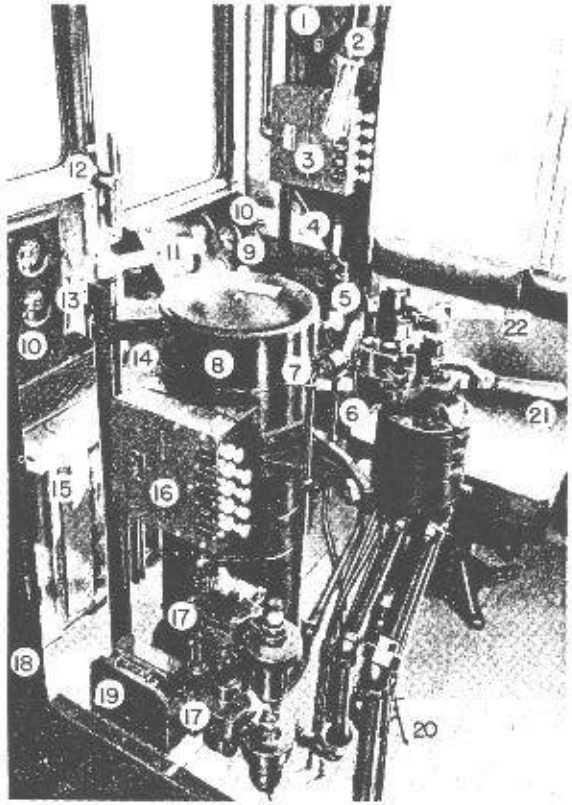
REVERSE LEVER

The reverse lever changes direction of movement of the locomotive. It operates the reverser drum in the high voltage cabinet which reverses the traction motors, as described in Section 1. The reverse lever must be in neutral to start the engine.

CONTROL PUSH-BUTTON SWITCH BOX

The switch box is located alongside and to the left of the controller. It contains five push-button switches:

1. Control - to energize the engine starting, reversing and S contactor circuits, and through the generator field button to the P contactor, transition and field circuits.
2. Generator Field - to close the battery field and shunt field contactors, enabling the main generator to produce power. The throttle must also be open approximately 1/2" to close the throttle switch and complete the contactor operating circuits.
3. Fuel Pump - to operate the engine fuel pump.
4. Engine Start - to start the engine. The switch is closed only while the engine is being started.
5. Cab Heater - to operate the cab heater motor.



1	HEADLIGHT SWITCH	12	WINDSHIELD WIPER
2	HORN CORD	13	BELL CORD
3	LIGHT SWITCHES	14	SHUTTER CONTROL LEVER
4	SANDING VALVE	15	CAB HEATER
5	SELECTIVE TRANS. SWITCH	16	CONTROL SWITCHES
6	REVERSE LEVER	17	FEED VALVES
7	BELL VALVE	18	HIGH VOLTAGE CABINET
8	CONTROL STAND	19	CENTER BRG. LUBRICATOR
9	THROTTLE	20	DOUBLE HEADING COCK
10	INSTRUMENT PANELS	21	AUTOMATIC BRAKE
11	ENGINE SHUTDOWN LEVER	22	INDEPENDENT BRAKE

Cab Interior - Right Side - 1000 HP
Fig. 17

The control switch box contains fuses corresponding to each of the above switches. These are readily accessible by opening the cover on the side of the box.

LIGHT PUSH-BUTTON SWITCH BOX

This switch box is located on the right cab wall, forward of the side window. It contains push-button switches and fuses for:

1. Front Headlight
2. Rear Headlight
3. Number Lights
4. Gauge Lights
5. Cab Lights

SELECTIVE TRANSITION SWITCH

This control is located in the controller stand. When pushed in, it prevents or forestalls transition from series to series-parallel, keeping the traction motors in series at all locomotive speeds. When pulled out, transition will take place automatically, as described in Section 1. The selective transition switch cannot be pushed in or pulled out when the throttle is full open due to a mechanical interlock in the controller stand. The throttle must be closed approximately 1" before the selective transition switch can be moved from one position to the other. On locomotives having tachometers, this throttle position will represent about 650 RPM.

NOTE: On some 1000 HP locomotives of early manufacture, the selective transition switch was not included as it was a later development. Selective transition switches were later installed on many of these locomotives and were located on top of the high voltage cabinets. Such switches have no interlocks with the throttle and the tachometer must be used to gauge maximum throttle opening at which the switch is to be operated.

SHUTTER OPERATING LEVER (Where Used)

This lever is located in front of the controller on the cab front wall and is connected to the shutters through linkage. Opening or closing the shutters regulates the temperature of the engine cooling water.

ENGINE SHUTDOWN LEVER (Where Used)

This lever is located above the controller and its purpose is to stop the Diesel engine. Depressing the button in the end of the lever and moving the lever toward the front of the cab until the lever latches in the "STOP" position will place the engine governor in a shutdown position. The Diesel engine cannot be started until the lever is moved back to the "RUN" position.

SANDING VALVE

The double-acting sanding valve is located to the right of the engineer. Moving the valve handle forward operates the four sand traps for forward movement and moving the handle to the rear operates the four sand traps for reverse movement.

WINDSHIELD WIPER VALVES

The speed of the wipers is controlled by a needle valve located at each of the wipers, which also turns them on and off. (A master valve located under the engineer's instrument panel controls the air supply to all wipers.) The wipers should not be run on a dry window as dirt on the glass or blade will scratch the glass. The wiper blades should be replaced when the rubber becomes worn or hard.

HEADLIGHT SWITCH

The headlight switch above the push-button switch box controls the front and rear headlights. The push buttons for these lights must first be "in" before the headlight switch can be used. The front and rear head-

light may be on "dim" at the same time if both switches are "in" at the light push-button switch box. Only one can be on "medium" or "bright" at a time.

HORN VALVE

The horn is operated by an air valve which is controlled by a pull-cord, the handle of which is readily accessible to the engineer. The air line to the horn has a cock, located under the right side of the cab floor, which must be open to operate the horn.

LOCOMOTIVE BELL VALVE

The locomotive signal bell is operated by an air valve located at the engineer's station. A pull-cord is located on the front cab wall in case of a failure of the air valve.

HAND BRAKE

The hand brake is located in the cab to the right of the rear cab door. The hand brake acts only on the rear pair of wheels of the No. 2 truck. To set brake, hold down the foot pedal and turn wheel. To release the brake, advance the wheel enough to release the foot pedal and then let go of wheel. Before moving the locomotive, make certain the brake is completely released. Whenever anyone is working around the locomotive trucks, the hand brake must be applied.

CAB HEATER

A valve located under the engineer's instrument panel controls the flow of water to the cab heater. To insure proper operation of the cab heater and water temperature gauge the valve at the cab heater must be either fully opened or fully closed. Also the drain valves below the water pump (Valve No. 4, Plate IV) must be closed when engine is operating for either the heater or the water temperature gauge to function properly.

NOTES

SECTION 3

OPERATION

PRECAUTIONS BEFORE STARTING ENGINE

The following operations should be performed when the engine is to be started after a layover. If the engine has been stopped for a short period, such as crew change, etc., step 6 may be omitted.

1. Check position of all valves:
   a. Drain valves in cooling system, lube oil system, and air reservoirs.
2. Check fuel supply.
3. Check engine cooling water level.
4. Check lube oil supply:
   a. In engine oil pan or oil tank.
   b. In engine governor.
   c. In air compressor.
5. At low voltage cabinet or electrical cabinet:
   a. Be sure all fuses are in place:
      150-ampere - Auxiliary Generator Charging
      60-ampere - Battery Field
      60-ampere - Battery Positive
      30-ampere - Auxiliary Generator Field
   b. Close main battery switch.
6. Test for water accumulation in engine cylinders:
   a. Open cylinder test valves (1-1/2 to 2 turns) at each cylinder.
   b. Place engine shutdown lever or throttle in "Stop" position at engineer's control station.
   c. Close control push-button switch.

d. Place reverse lever in neutral.
e. Press "ENGINE START" button in for time sufficient to turn engine several revolutions.
f. Watch cylinder test valves while engine is being rotated. If discharge of water appears, do not start engine until cause of water accumulation has been located and corrected.
g. Close cylinder test valves.

TO START ENGINE

1. Place reverse lever in "neutral" position.

2. Place shutdown lever in "RUN" or throttle in "IDLE."

3. Close control switch and fuel pump switch. Open generator field switch.

4. When fuel gauge shows pressure, press engine "START" button in and hold until engine fires. When starting an engine containing very cold oil, it may be necessary to hold the injector layshaft of the engine in slightly open position for a few minutes to keep the engine from dying after starting. Use the injector layshaft wrench for this purpose in earlier locomotives, and the layshaft manual control lever in later locomotives. Hold the layshaft just far enough to keep the engine turning over until the governor takes control.

NOTE: Starting contactors will not close and start the engine if reverse lever is in forward or reverse position (Isolation switch, if used, must be in "Start" position). Check starting contactors after engine is started to make certain they are open. Check ground protective relay to see that it has not tripped when engine is started.

TO WARM UP ENGINE

1. Close shutters, if open. (Manual)

2. Check lubricating and piston cooling oil pressures. If readings are excessive (gauge hands at or near the pin), hold engine speed below idling by use of injector layshaft wrench or manual layshaft control lever, as under item (4) of "TO START ENGINE." Continue this action until the oil warms up to the point where gauge readings come within scale of the dials with engine idling.

3. Allow engine to idle until temperature rises to 125 degrees.

TO STOP ENGINE

1. Close throttle.

2. Pull generator field switch out.

3. Place engine shutdown lever or throttle in the "Stop" position.

4. Place reverse lever in neutral and remove lever from controller.

PRECAUTIONS BEFORE MOVING LOCOMOTIVE

1. Check lubricating and piston cooling oil pressures.

2. Make sure engine cooling water temperature is 125 degrees or over.

3. Check main reservoir pressure. If air is not fully pumped up during warm-up period, the engine may be speeded up by opening the throttle about 1-1/2".

CAUTION: Keep the reverse lever in neutral and the generator field switch open.

4. Check control air pressure.
5. Release hand brake.

TO MOVE LOCOMOTIVE

1. Make certain that hand brake is released.
2. Close generator field switch.
3. Place reverse lever in direction locomotive is to be moved.
4. Release air brake.
5. Open throttle as required.

HANDLING CONTROLS WHILE LOCOMOTIVE IS IN OPERATION

1. Throttle

During operation, it is never necessary to move the throttle hastily, except in an emergency. The throttle should be opened with a steady motion but gradually enough to move the load without slipping the wheels. Particularly, the throttle should not be "pumped" (rapidly opened and closed) when starting. This action opens and closes the shunt field and battery field contactors each time the throttle is shut off, resulting in deterioration of these parts of the equipment if the practice is continued.

When operating over railroad crossings, the throttle must be reduced to about one-third of full throttle until all of the locomotive wheels have passed over the cross-

ing. This is to prevent arcing of the brushes on the traction motor commutators when the wheels are jarred crossing the frogs.

CAUTION: If wheel slipping occurs, the throttle should be reduced until slipping stops before any sand is used.

If wheel slip light shows steady (on 1000 HP locomotives only), the throttle should be returned to idle and then reopened. This will effect transition from series-parallel back to series.

2. Reverse Lever

Under no conditions should the reverse lever be moved while the locomotive is in motion. Any attempt to do so will result in damage to the equipment. When leaving the locomotive, the reverse lever should be removed from the controller.

3. Transition

When the locomotive is being used in heavy yard switching service, or when the operating conditions are such that frequent backward transition would be required, the selective transition switch should be "IN-SERIES," thus keeping the traction motors connected in series.

When the locomotive is being used on fast, light switching or transfer work where it will be operating at speeds above the transition speeds shown in the table much of the time, the switch should be in the "OUT-AUTO" position. Under these conditions, the switch will be pushed in only at such times when it is apparent that the period of series-parallel operation will be short, and hence continued series operation is advisable.

When operating continuously at full throttle such as when hauling a heavy train from one yard to another or anywhere full throttle is used for more than a short distance, Tonnage Ratings given in Chart X must be observed. The minimum continuous full throttle speed for 1000 HP locomotives falls above the transition speeds so continuous full throttle operation will be in series-parallel.

SWITCHER AND ROAD SWITCHER TRANSITION SPEEDS

MODEL	HORSEPOWER	GEAR RATIO	TRACTION MOTOR CONN.	CONT. SPEED MPH	FORWARD* TRANSITION SPEED MPH	BACKWARD** TRANSITION SPEED MPH
SW-1	600	62:15	Perm. in Series	7.3	None	None
SW-1	600	62:15	Perm. in Ser.-Par.	7.3	None	None
SW-1	600	62:15	Auto. Ser. to Ser.-Par.	7.3	11	11
SW-1	600	65:12	Perm. in Series	5.6	None	None
SW-1	600	65:12	Perm. in Ser.-Par.	5.6	None	None
SW-1	600	65:12	Auto. Ser. to Ser.-Par.	5.6	8	8
NW-2	1000	62:15	Ser. to Ser.-Par.	11***	8.5	8.5
NW-2	1000	65:12	Ser. to Ser.-Par.	8.5***	8.5	8.5
NW-5	1000	62:15	Ser. to Ser.-Par.	11***	8.5	8.5
NW-5	1000	62:15	Ser.-Par. to Par.	11	24	24
NW-5	1000	65:12	Ser. to Ser.-Par.	8.3***	8.5	8.5
NW-5	1000	65:12	Ser.-Par. to Par.	8.3	18	18

*Forward transition takes place automatically - Controlled by a voltage relay
**All backward transitions are made manually
***This is above transition speed

4. Headlight

a. To burn either headlight dim, push in the "HEADLIGHT - FRONT (or REAR)" switch on the light push-button switch box. Both may burn dim at the same time. Keep the headlight switch above the push-button switch box in center or "DIM" position.

b. To burn either headlight medium or full beam push in the proper push-button switch, then move the headlight switch to "MEDIUM" or "FULL" position for the particular headlight desired. Only one headlight will burn medium or full at a time.

5. Sanding Valve

The double-acting sanding valve is located to the

right of the engineer. Moving the valve handle forward operates the four sand traps for forward movement, and moving the handle to the rear operates the four sand traps for reverse movement.

When using the sanding valve, place the lever in the latched position in the direction the locomotive is being moved. Partial opening of the valve will provide only a "blowout" feature to clean out the sand traps.

Due to the high tractive effort and even pulling power of the locomotive, it should seldom be necessary to use sand to start or stop a train except under extremely bad rail conditions, and then only sparingly, as sand is injurious to the moving parts of the trucks and traction motors.

6. Cooling Water Temperature Control

a. Shutter Control Lever (used with manual control)

The engine cooling water temperature should be maintained at 165° F. plus or minus 15°. Water temperature should be held as even as possible.

When leaving a locomotive for any length of time, such as a crew change, the shutters should be closed to maintain the water temperature.

b. Automatic Shutter Control

On locomotives furnished with automatic shutter control there is no manual control lever in the cab. A temperature control switch is located in the outlet of the cooling system which operates an electro-magnetic shutter control valve. When energized the shutter magnet valve admits air to a cylinder which opens the shutters. Spring action closes the shutters when the air pressure

is released. The shutters open at 170° and close at 160°. These temperatures may differ somewhat from the gauge temperature due to a difference in location in the cooling system.

PERIODICAL CHECKS AND INSPECTIONS WHILE LOCOMOTIVE IS IN OPERATION

Items 7, 8 and 9 below pertain to engine compartment equipment and may be made while the locomotive is at a stop. The other checks should preferably be made when the locomotive is operating at full throttle.

1. Lubricating Oil Pressure

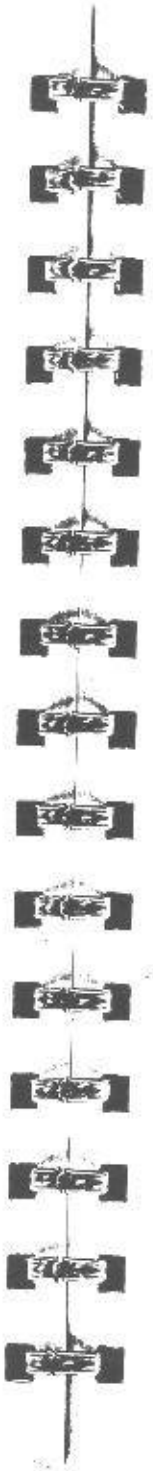
Readings should be between 30 and 40 pounds with the engine at 800 RPM and oil warm. The pressure should not fall below 20 pounds at 800 RPM. However, if the water temperature cannot be held below 180° F., it will be permissible to operate the engine with lubricating oil pressure as low as 15 pounds. This low limit on pressure can only be permitted when the oil temperature is high as a result of the water temperature being above 180° F. The lubricating oil pressure should be 6 pounds or over when the engine is idling.

2. Piston Cooling Oil Pressures

Readings should be between 20 and 30 pounds with the engine at 800 RPM and oil warm. If the pressure falls below 15 pounds at full throttle, stop the engine. Pressure should be 5 pounds or over when the engine is idling.

3. Engine Water Temperature

The temperature should be kept within the range of 150 and 180 degrees, and as near 165 degrees as possible.



4. Fuel Pressure

The reading of fuel return pressure gauge - sometimes referred to as the cross-flow pressure - should be approximately 5 pounds. If the engine speed diminishes while operating at full throttle and the fuel pressure gauge drops to zero, the fuel filters are clogged. (See "Lack of Fuel," Section 4.) The condition should be reported to the maintenance point.

5. Ammeter

While the engine is running, the battery ammeter should show zero or a slight charge. If it shows discharge continually, report the condition to the maintenance point.

6. Voltmeter (On Locomotives So Equipped)

The instrument should read approximately 74 volts.

7. Engine Water Levels

The engine water level should be checked periodically. The water level shown in the gauge glass on the tank will vary with the engine speed, being lower when the engine is speeded up. When the engine is operating at 800 RPM, the level should not fall below the line painted on the tank or below 3 inches in the glass if no line is shown on the tank. See "Low Water Level," Section 4.

At no time should there be rapid fluctuations of level, or bubbling in the glass. Either of these conditions indicates low water or hot water.

8. Engine Oil Levels

The engine oil levels should be checked at least twice in each eight-hour shift. The dipsticks are marked to indicate the permissible limits of the oil levels.

APRIL 1947

9. Belts

The belts driving the auxiliary generator, fans, and traction motor blowers should be inspected periodically. Loose or broken belts must be reported to the maintenance point promptly. The locomotive should not be operated longer than is absolutely necessary with a broken belt. Should a traction motor blower (1000 HP) be inoperative because of broken belts, the locomotive must not be operated under load. It may be run light to the maintenance point for belt replacement.

PERIODICAL OPERATIONS

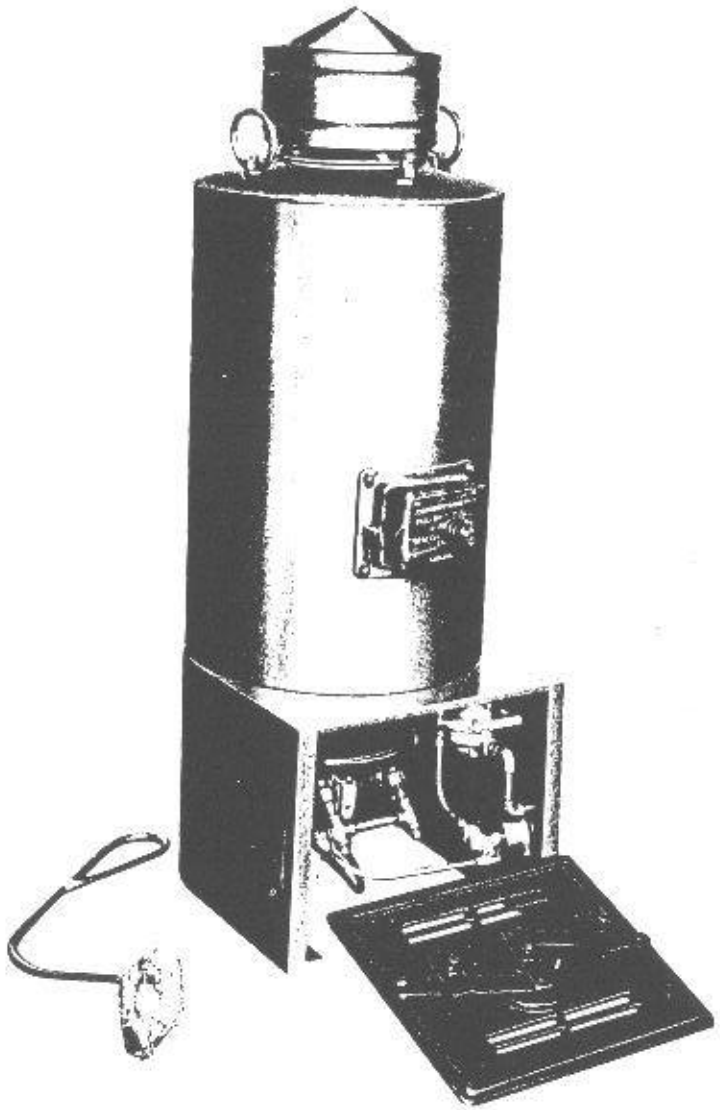
1. Purolator Filter Cleaning

On earlier locomotives having the Purolator fuel pump suction filter, the handle of the filter should be turned periodically. The frequency of this operation depends on fuel conditions and is determined in service.

2. Draining Air System

The following points in the air brake and control air system should be drained periodically. The frequency of draining will depend on atmospheric conditions, particularly humidity, and will be determined in service for each locality.

a. Drain cock at bottom of each reservoir.
b. Drain cock on dirt collector at rear of right-hand main reservoir.
c. Drain cocks at bottom of air compressor intercooler.
d. Drain cock at bottom of air compressor governor.
e. Drain cock at bottom of control air reservoir, under cab floor.
f. Drain cock at bottom of filter next to control air reservoir.



Water Heater
Fig. 18

OPERATION OF WATER HEATER (Where Used)

Before starting water heater:

a. Stop engine and open "G" valve. Allow system to drain until flow from "G" valve stops.
b. Open by-pass valves below water pumps (See Charts III and IV).
c. Open valve in line to water heater (in engine room, behind heater). Close valve in drain from this line.
d. Open valve in line from water heater to engine manifold (used on early installations only).
e. Partially open cab heater valve.

1. To Start Heater

Saturate the torch furnished with the heater (do not use a waste torch) preferably with kerosene; light and place on top of the refractory lining of the burner. Turn the blower fan motor "ON" and run for about one-half minute to warm the pan. Open the fuel metering valve to the stop. Remove the torch after it has ignited the oil and burned itself out. (This should take about 2 to 3 minutes.)

2. To Adjust The Burner

To regulate the fire, adjust the fuel metering valve maximum stop so that the white flame tips do not come above the door level.

If the flame has smoky tips, adjust the air shutter to maintain white flame tips.

3. To Stop Heater

Close the fuel metering valve and allow the blower motor to run for at least three minutes before switching to "OFF." This is to burn out any loose carbon in the fire pot.

MISCELLANEOUS OPERATING INSTRUCTIONS

1. Towing Locomotive

When preparing the locomotive for dead-heading or yard movement where it will be towed by other power, remove reverse lever from controller.

a. If the locomotive is to be towed any appreciable distance, the reverse drum should be locked in its neutral position. To lock the reverser drum, remove the pin which is screwed into the left-hand side of the reverser drum stand. Turn the drum manually to its neutral position, using wrench on square shaft extension at bottom of reverser. Insert the pin through the hole in the opposite side of the reverser drum stand. The pin will then engage with a tapped hole in the shaft of the reverser drum, locking the drum when the pin is screwed in.

b. For setting of air brake equipment, see air brake manufacturer's Instruction Pamphlet.

c. If it is necessary to keep engines idling for any reason while towing locomotive, the fuel pump and main battery switches should be left in the closed position.

2. Running Through Water

Under absolutely no circumstances should the locomotive pass through water which is deep enough to touch the bottom of the traction motor frames. When passing through water, always go at a very slow speed (2 to 3 miles per hour). Water any deeper than 3 inches above the top of the rails is likely to cause damage to the traction motors.

3. Freezing Weather Precautions

If the locomotive is to be left standing out in freezing weather, the system should be drained or steam applied to the system. Drain valves are shown in Charts III and IV. Remove drain plug in bottom of right-hand water pump. A steam connection is provided on the right side to the rear of the fuel tank, underneath the locomotive frame. When steam is applied to the system, the "G" valve should be opened so condensate from steam will not raise the water level and fill the radiators. A steam admission valve and check valve are located at the rear of the main generator, right side. The steam pressure applied to the cooling system should not exceed 50 pounds. When disconnecting the steam line, close the steam admission valve to prevent loss of water in case check valve does not seat properly.

NOTE: The "G" valve was designated as the "low level valve" on earlier locomotives.

4. Air Braking With Power

In order to keep the train stretched while using the automatic air, it may be necessary to brake the train with power still supplied by the locomotive. In such case, the throttle should be reduced. It is very important that the locomotive brakes be released and kept in the released position when the locomotive is supplying power. This must be observed.

5. Isolating One Power Truck (1000 HP Locomotives)

Motor cutout switches are located in the high voltage cabinet to isolate the trucks if one of the locomotive trucks has been derailed or a traction motor has failed. These switches are marked MCO-1 for the front truck and MCO-2 for the rear truck. The switches are of the double pole, double throw type. The normal position of

each switch is up. To cut out a truck, the switch for that truck is thrown to the extreme down position, the switch for the other truck being left in its normal position. When one truck is cut out, the selective transition switch should be in "OUT-AUTO" position.

If one truck is on the ground, power should not be applied to that truck. Any person throwing a motor cut-out switch should clearly understand that it is to be done only in extreme necessity and that the locomotive must not handle any cars with a truck isolated. Do not operate at more than one-half throttle with a truck isolated.

NOTES

NOTES

SECTION 4

LOCATION OF DIFFICULTIES

ENGINE DOES NOT ROTATE WHEN "ENGINE START" SWITCH IS PRESSED

1. Check starting contactors (ST+ and ST-). If the contactors fail to close, causes may be:
   a. Main battery switch open in low voltage cabinet (1000 HP) or electrical cabinet (600 HP).
   b. Positive fuse (60 amp.) blown — same location.
   c. Control switch open in control push-button switch box.
   d. Control fuse (30 amp.) blown in control push-button switch box.
   e. Reverse lever in forward or reverse instead of neutral.
   f. Engine start fuse (15 amp.) blown in control push-button box.
   g. Defective "ENGINE START" switch.
   h. Line switch closed or line switch interlock contacts open or dirty (600 HP).

2. If the starting contactors close, causes of failure to rotate may be:
   a. Weak battery. Test by pressing "START" switch with cab lights on. If lights go out, battery is weak.
   b. Starting fuse (400 amp.) blown in low voltage cabinet (1000 HP) or electrical cabinet (600 HP).
   c. Starting contactors failing to make contact.

ENGINE ROTATES BUT DOES NOT FIRE WHEN "ENGINE START" SWITCH IS CLOSED

1. Check to see that engine shutdown lever is in "RUN" position or throttle in "IDLE".
2. Check cylinder test valve at each cylinder, making sure that they are closed.
3. Check injector linkage in event that it may be stuck in shutdown position.
4. Check to see that overspeed trip shaft is latched in "RUN" position.
5. Check for proper fuel supply. 15-Ampere fuel pump fuse in control switch box may be blown. Check emergency fuel cutoff valve.

NOTE: If engine fires but dies, trouble may be due to excessively cold oil. Manipulate layshaft manual control lever or injector layshaft wrench as under "To Warm Up Engine," Section 3.

LOCOMOTIVE DOES NOT MOVE WHEN THROTTLE IS OPENED

First note whether engine speeds up. If it fails to do so, check for causes listed under "Engine Will Not Speed Up When Throttle Is Opened." If the engine speeds up, check the position of the battery field contactor and the "S" contactor on locomotives with automatic transition, or the battery field contactor and line switch on 600 HP locomotives which do not have transition equipment. The line switch of the 600 HP is similar in construction and purpose to the "S" contactor. It is located under the cab floor, left side.

If both battery field contactor and "S" contactor (or line switch) are closed, check items listed under 1. If both are open, check list 2. If the battery field contactor is closed and the "S" contactor (or line switch) is open, check for cause under 3. If the battery field contactor is open and the "S" contactor (or line switch) closed, check for trouble under 4.

NOTE: When checking action of contactors, open throttle approximately 1 inch. After observing position of contactors, close throttle. If it is necessary to check the contacts or interlocks of any high voltage equipment (P1, P2 or S contactors, line switch or reverser drum), stop engine for safety.

	600 HP		With Auto. Trans.	1000 HP	
	Early	Late		Early	Late
1. If the engine speeds up - both S contactor and battery field contactor closed:					
a. Hand brake applied	x	x	x	x	x
b. Independent air brake applied	x	x	x	x	x
c. Battery field fuse (60 amp.) blown in low voltage cabinet	x	x	x	x	x
2. Both battery field contactor and "S" contactor (or line switch) open:					
a. Positive fuse (60 amp.) blown in low voltage cabinet (1000 HP) or electrical cabinet (600 HP)	x	x	x	x	x
b. Control switch open in control push-button switch box	x	x	x	x	x
c. Control fuse (30 amp.) blown in control push-button switch box	x	x	x	x	x

	600 HP Early	600 HP Late	With Auto. Trans.	1000 HP Early	1000 HP Late
d. Reverse lever in neutral	x	x	x	x	x
e. Reverser drum failing to operate and not fully in position corresponding to reverse lever setting	x	x	x	x	x
f. Interlock on reverser drum dirty or not making contact	x	x	x	x	x
g. Ground relay tripped				x	
h. One or both starting contactors stuck closed or interlock open or dirty	x	x	x		
3. Battery field contactor closed - "S" contactor (or line switch) open:					
a. Either motor cutout switch down (open)				x	x
b. Interlock on P1 contactor (closed when P1 is open) open or making poor contact			x	x	x
c. Low control air pressure	x	x	x	x	x
d. Defective "S" contactor magnet valve or other mechanical difficulty	x	x	x	x	x
4. Battery field contactor open - "S" contactor (or line switch) closed:					
a. Generator field switch open in control push-button switch box	x	x	x	x	x

	600 HP Early	600 HP Late	With Auto. Trans.	1000 HP Early	1000 HP Late
b. Generator field fuse (15 amp.) blown in control push-button switch box	x	x	x	x	x
c. Throttle switch making poor contact or open, because throttle insufficiently opened	x	x	x	x	x
d. Ground protective relay tripped	x	x	x		x
e. One or both starting contactors stuck closed or having interlocks open or dirty				x	x
f. Shunt field contactor (SH) not closing because of mechanical or electrical defect		x	x	x	x
g. Interlock on shunt field contactor open or dirty		x	x	x	x
h. Wheel slip relay open	x			x	
i. Wheel slip relay closed		x	x		x

NOTE: On all locomotives except early 600 HP models, the shunt field contactor must close to establish the circuit which closes the battery field contactor.

On early 600 HP locomotives only, the shunt field contactor may be open although the battery field contactor is closed. In case locomotive will not move or develops little power, check shunt field contactor. If open, while battery field contactor is closed, causes are poor contacts in ground protective relay or defective shunt field contactor.

ENGINE WILL NOT SPEED UP WHEN THROTTLE IS OPENED

If the engine shutdown cylinder holds the engine speed to idle, check lubricating oil and piston cooling oil gauges carefully. If the lubricating oil pressure is 6 pounds or over and the piston cooling oil pressure 5 pounds, speed the engine up slightly by use of the layshaft manual control lever or injector layshaft wrench. Open throttle about one inch and release layshaft lever or wrench. If engine speed holds, resume normal locomotive operation, watching oil pressure gauges carefully.

If lubricating or piston cooling oil pressures are low when the shutdown cylinder is operative, or if the engine speed fails to hold when above test is made, stop engine and call for Maintainer or have locomotive towed to maintenance point.

Other causes may be disconnected throttle linkage or defective governor.

LOCOMOTIVE STOPS IN OPERATION - ENGINE CONTINUES TO RUN

Make checks outlined under "If Locomotive Does Not Move When Throttle Is Opened."

ENGINE STOPS

1. Check engine overspeed trip.
2. Check fuel supply, fuel pump operation and emergency fuel cutoff valve.

GROUND PROTECTIVE RELAY TRIPPED

1. Push in button on ground protective relay (GR). If the relay trips repeatedly, do not load the locomotive until the condition is corrected.

CAUTION: Close throttle to idle before resetting button.

LOCOMOTIVE WILL NOT REVERSE

If the reverser drum fails to follow the movement of the reverse lever, check for:

1. Control switch open in control push-button switch box.
2. Control fuse (30 amp.) blown in control push-button switch box.
3. Positive fuse (60 amp.) blown in low voltage cabinet.
4. Defective magnet valve at reverser drum.
5. Low control air pressure.
6. Reverser drum sticking mechanically.

In emergency, it may be possible to operate the reverser drum manually by pressing the buttons on the magnet valve or applying wrench to the square portion of the lower end of the reverser drum shaft. CAUTION: Make sure throttle is closed and generator field switch open before attempting such action.

LACK OF POWER

The causes for lack of power listed below are given only for the general information of enginemen. Many of the items cannot be readily identified under yard or transfer service conditions.

In the engine, the causes may be:

1. Poor combustion due to -
   a. Low grade fuel.
   b. Injectors not functioning properly.
   c. Insufficient air because of fouled engine air filters or air box covers not sealed properly.
2. Insufficient fuel due to dirty filters.

3. Pilot valve or setting of pilot valve linkage.
4. Leaking exhaust valves.
5. Incorrect timing of injectors or exhaust valves.
6. Restriction in exhaust.
7. Throttle movement not transmitted to governor due to lack of control air or leaky piping (defective throttle linkage, engine shutdown cylinder or valve.)

In the electrical system, the causes may be:

1. Low generator field excitation due to -
   a. Faulty connection in generator field circuit.
   b. Defective load regulator.
   c. Open or dirty contacts on battery field or shunt field contactors.
   d. Insufficient low voltage supply because of weak battery in combination with faulty auxiliary generator or voltage regulator.
2. Defective traction motors.
3. Dirty or loose traction motor lead connections.
4. Dirty or improperly seated power contactors.
5. One traction motor cutout switch open.

EXHAUST SMOKE

Smoke at the exhaust is usually an indication of poor combustion, but may be due also to excess lubricant passing into the combustion chamber. Fuel in a partially burned condition, or engine overload, will cause a black exhaust. If fuel is not igniting, the exhaust smoke may show blue. Blue smoke may appear at light loads, or upon starting, due to low temperature of the combustion chamber. Misfiring, improper fuel, incorrect timing,

a faulty injector, or insufficient air may be the cause of exhaust smoke.

Smoke may also be an indication of a continuous engine overload due to improper pilot valve adjustment, plugged pilot valve feed line, or inoperative load regulator.

LACK OF FUEL

This trouble may be either complete or partial - i.e., the engine may be getting no fuel at all or an insufficient amount. In the first instance, the engine will stop. In the second, the engine speed will drop off and engine will run irregularly, and hunt, especially when the throttle is opened with the locomotive under load. Causes for complete stoppage of fuel may be:

1. Empty tank - check tank sight glasses.
2. Emergency fuel cutoff valve closed.
3. Fuel pumped stopped due to:
   a. Fuel pump switch open in the control push-button switch box.
   b. Fuel pump fuse (15 amp.) blown in control push-button switch box.
   c. Defective coupling between fuel pump and motor.
   d. Positive fuse (60 amp.) blown on low voltage cabinet.
   e. Main battery switch open - if engine is stopped.
4. Suction or discharge filters completely clogged or air leak in fuel pump suction. Usually, a partial loss of fuel supply will be noted before these conditions become sufficiently pronounced to cause complete fuel failure. If trouble is in a discharge filter, the fuel pump discharge gauge in the engine compartment will read high - 60 pounds or over.

Causes for insufficient supply of fuel are:

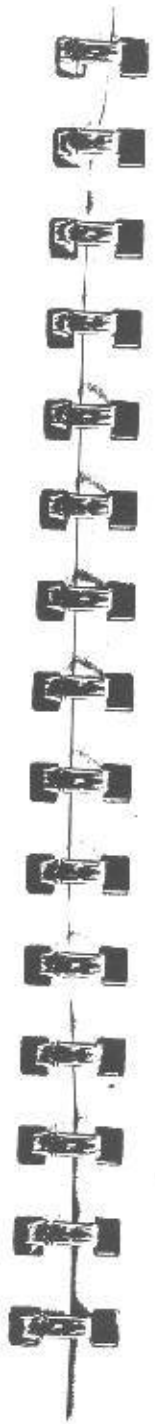
1. Air leaks in suction line or in seals of fuel pump.
2. Partial stoppage of fuel pump suction line.
3. Dirty suction strainers.
4. Dirt under 60-pound relief valve. If valve is held far enough open by such a condition or the spring is broken, all the fuel will by-pass and the engine will stop.

   NOTE: Conditions 1, 2, 3 or 4 may sometimes be recognized by low reading of the gauge in engine compartment, connected to the line between the fuel pump and the initial discharge filter (Nugent on earlier locomotives, Ful-flo on later models).

5. Discharge filter dirty. The gauge referred to in the NOTE above will read high (over 30 pounds). The second fuel gauge, connected to the line between the discharge filter and the sintered bronze filter, will show below normal reading. If condition occurs on earlier locomotives, using Nugent filter, turn handle to divert flow to alternate element.
6. Sintered bronze filter dirty. Both gauges will read high. Turn sintered bronze filter handle to other side when handle is provided. If this does not remedy the condition, put handle on center. Report to maintenance point for attention.

LOW WATER LEVEL

The supply of engine cooling water will ordinarily be kept up by the maintenance point. Should it be necessary in an emergency to add water to the cooling system, the following procedure should be followed, using either the top or side filler pipe. See "Cooling System," Section 1.



1. Shut down engine and open "G" valve.
2. Add water slowly until it runs out the "G" valve.
3. Close "G" valve.

DERAILMENT OR WRECK

If the locomotive has been derailed, it must first be determined whether the locomotive can be rerailed under its own power. If one truck, or one pair of wheels is derailed, this can be done by isolating the derailed truck electrically, as outlined in Section 3. With the derailed truck isolated, never operate the throttle in more than one-half open position.

If the locomotive is to be lifted back on the rail by a crane, the side bearing safety plates should be inspected to determine whether they were bent or cracked.

After the locomotive is rerailed, make a thorough check to determine whether the gear cases, traction motors, or any part of the truck has been damaged.

In case of a wreck, a locomotive may be lifted by the coupler shank providing a new coupler is installed and proper blocking is provided between the top and sides of the coupler shank and draft gear box. Electro-Motive will not assume any responsibility for possible damage or breakage of parts by lifting the locomotive in this manner.

The truck and underframe side bearing safety locks on these locomotives have sufficient strength to lift the trucks with the carbody. However, if the trucks are to be lifted with the carbody, a safety chain or cable should be swung around the carbody and trucks and blocking placed between journal box and pedestal tie bar. The springs should also be blocked.

If it is necessary to remove one or both trucks from under a locomotive, Chart IX shows the various jacking pads and their locations as well as the lift required so the trucks may be removed sideways.

In removing a truck from one end, the opposite end of the locomotive must also be raised at least half-way out of the center bearing casting or two inches, otherwise the center bearing casting will be sprung out of shape or cracked.

When removing a truck endways, the end at which the truck is to be removed will have to be raised an additional 12 to 13 inches in order to clear the draft gear box and other parts of the underframe. The foot boards on this end will also have to be removed.

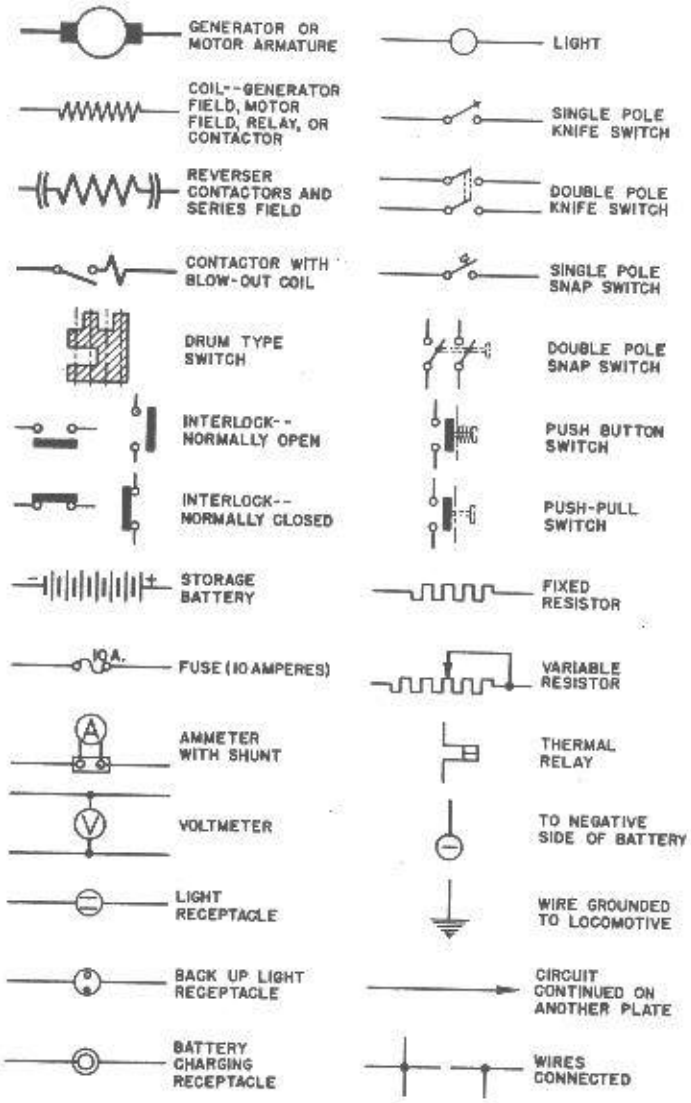
If the truck is to be removed sideways, the locomotive will have to be raised by placing the jacks under the jacking pads. After the locomotive is raised to the required height, suitable blocking should be placed under the end frame and draft gear box before removing jacks.

In cases where an overhead crane is not available and jacks are used for lifting, care must be exercised that jacks on opposite ends of the locomotive are raised equal amounts so each jack takes one-half the load for that end, otherwise the frame may be sprung out of shape.

Blocking should always be provided if the locomotive frame is to be held in a raised position for any length of time.

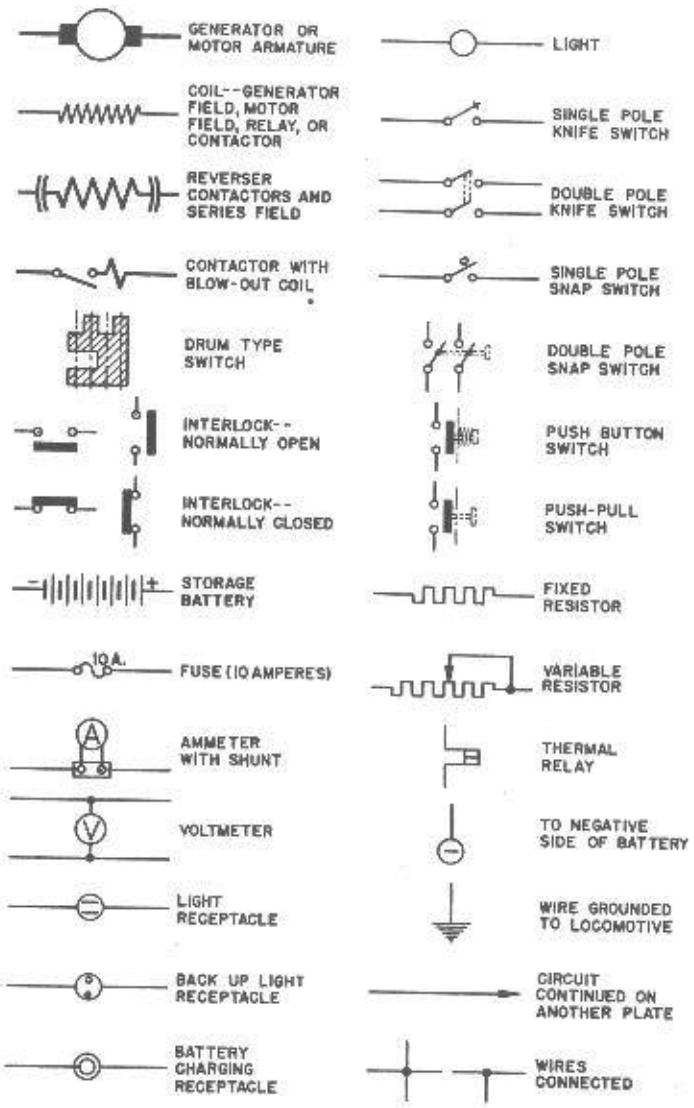
NOTES

ELECTRICAL SYMBOLS



Electrical Symbols CHART V

ELECTRICAL SYMBOLS



Electrical Symbols CHART V

LEGEND OF ELECTRICAL EQUIPMENT

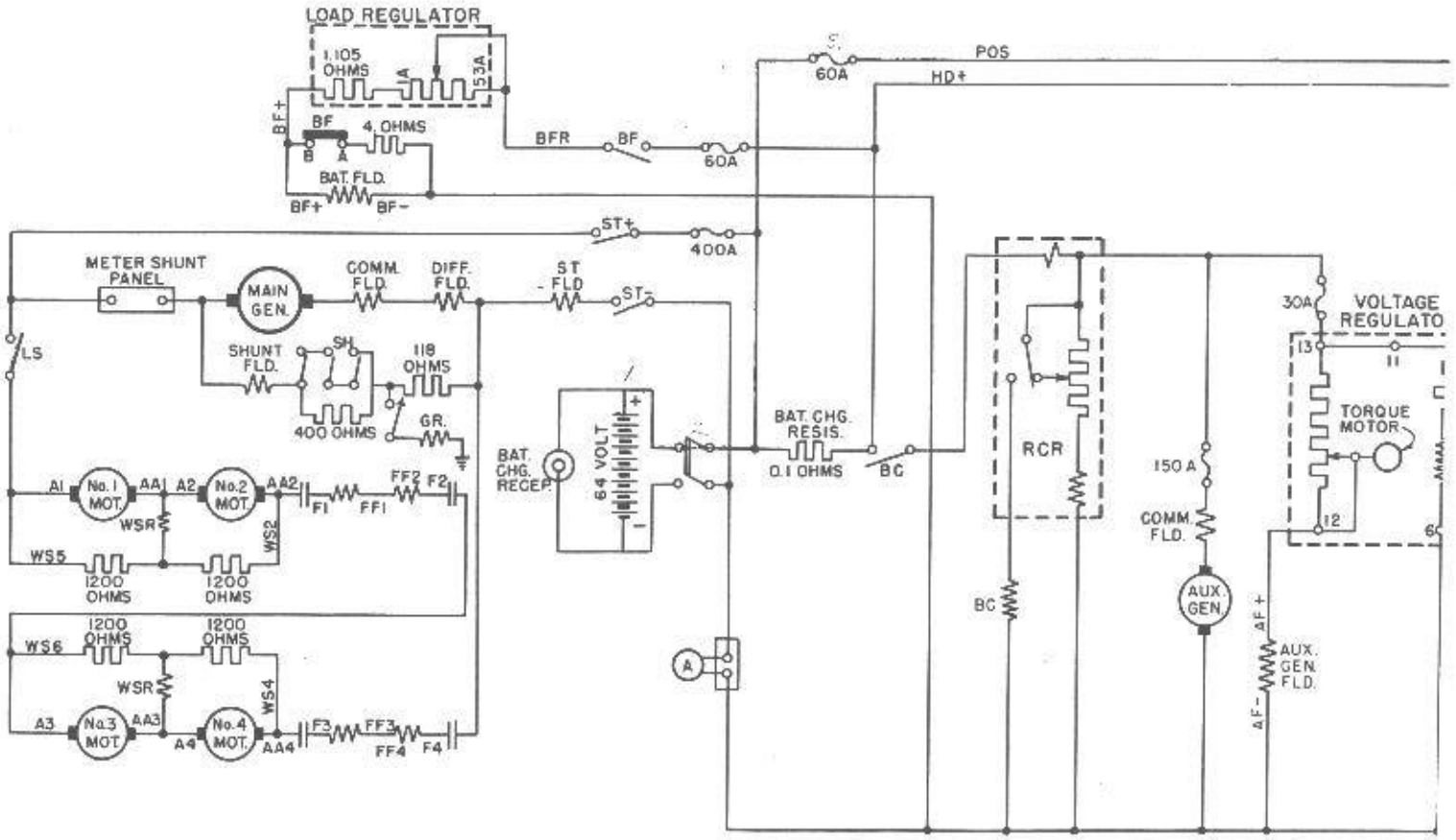
The following is a list of abbreviations used to identify electrical equipment on the wiring diagrams. The wire designations appearing on the diagrams conform with the identification bands on the wires throughout the locomotive.

The contactors, pressure switches and relays are shown in de-energized position in the wiring diagram as though the locomotive were standing with engine stopped and all manually operated switches open

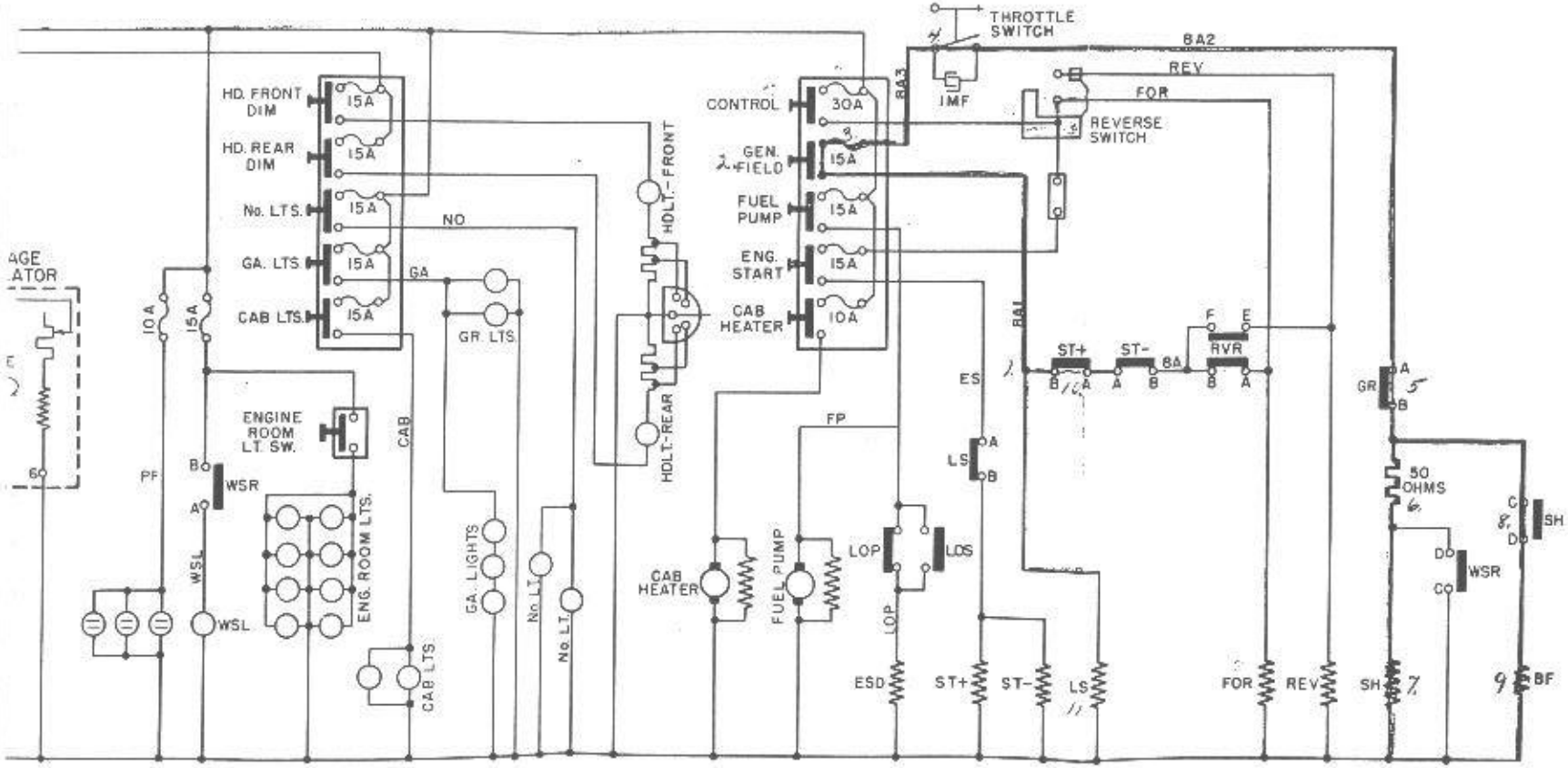
Interlocks shown in the open position (o o) are open when the contactor to which they are attached is open. Interlocks shown in the closed position (o-o) are closed when the contactor is open.

A	Battery Charging Ammeter
BC	Battery Charging Contactor
BF	Battery Field Contactor
ESD	Engine Shutdown Cylinder Magnet Valve
FOR	Reverser Drum Magnet Valve (Forward)
GR	Ground Protective Relay
LS	Line Switch
LOP	Low Oil Pressure Alarm Switch
LOS	Lube Oil Suction Alarm Switch
RCR	Reverse Current Relay
REV	Reverser Drum Magnet Valve (Reverse)
RVR	Reverser Drum Interlock
SH	Shunt Field Contactor
ST-, ST+	Starting Contactors
WSL	Wheel Slip Indicator Light
WSR	Wheel Slip Relay

1 To 4 2nd Sequence Shunt Field



and Battery Contactors Close.



Typical Wiring Diagram - 600 HP
(No Transition)
Chart VI

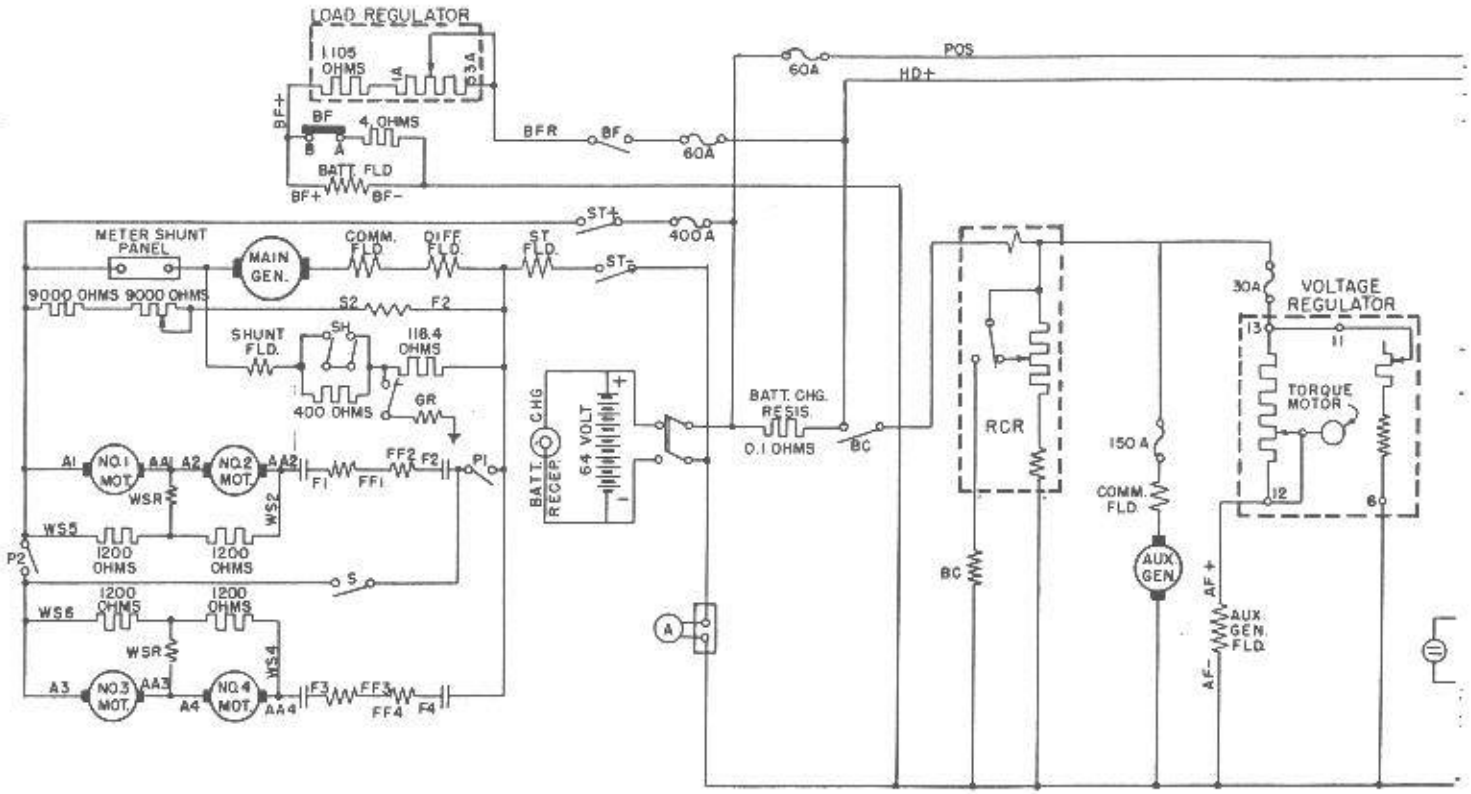
LEGEND OF ELECTRICAL EQUIPMENT

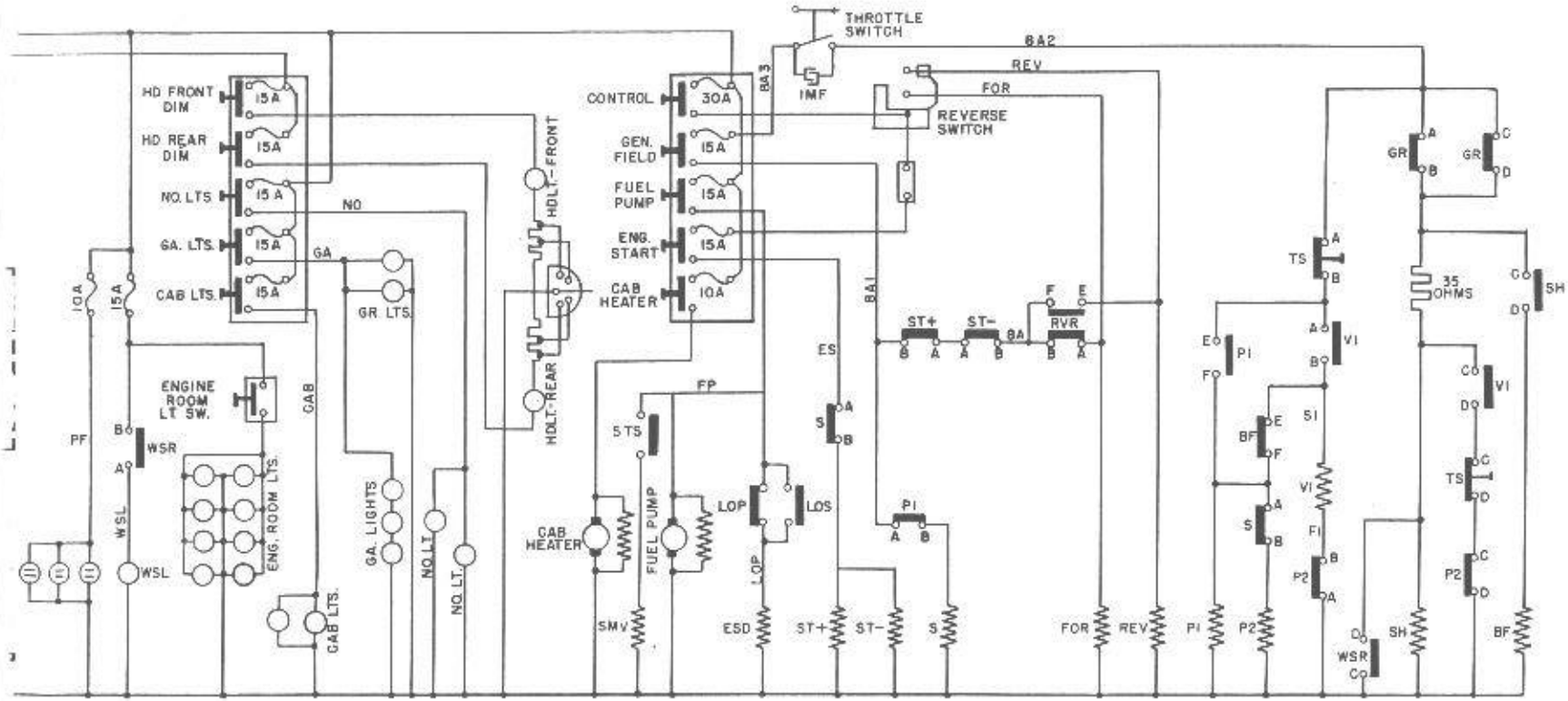
The following is a list of abbreviations used to identify electrical equipment on the wiring diagrams. The wire designations appearing on the diagrams conform with the identification bands on the wires throughout the locomotive.

The contactors, pressure switches and relays are shown in de-energized position in the wiring diagram as though the locomotive were standing with engine stopped and all manually operated switches open.

Interlocks shown in the open position (o o) are open when the contactor to which they are attached is open. Interlocks shown in the closed position (o o) are closed when the contactor is open.

A	Battery Charging Ammeter
BC	Battery Charging Contactor
BF	Battery Field Contactor
CLR	Current Limiting Relay
ESD	Engine Shutdown Cylinder Magnet Valve
FOR	Reverser Drum Magnet Valve (Forward)
GR	Ground Protective Relay
LOP	Low Oil Pressure Alarm Switch
LOS	Lube Oil Suction Alarm Switches
MCO1, MCO2	Motor Cutout Switches
P1, P2	Power Contactors (Series-Parallel)
RCR	Reverse Current Relay
REV	Reverser Drum Magnet Valve (Reverse)
RVR	Reverser Drum Interlock
S	Power Contactor (Series)
SH	Shunt Field Contactor
ST-, ST+	Starting Contactors
TS	Selective Transition Switch
VI	Transition Relay
VT	Time Delay Relay
WSL	Wheel Slip Indicator Light
WSR	Wheel Slip Relay


LOAD REGULATOR
1105 OHMS
1A
53A
BF+
BF
B
A
4 OHMS
BATT. FLD
BF+
BF-
BFR
BF
60A
POS
HD+
60A
ST
400A
METER SHUNT PANEL
MAIN GEN.
COMM. FLD.
DIFF FLD.
ST FLD.
ST
9000 OHMS
9000 OHMS
S2
F2
SHUNT FLD.
SH
118.4 OHMS
400 OHMS
GR
A1
NO.1 MOT.
AA1
A2
NO.2 MOT.
AA2
FF2
F2
P1
WSR
WS2
F1
FF1
WS5
1200 OHMS
1200 OHMS
P2
S
1200 OHMS
1200 OHMS
WS6
WSR
WS4
A3
NO.3 MOT.
AA3
A4
NO.4 MOT.
AA4
F3
FF3
FF4
F4
BATT. CHG. RECEP.
64 VOLT
BATT. CHG. RESIS.
0.1 OHMS
BC
A
RCR
BC
150 A
COMM. FLD.
AUX GEN.
AF+
AUX GEN. FLD.
AF-
30A
VOLTAGE REGULATOR
13
11
TORQUE MOTOR
12
6



Typical Wiring Diagram - 600 HP
(With Automatic Transition)
Chart VII

LEGEND OF ELECTRICAL EQUIPMENT

The following is a list of abbreviations used to identify electrical equipment on the wiring diagrams. The wire designations appearing on the diagrams conform with the identification bands on the wires throughout the locomotive.

The contactors, pressure switches and relays are shown in de-energized position in the wiring diagram as though the locomotive were standing with engine stopped and all manually operated switches open

Interlocks shown in the open position (o_o) are open when the contactor to which they are attached is open. Interlocks shown in the closed position (σ¯σ) are closed when the contactor is open.

A	Battery Charging Ammeter
BC	Battery Charging Contactor
BF	Battery Field Contactor
ESD	Engine Shutdown Cylinder Magnet Valve
FOR	Reverser Drum Magnet Valve (Forward)
GR	Ground Protective Relay
LS	Line Switch
LOP	Low Oil Pressure Alarm Switch
LOS	Lube Oil Suction Alarm Switch
RCR	Reverse Current Relay
REV	Reverser Drum Magnet Valve (Reverse)
RVR	Reverser Drum Interlock
SH	Shunt Field Contactor
ST-, ST+	Starting Contactors
WSL	Wheel Slip Indicator Light
WSR	Wheel Slip Relay

TONNAGE RATINGS
SWITCHER LOCOMOTIVES

62:15 Gear Ratio
(Based On 10 Lbs. Per Ton Rolling Resistance)

	600 HP				1000 HP		
Percent Ruling Grade	Grades 0.8 Mile or Less	Grades 1 Mile or Less	Grades 3 Miles or Less	Grades Contin-uous	Grades 1 Mile or Less	Grades 3 Miles or Less	Grades Contin-uous
Level	3480	3290	2450	2300	4700	3880	3000
.1	2880	2730	2030	1900	3900	3210	2480
.2	2460	2320	1720	1610	3320	2730	2100
.3	2140	2020	1490	1400	2890	2380	1830
.4	1890	1780	1320	1230	2560	2100	1610
.5	1690	1600	1180	1100	2290	1880	1440
.6	1530	1440	1060	990	2070	1690	1290
.7	1390	1310	960	900	1890	1540	1180
.8	1280	1200	880	820	1730	1410	1080
.9	1180	1110	810	760	1600	1300	990
1.0	1090	1030	750	700	1480	1210	920
1.1	1020	960	700	650	1380	1130	850
1.2	950	900	650	610	1290	1050	790
1.3	890	840	610	570	1220	990	740
1.4	840	790	570	530	1150	930	700
1.5	800	750	540	500	1080	880	660
1.6	750	710	510	470	1020	830	620
1.7	710	670	480	450	970	780	580
1.8	680	640	450	420	920	750	550
1.9	650	610	430	400	880	710	530
2.0	620	580	410	380	840	680	500
2.1	590	550	390	360	800	650	480
2.2	560	530	370	340	770	620	450
2.3	540	510	360	330	740	590	430
2.4	520	490	340	310	710	570	410
2.5	500	470	330	300	680	540	400
2.6	480	450	310	290	650	520	380
2.7	460	430	300	280	630	500	360
2.8	440	410	290	260	610	480	350
2.9	430	400	280	250	590	460	330
3.0	410	380	260	240	560	450	320

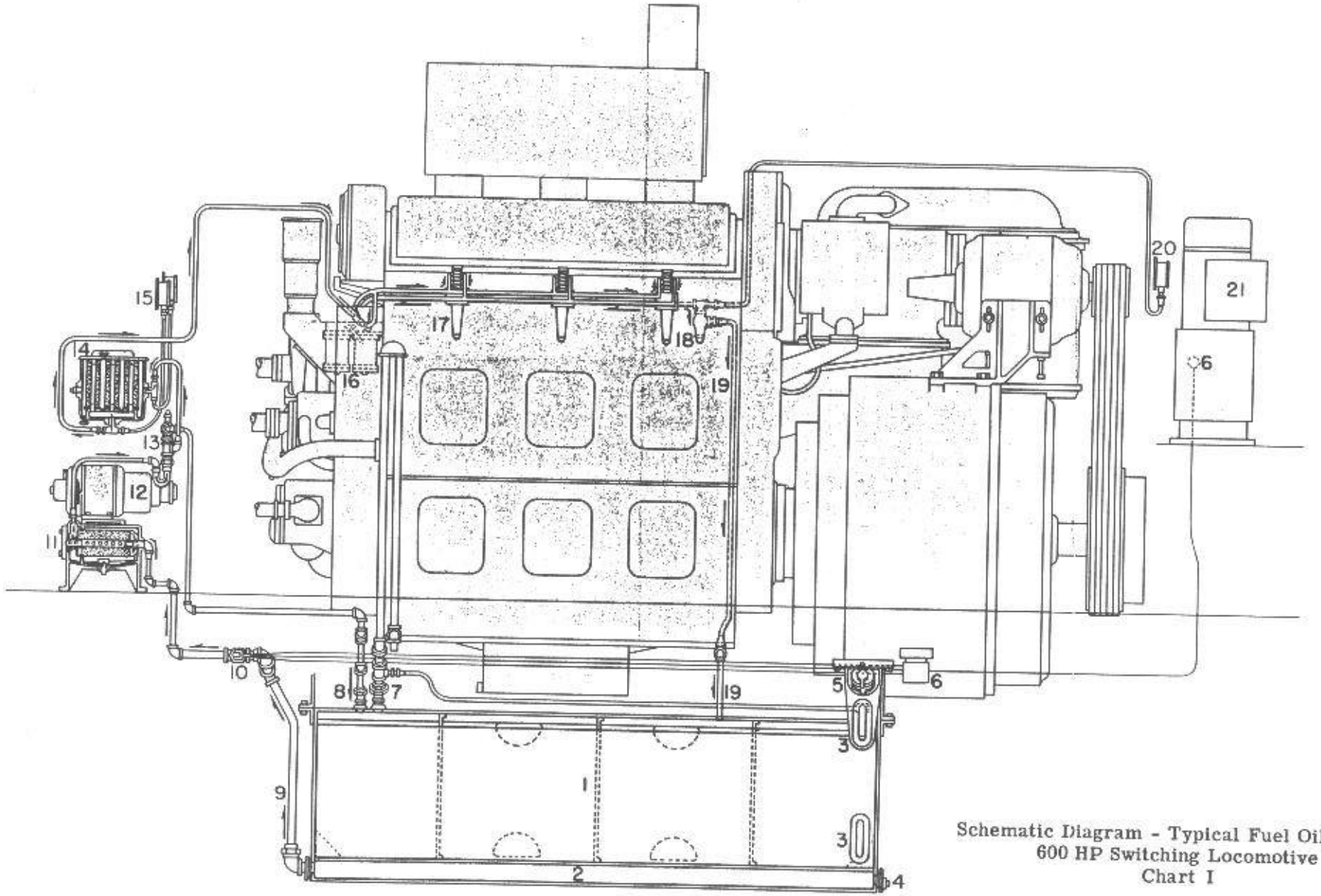
Chart X
Part 1

TONNAGE RATINGS
SWITCHER LOCOMOTIVES

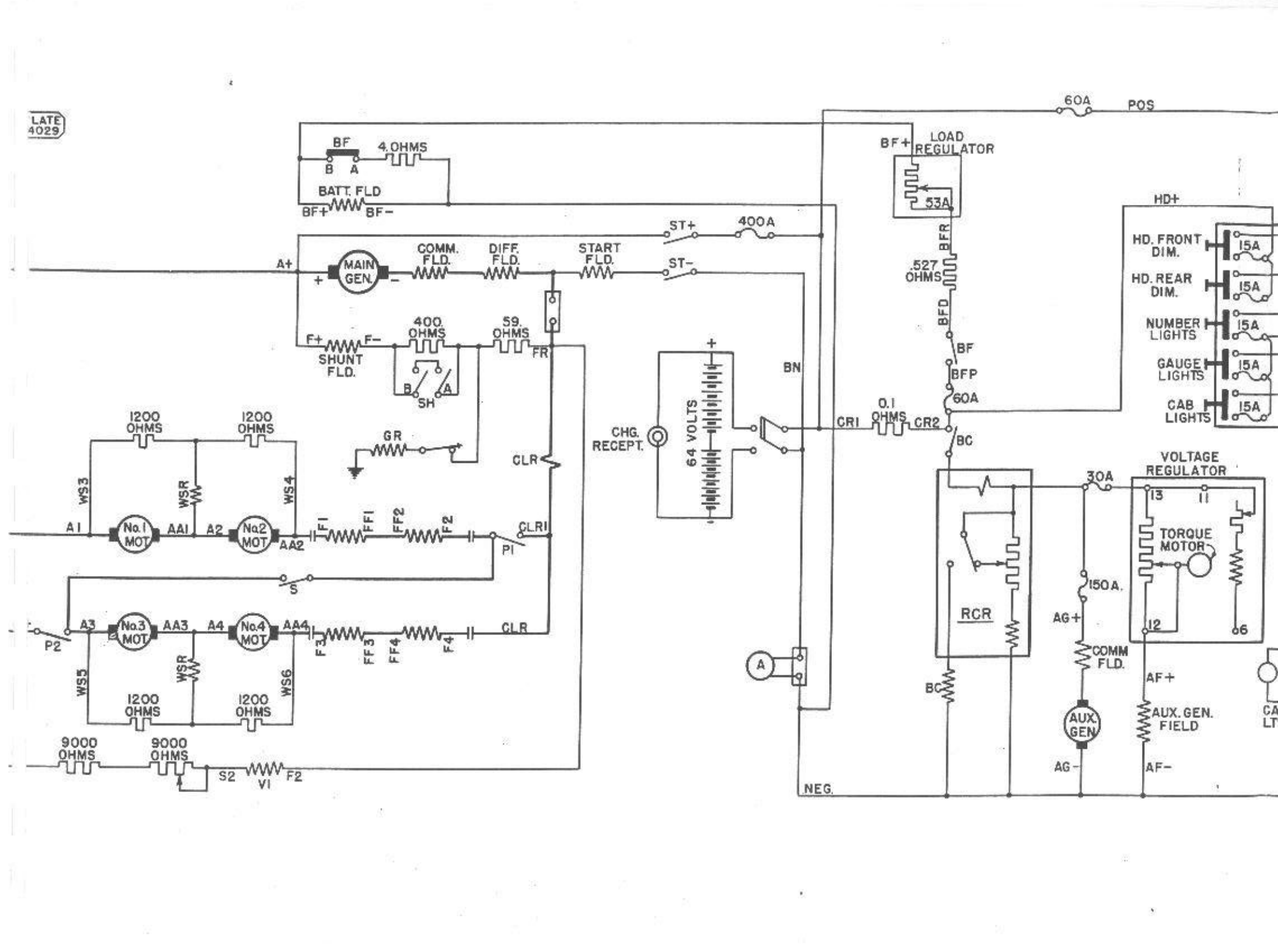
65:12 Gear Ratio
(Based On 10 Lbs. Per Ton Rolling Resistance)

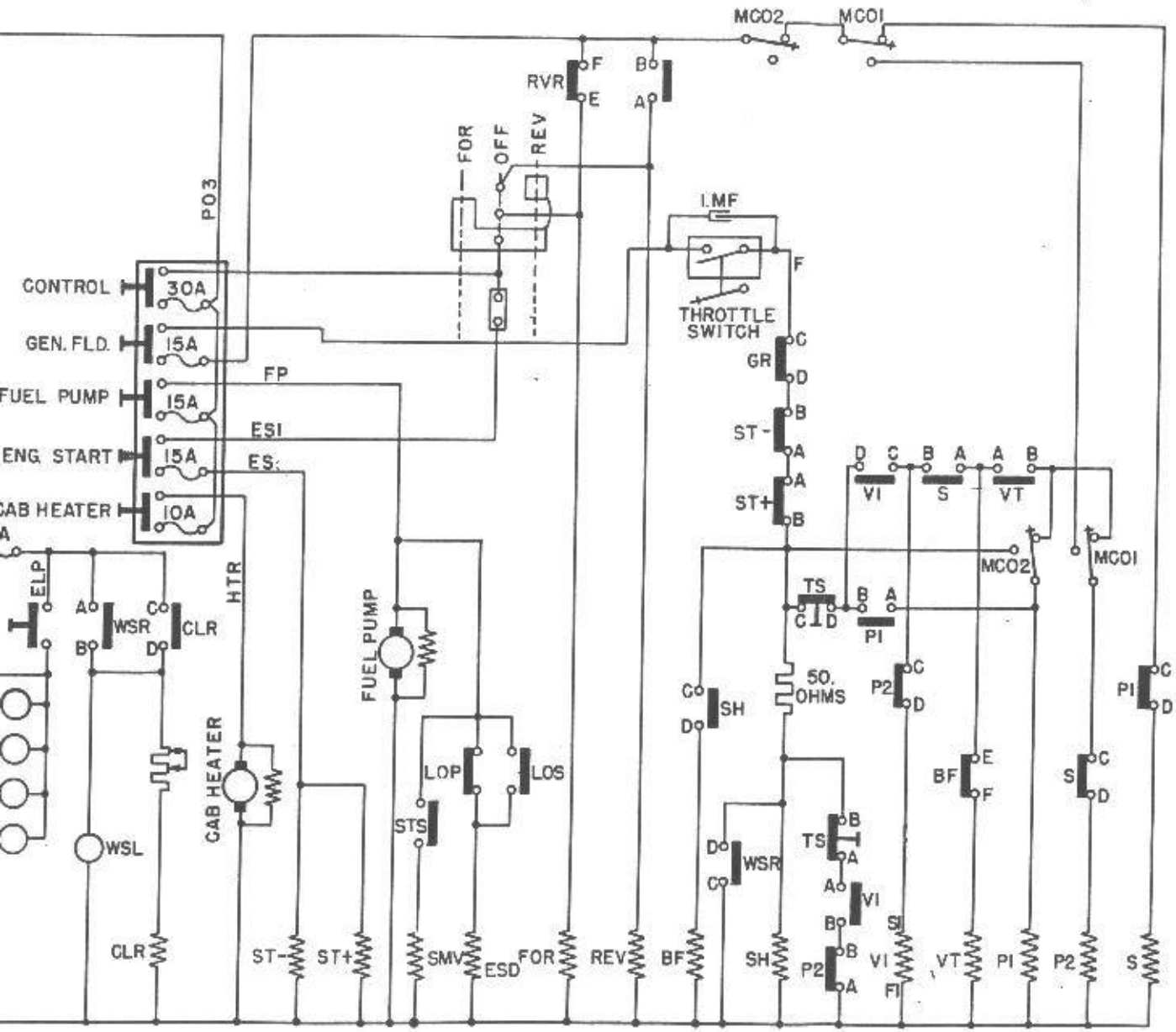
Percent Ruling Grade	600 HP Grades 0.8 Mile or Less	600 HP Grades 1 Mile or Less	600 HP Grades Continuous	1000 HP Grades 2 Miles or Less	1000 HP Grades 8 Miles or Less	1000 HP Grades Continuous
Level	4280	4040	3050	5230	4390	3970
.1	3550	3350	2520	4340	3640	3290
.2	3030	2850	2150	3700	3100	2800
.3	2640	2490	1870	3220	2700	2440
.4	2330	2200	1650	2850	2390	2150
.5	2090	1970	1470	2550	2130	1920
.6	1890	1780	1330	2310	1930	1740
.7	1720	1620	1210	2110	1760	1580
.8	1580	1490	1110	1940	1610	1450
.9	1460	1380	1020	1790	1490	1340
1.0	1360	1280	950	1660	1380	1240
1.1	1270	1190	880	1550	1290	1160
1.2	1190	1120	830	1450	1200	1080
1.3	1120	1050	770	1360	1130	1010
1.4	1050	990	730	1290	1060	950
1.5	990	930	690	1210	1000	900
1.6	940	890	650	1150	950	850
1.7	900	840	620	1090	900	810
1.8	850	800	580	1040	860	770
1.9	810	760	560	990	820	730
2.0	780	730	530	950	780	690
2.1	740	700	510	910	740	660
2.2	710	670	480	870	710	630
2.3	680	640	460	830	680	610
2.4	650	610	440	800	650	580
2.5	630	590	420	770	630	560
2.6	610	570	410	740	600	540
2.7	580	550	390	710	580	520
2.8	560	530	380	690	560	500
2.9	540	510	360	660	540	480
3.0	530	490	350	640	520	460

Chart X
Part 2

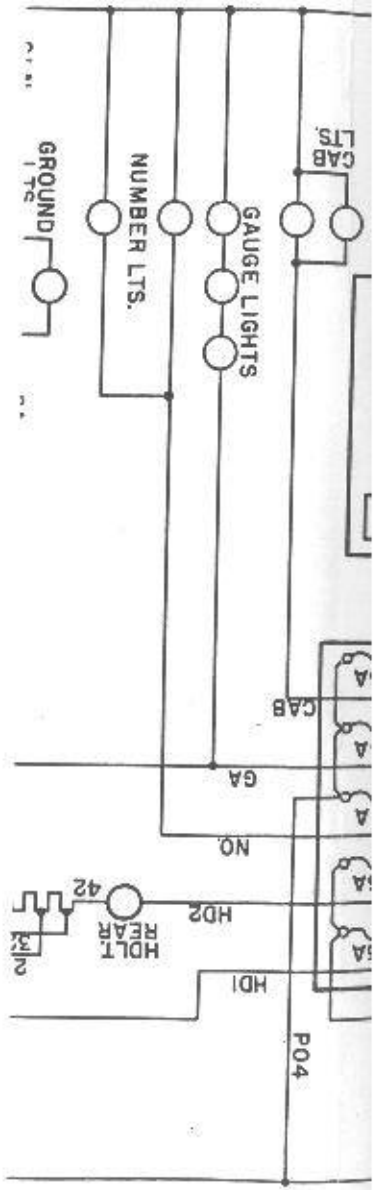


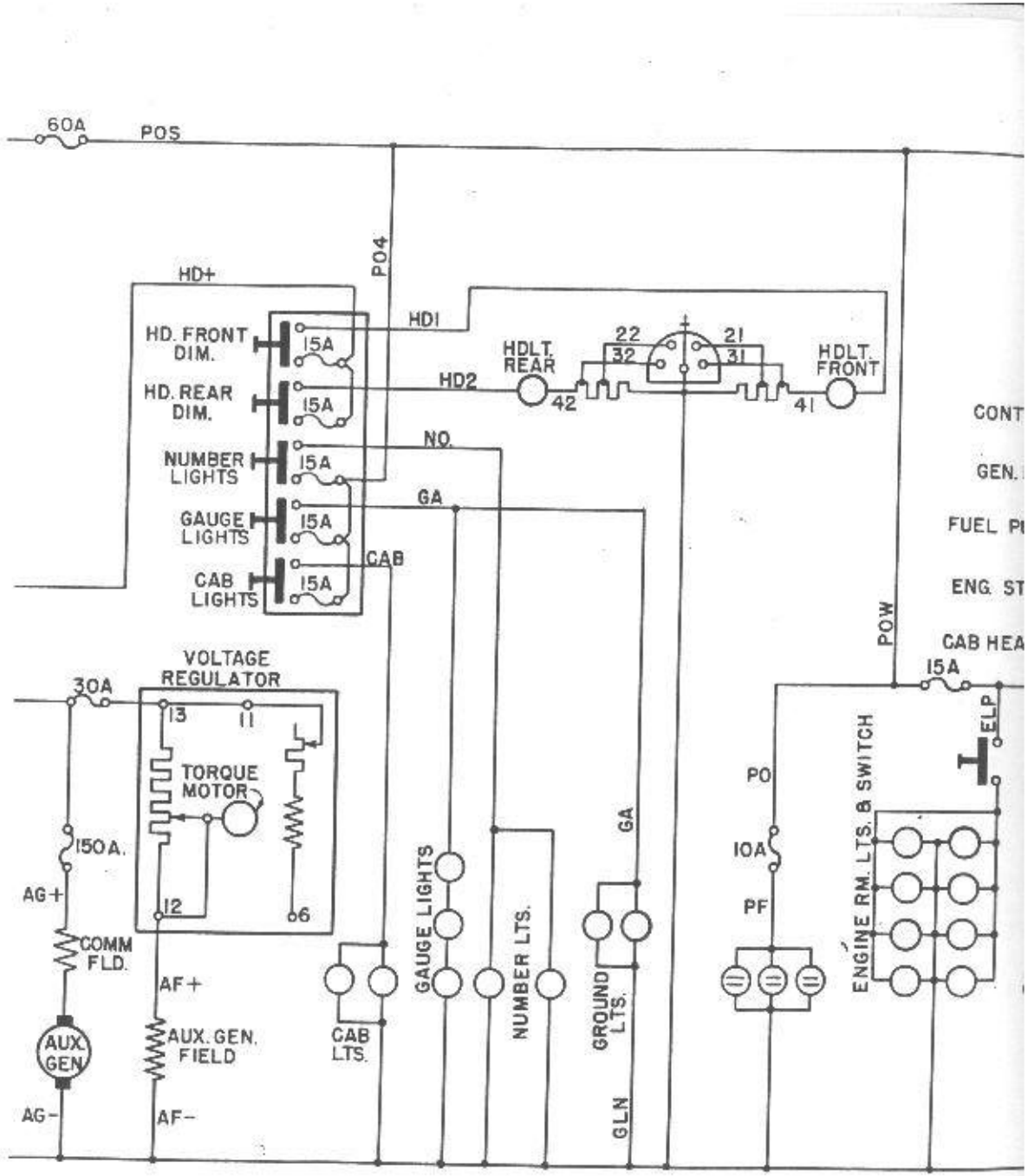
Schematic Diagram - Typical Fuel Oil System
600 HP Switching Locomotive
Chart I

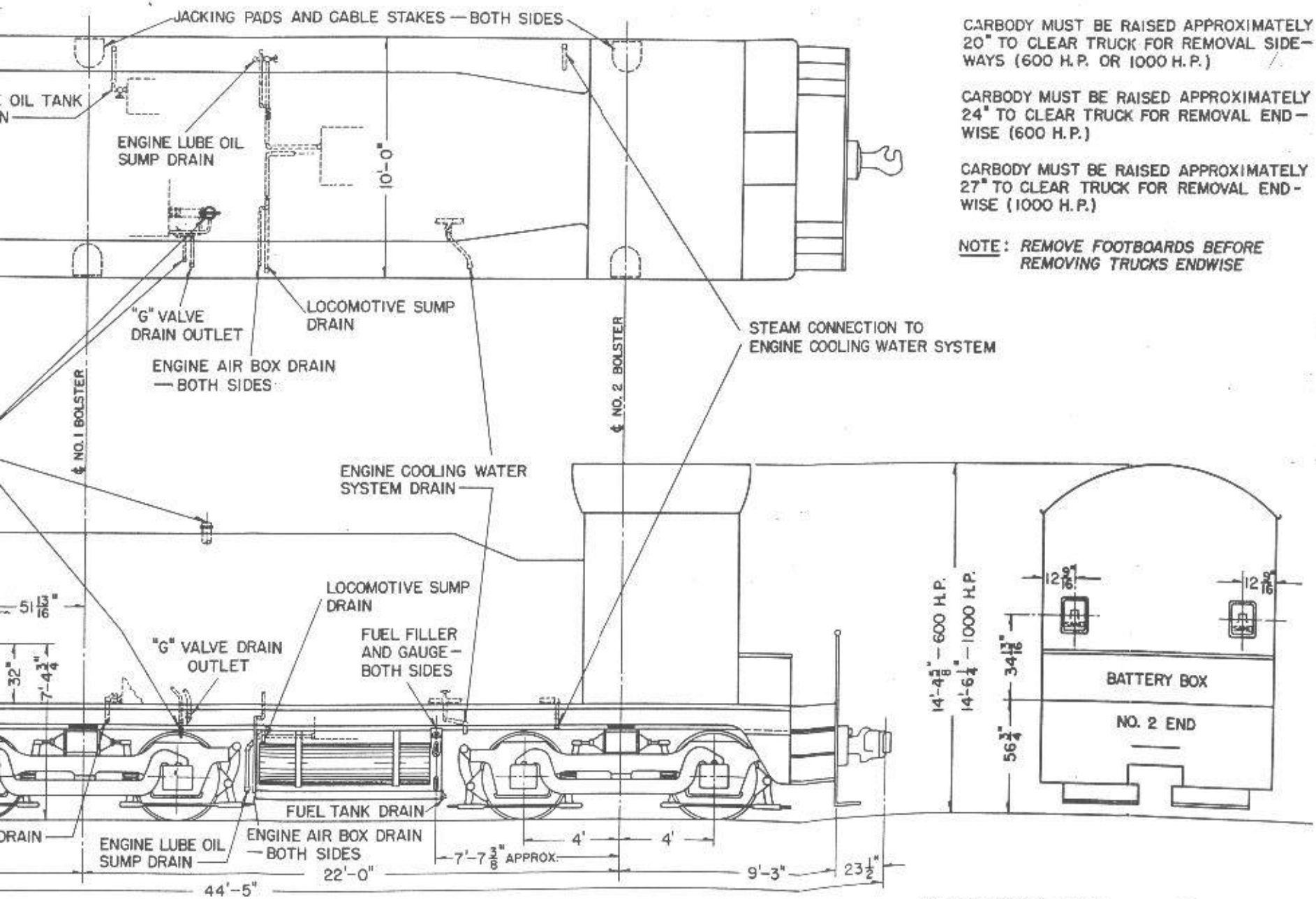

LATE 4029
BF
4 OHMS
B A
BATT. FLD
BF+ BF-
60A
POS
BF+
LOAD REGULATOR
53A
HD+
HD. FRONT DIM.
HD. REAR DIM.
NUMBER LIGHTS
GAUGE LIGHTS
CAB LIGHTS
15A
ST+
400A
ST-
A+
MAIN GEN.
COMM. FLD.
DIFF. FLD.
START FLD.
.527 OHMS
BFR
BFD
BF
BFP
60A
400 OHMS
59 OHMS
F+
F-
SHUNT FLD.
FR
SH
BN
CHG. RECEPT.
64 VOLTS
CR1
0.1 OHMS
CR2
BC
1200 OHMS
GR
CLR
WS3
WSR
WS4
A1
No.1 MOT
AA1
A2
No.2 MOT
AA2
F1
FF1
FF2
F2
CLR1
P1
S
VOLTAGE REGULATOR
30A
13
11
TORQUE MOTOR
12
6
RCR
150A.
AG+
COMM FLD.
AF+
AUX. GEN. FIELD
AUX. GEN
AG-
AF-
A3
No.3 MOT
AA3
A4
No.4 MOT
AA4
F3
FF3
FF4
F4
CLR
P2
WS5
WSR
WS6
9000 OHMS
S2
V1
F2
NEG.



Typical Wiring Diagram - 1000 HP
Chart VIII




60A
POS
P04
HD+
HD. FRONT DIM.
15A
HD. REAR DIM.
15A
NUMBER LIGHTS
15A
GAUGE LIGHTS
15A
CAB LIGHTS
15A
HD1
HD2
NO.
GA
CAB
HDLT. REAR
42
22
32
21
31
41
HDLT. FRONT
CONT
GEN.
FUEL P
ENG. ST
CAB HEA
POW
15A
ELP
VOLTAGE REGULATOR
30A
13
11
TORQUE MOTOR
12
6
150A.
AG+
COMM FLD.
AUX. GEN.
AG-
AF+
AUX. GEN. FIELD
AF-
CAB LTS.
GAUGE LIGHTS
NUMBER LTS.
GA
GROUND LTS.
GLN
PO
10A
PF
ENGINE RM. LTS. & SWITCH



CARBODY MUST BE RAISED APPROXIMATELY 20" TO CLEAR TRUCK FOR REMOVAL SIDEWAYS (600 H.P. OR 1000 H.P.)

CARBODY MUST BE RAISED APPROXIMATELY 24" TO CLEAR TRUCK FOR REMOVAL ENDWISE (600 H.P.)

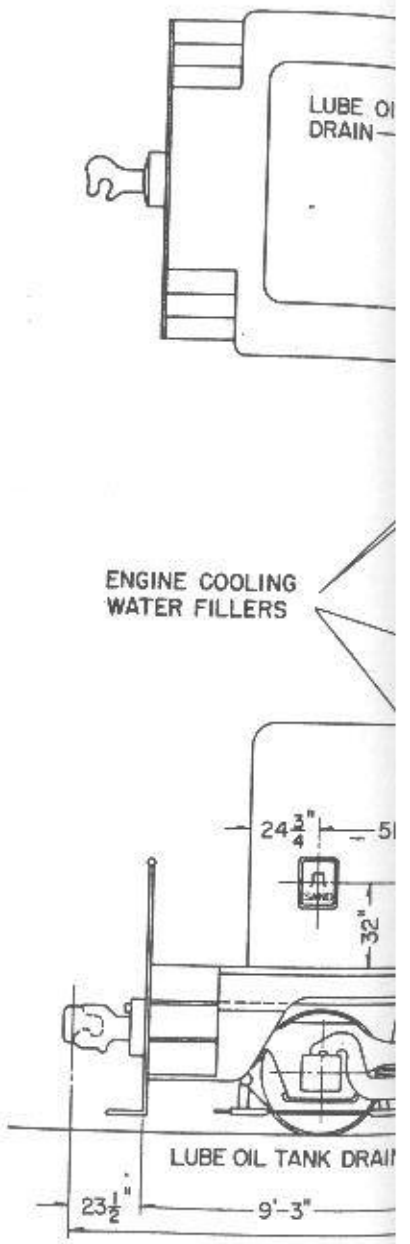
CARBODY MUST BE RAISED APPROXIMATELY 27" TO CLEAR TRUCK FOR REMOVAL ENDWISE (1000 H.P.)

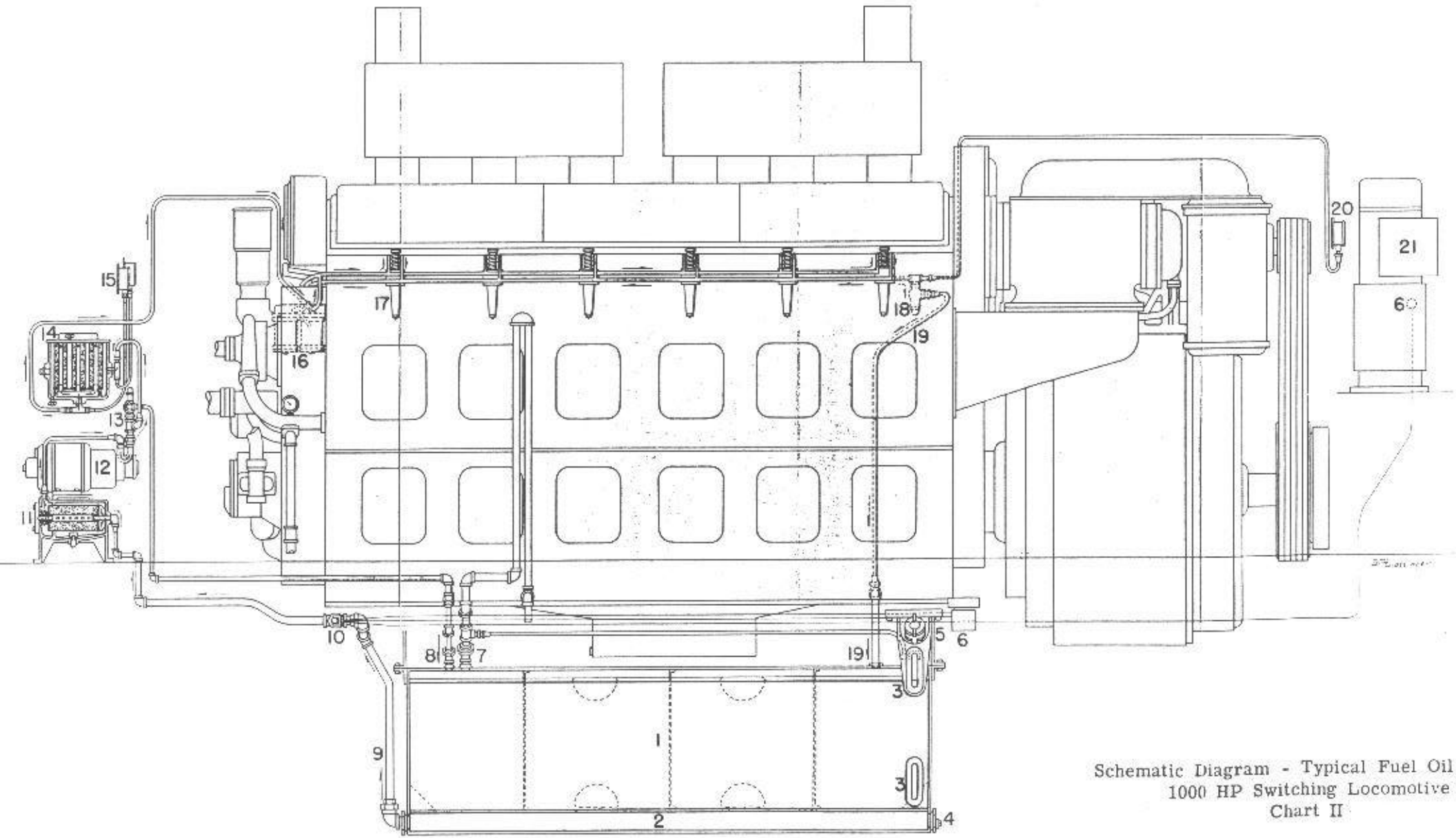
NOTE: *REMOVE FOOTBOARDS BEFORE REMOVING TRUCKS ENDWISE*

Drains, Fillers, Clearances & Jacking Pads
Chart IX

NOTES

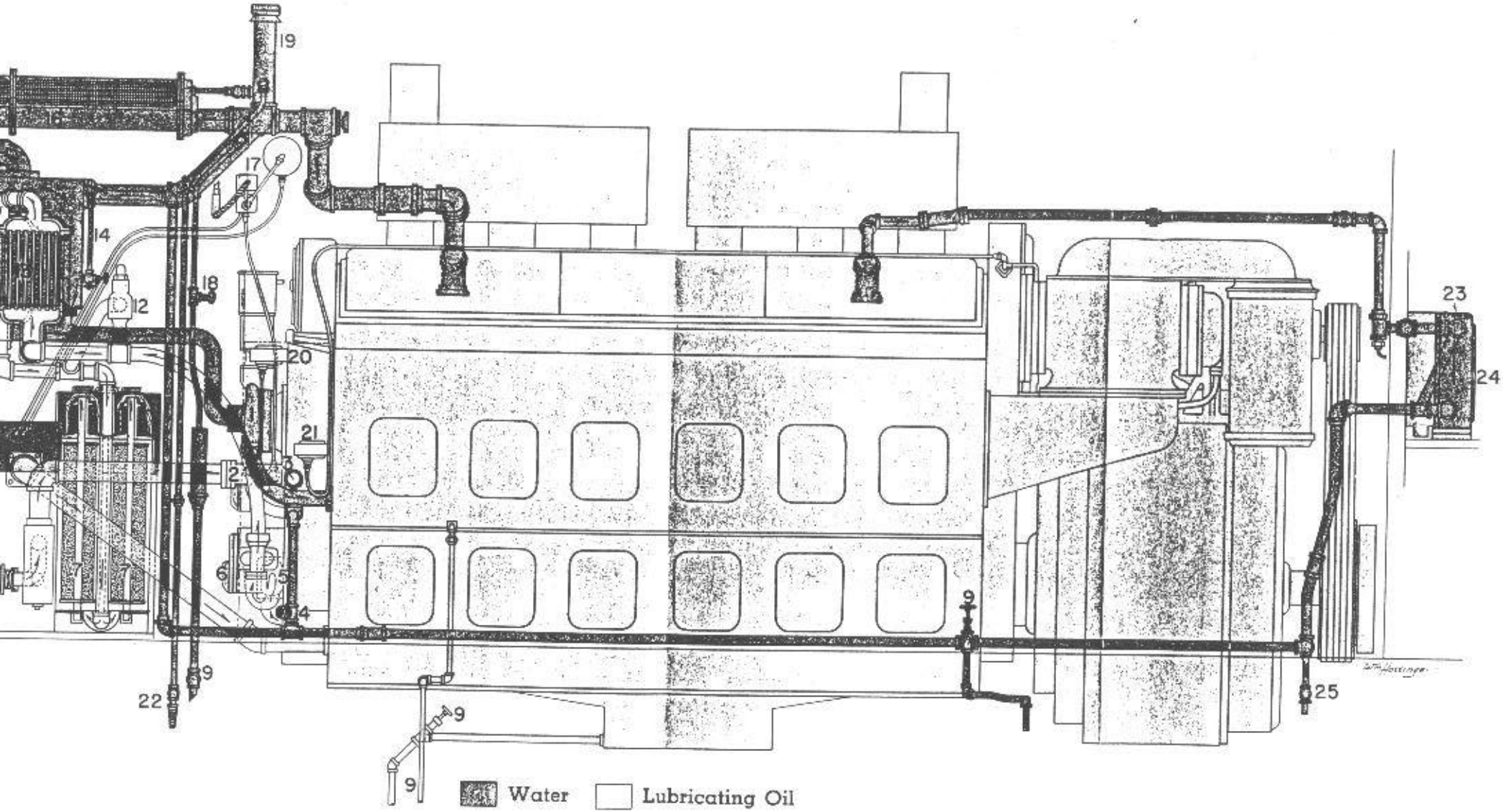
1. Fuel Tank
2. Fuel Tank Sump
3. Sight Gauge
4. Fuel Tank Water Drain Plug
5. Fuel Filler
6. Emergency Fuel Cutoff Pull Ring
7. Fuel Tank Vent
8. By-Pass Return Line
9. Fuel Supply
10. Emergency Fuel Cutoff Valve
11. Suction Filter
12. Fuel Pump and Motor
13. Relief Valve – 60 Lbs.
14. Discharge Filter
15. Fuel Gauges – Inlet
16. Sintered Bronze Filters
17. Injector
18. Relief Valve – 5 Lbs.
19. Fuel Return Line
20. Fuel Return Pressure Gauge
21. Control Switch Box



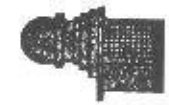


Schematic Diagram - Typical Fuel Oil Syst
1000 HP Switching Locomotive
Chart II

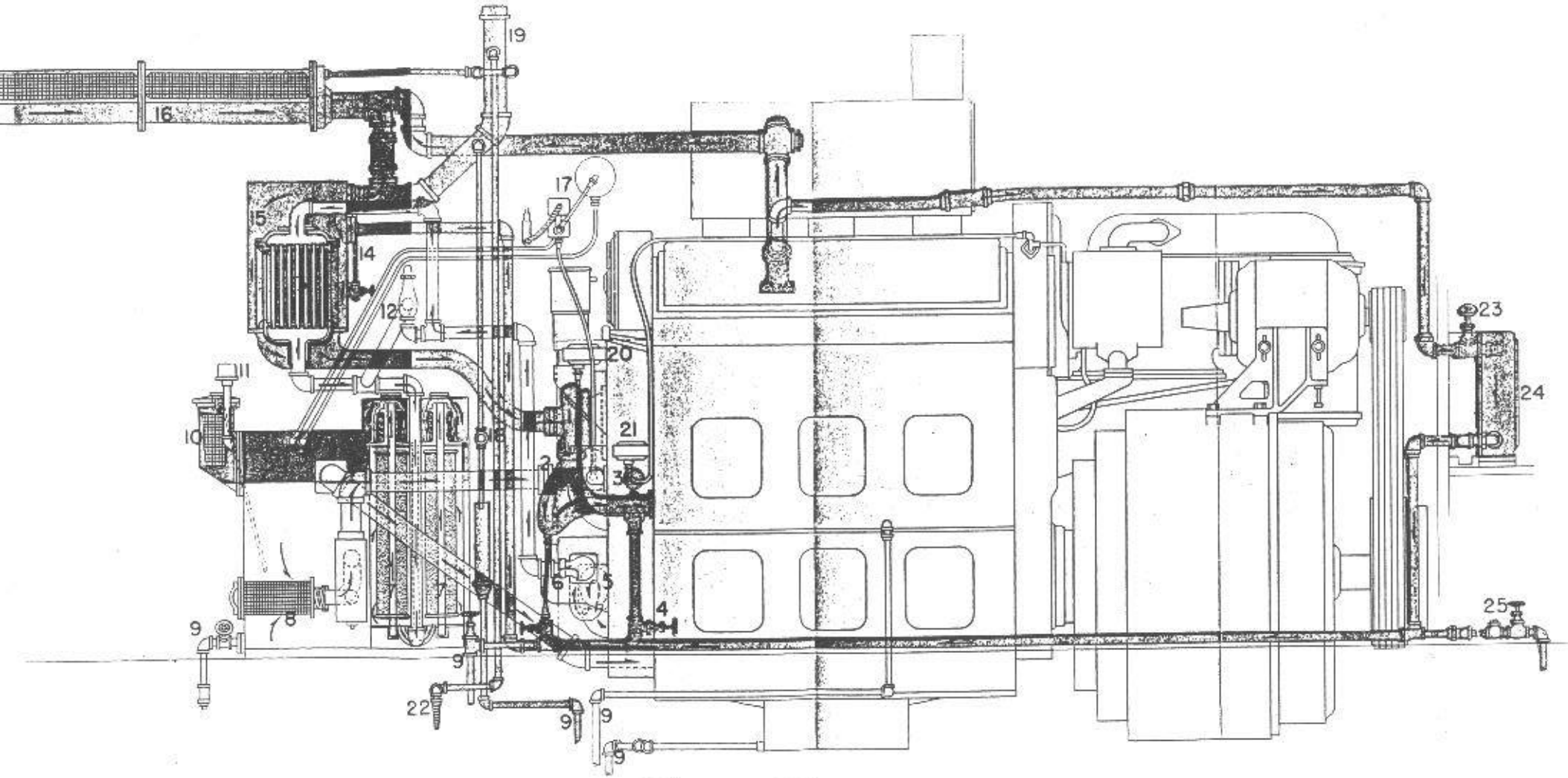
1. Water Pump
2. Lubricating Oil Pump
3. Water Pressure Gauge
4. By-Pass Valve
5. Sump Oil Screen
6. Scavenging Oil Pump
7. Lube Oil Filters
8. Lube Oil Strainers
9. Drains
10. Strainer Basket
11. Vent
12. Relief Valve
13. Lube Oil Cooler
14. Water Level Gauge
15. Cooling Water Tank
16. Radiator
17. Engine Shutdown Cylinder
18. "G" Valve
19. Roof Filler
20. Lube Oil Suction Switch
21. Lube Oil Pressure Switch
22. Side Filler
23. Cab Heater Valve
24. Cab Heater
25. Steam Admission Line



Lubricating Oil & Cooling Systems - 1000 HP
Chart IV



1. Water Pump
2. Lubricating Oil Pump
3. Water Pressure Gauge
4. By-Pass Valve
5. Sump Oil Screen
6. Scavenging Oil Pump
7. Lube Oil Filters
8. Lube Oil Strainers
9. Drains
10. Strainer Basket
11. Vent
12. Relief Valve
13. Lube Oil Cooler
14. Water Level Gauge
15. Cooling Water Tank
16. Radiator
17. Engine Shutdown Cylinder
18. "G" Valve
19. Roof Filler
20. Lube Oil Suction Switch
21. Lube Oil Pressure Switch
22. Side Filler
23. Cab Heater Valve
24. Cab Heater
25. Steam Admission Line



Lubricating Oil & Cooling System - 600 HP
Chart III