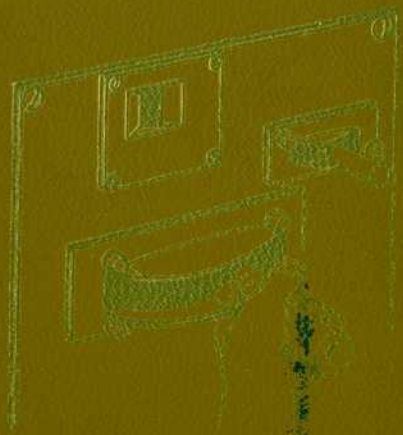

SD40

OPERATOR'S MANUAL

Electro-Motive Division
La Grange, Illinois

SD40

OPERATOR'S MANUAL

GENERAL MOTORS LOCOMOTIVES

6th Edition
May, 1971

SERVICE DEPARTMENT

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

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13387

NOTICE

The data appearing in this manual is intended as a guide and as an aid in explaining the locomotive equipment used during operation. It is generally applicable to the basic locomotive, that is, a locomotive without optional extra equipment. Some data is also included for a number of the more frequently used extras. When special extra equipment is involved, consult specific drawings or instructions as provided by the railroad.

The information contained in this manual is based on data available when released for printing.

Minor differences encountered in equipment are due to changes made after the manual was sent to press. These changes will be covered in subsequent editions of this manual.

INTRODUCTION

This manual has been prepared to serve as a guide to railroad personnel engaged in the operation of the 3000 horsepower General Motors Model SD40 turbocharged diesel-electric locomotive.

The contents are divided into four sections as follows:

1. General Description — Provides general description of principal equipment components.

2. Cab Controls — Explains functions of cab control equipment used in operating the locomotive.

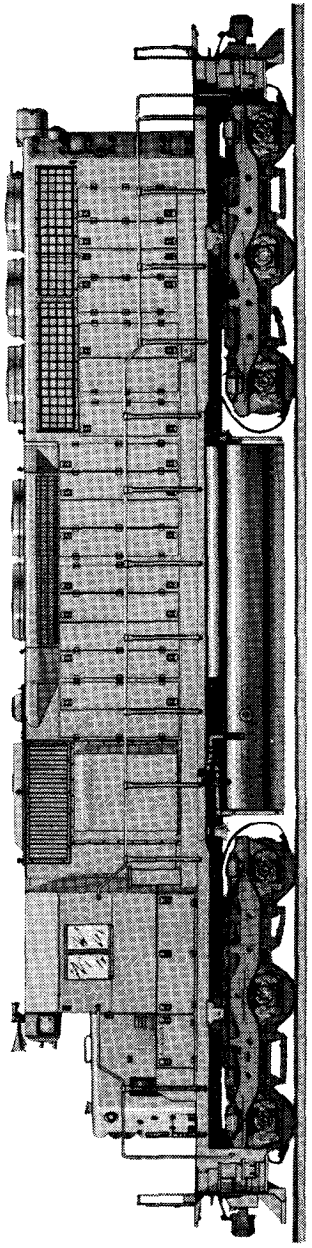
3. Operation — Outlines procedures for operation of the locomotive.

4. Trouble Shooting — Describes cause, location and correction of possible troubles occurring during operation.

A block of page numbers is allocated to each section, Section 1 starting with page 101, Section 2 with 201 and the others following in this manner. Figures are identified by section and sequence. For example: Fig. 2-3 is the third figure used in Section 2.

To obtain the most benefit from this manual, it is recommended that the sections be read in the sequence in which they appear.

Information pertaining to maintenance, adjustment, and testing is contained in the SD40 Locomotive Manual. Instructions for testing and maintenance of individual locomotive components will remain a part of the standard EMD Maintenance Instruction bulletin series.



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SD40 Locomotive

GENERAL DATA

Model Designation	SD40
Locomotive Type	(C-C) 0660
Locomotive Horsepower	3000
Diesel Engine Model	645E3
Type	Turbocharged
Number Of Cylinders	16
Cylinder Arrangement	45 "V"
Cylinder Bore And Stroke	9-1/16" x 10"
Operating Principle	2 Stroke Cycle, Turbocharged, Unit Injection, Water Cooled
Full Speed	900 RPM
Idle Speed	315 RPM
Main Generator Model	AR10 - D14
Traction Alternator (Rectified Output)	AR10
Number Of Poles	10
Nominal Voltage (DC)	600
Frequency (at 900 RPM)	75 cps
Companion Alternator	D14
Nominal Voltage (AC)	180
Number Of Poles	16
Frequency (At 900 RPM)	120 cps
Auxiliary Generator Voltage (DC)	74
Rating —	10 KW
Traction Motors	
Model	D77
Number	6
Type	DC, Series Wound Axle Hung
Driving Wheels	
Number	6 Pair
Diameter	40"
Tread	Tapered

TABLE OF CONTENTS

Maximum Speed Options With Gear Ratio

Gear Ratio	Top Speed* MPH
62:15	65
61:16	70
60:17	76
59:18	82
58:19	88

*Based on rated RPM of traction motors.

Air Compressor
- Type . . . . . 2 Stage
- Number Of Cylinders 3
- Capacity (At 900 RPM) . . . . 254 Cu. Ft./Min.
- Air Compressor Cooling . . . . . Water
- Lube Oil Capacity . . . . . 10-1/2 Gal.

Storage Battery
- Number Of Cells 32
- Voltage 64
- Rating (8 Hour) . . . . . 420 Amp Hr.

Supplies
- Lubricating Oil Capacity . . . . . 243 Gal.
  - With Deep Sump Oil Pan . . . . . 395 Gal.
- Cooling Water Capacity . . . . . 254 Gal.
- Fuel Capacity (Basic) . . . . . 3200 Gal.
  - With Extra Capacity . . . . . 4000 Gal.
- Sand . . . . . 56 Cu. Ft.

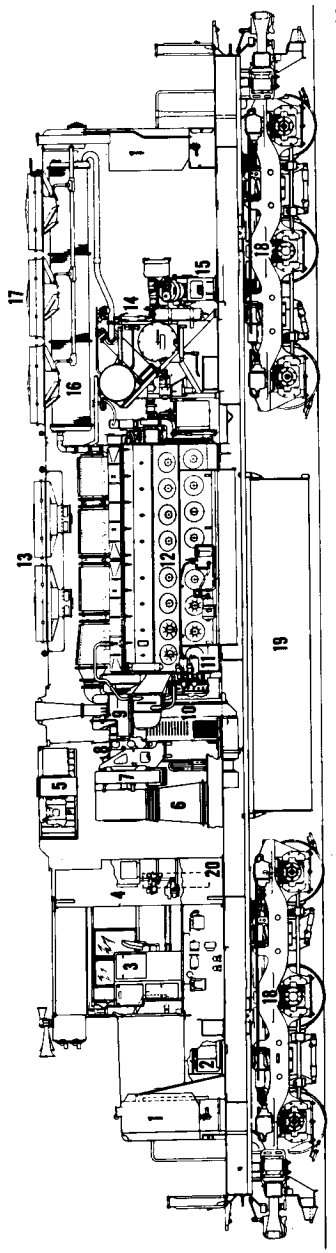
Air Brakes . . . . . Type 26L

Approximate Weight On Rails . . . . . 368,000 lbs.

Weight On Drivers 100%

Major Dimensions
- Length Between Coupler Faces . . . . 65' 9-1/2"
- Width Over Underframe . . . . . 10'
- Overall Height — Top Of Rail To Top Of Cooling Fan . . . . . 15' 7-3/16"

Minimum Curve Radius
- Single Unit . . . . . 30°or 193'
- Coupled to Standard 50' Car . . . . 17°or 338'
- Two Units Coupled . . . . . 23°or 250'



1. Sand Box
2. Battery
3. Control Stand
4. No. 1 Electrical Cabinet
5. Inertial Air Filter
6. Traction Motor Blower
7. Generator Blower
8. Auxiliary Generator
9. Turbocharger
10. Main Generator
11. Engine Cranking Motors
12. Engine 16-645E3
13. Dynamic Brake Fans
14. Equipment Rack
15. Air Compressor
16. Radiators
17. Radiator Cooling Fans
18. Trucks
19. Fuel Tank
20. Electrical Cabinet Air Filter

Fig. 1-1 – General Arrangement – SD40 Locomotive

SECTION 1

GENERAL DESCRIPTION

INTRODUCTION

The General Motors Model SD40 locomotive, illustrated in Fig. 1-1, is equipped with a turbocharged diesel engine that delivers 3000 horsepower to the main generator for tractive purposes. This power is then distributed to six traction motors, each of which is directly geared to a pair of driving wheels.

The basic locomotive is arranged and equipped so that the short hood or cab end is considered the front or forward part of the unit. However, the locomotive operates equally well in either direction, and on special order controls may be arranged so that the long hood end is forward, or dual controls may be provided.

The locomotive may consist of one or more individual units, each of which is a completely functional power plant. When coupled together for multiple unit operation, all can be simultaneously controlled from a single set of controls located in the cab of the lead unit. This is accomplished through jumper cables connected between the units.

The general arrangement of equipment used on the SD40 locomotive is shown in Fig. 1-1. Each of the more important equipment components is numbered and identified in this illustration.

On special order, an SD locomotive can be equipped with a steam generator for use in passenger service. The fuel tank is divided into a combination fuel tank and water tank and the gear ratio at the traction motor pinion will generally be suitable for high speed

operation. Operating instructions for the SD and SDP models are the same, except for those operations relating to the steam generator. Instructions for operation of the steam generator are provided by the manufacturer of that equipment.

HOW THE LOCOMOTIVE OPERATES

1. The fuel pump is driven by an electric motor which, for fuel priming, uses current from the storage battery. Once the engine is started and running, the fuel pump motor uses current directly from the auxiliary generator. The fuel pump transfers fuel from the fuel tank under the locomotive to the engine injectors.

2. The diesel engine is started by means of two series connected 32-volt cranking motors that engage the flywheel ring gear when starting current is applied. The storage battery supplies electric current to engage the starting pinions and rotate the cranking motors.

3. When the engine is running, it supplies mechanical power through shafts and couplings to directly drive three electrical generators, the air compressor, motor and generator blowers, and engine mounted lube oil and cooling water pumps.

4. The auxiliary generator charges the storage battery and supplies low voltage direct current for the control and lighting circuits. The companion alternating current generator furnishes power to the static exciter, various transductors, the three radiator cooling fans, and the inertial separator blower motor. The main traction alternator supplies high voltage AC to a power rectifier assembly which then delivers high voltage DC to the traction motors for locomotive pulling power.

5. By means of the cab controls, low voltage circuits are established to actuate the engine governor and the switchgear in electrical cabinets. This switchgear controls generator excitation and distribution of power.

6. Six traction motors are located under the locomotive. Each traction motor is directly geared to an axle and pair of driving wheels. These motors are located in two trucks which support the locomotive weight and distribute it to the driving wheels.

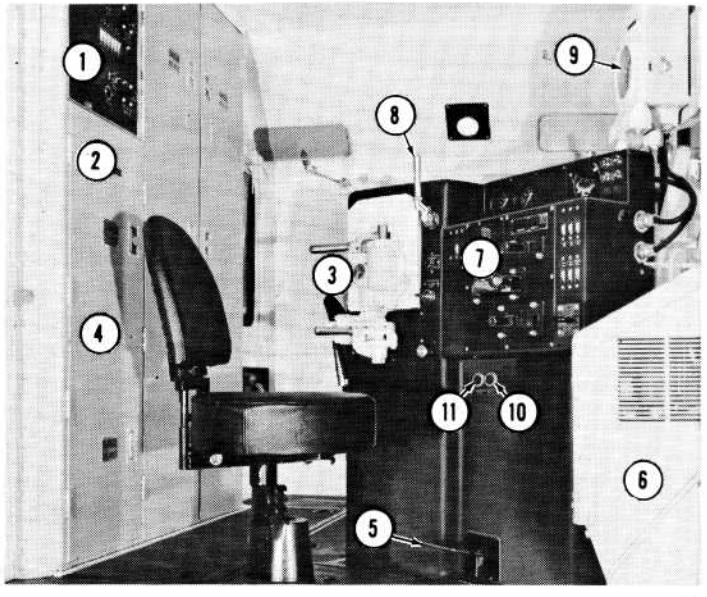
7. The throttle electrically controls speed and power by actuating a governor mounted on the engine and by tying the response of the locomotive power control system to throttle position. The main generator converts the engine's mechanical power to electrical power, which is then distributed to the traction motors through circuits established by the various switchgear components in the electrical cabinet.

8. At locomotive start the throttle controls electrical devices that provide rapid power response at a level consistent with smoothly controlled starting.

9. During heavy-drag low-speed operation, as well as at moderate and high operating speeds, a load regulator operates to maintain power output at the specific level called for by throttle position. This prevents the engine from being overloaded or underloaded.

10. The air compressor supplies, to the reservoirs, air under pressure used primarily for the air brakes. The air brakes are controlled by the operator through suitable equipment in the cab.

11. Except for manual operation of the cab controls, the locomotive operation is completely automatic. Various alarms and safety devices will alert the operator should any operating difficulties occur.



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1. Engine Control Panel
2. Circuit Breaker Panel
3. Air Brake Controls
4. Switch And Fuse Panel
5. Safety Control Pedal
6. Cab Heater
7. Locomotive Controller
8. Air Horn Lever
9. Speed Recorder
10. GRD/FAULT Reset Button
11. Attendant Call Button

Fig. 2-0 — Locomotive Control Station

SECTION 2

ENGINE STARTING AND CAB CONTROLS

INTRODUCTION

A switch for fuel priming and engine cranking is located at the equipment rack in the engineroom. All other basic control equipment used during locomotive operation is at four locations within the cab, Fig. 2-0.

1. The Switch And Fuse Panel
2. Circuit Breaker Panel
3. The Engine Control Panel
4. The Locomotive Control Stand

ENGINE STARTING CONTROLS, Fig. 2-1

Fuel Prime And Engine Start Switch

This switch, located on the equipment rack in the engineroom, is a three-position rotary switch used for fuel priming and engine starting. Before attempting to start the diesel engine, the isolation switch in the locomotive cab must be placed in the START position. The rotary switch must then be placed in the FUEL PRIME position and held there for 10 to 15 seconds to operate the fuel pump. The layshaft lever must then be positioned and the rotary switch placed in the ENGINE START position and held (for no longer than 20 seconds) until the engine starts.

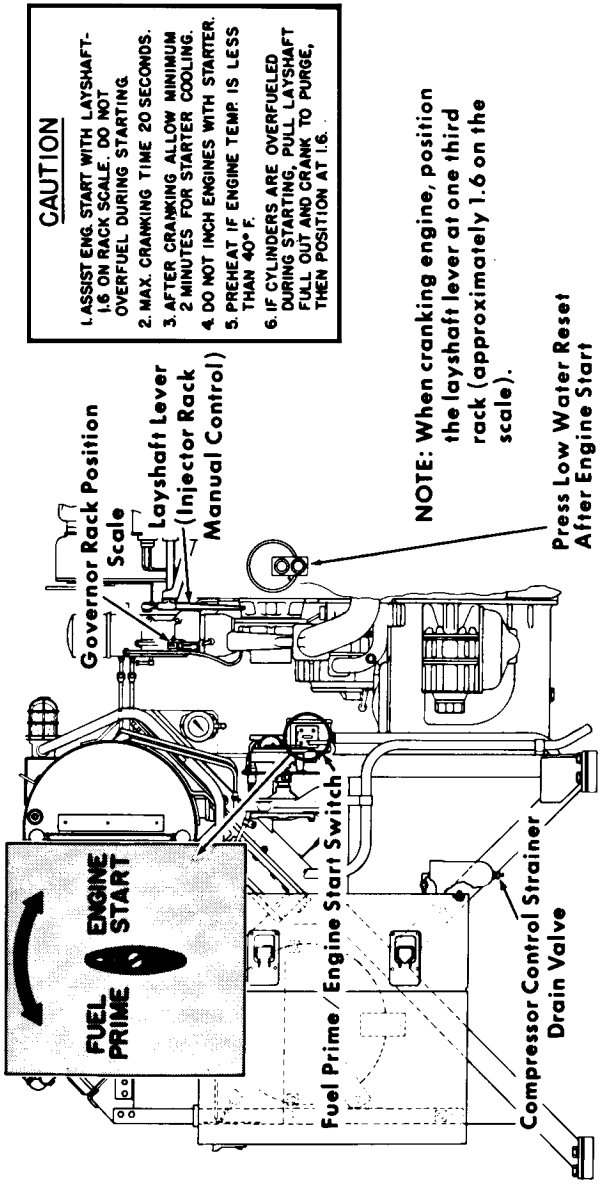


Fig. 2-1 — Engine Starting Controls

Layshaft Lever

This engine mounted hand operated lever operates the injector racks. It is used to position the injector racks during engine cranking, thereby providing an immediate supply of fuel to the cylinders.

Low Water Reset Pushbutton

The low water detector will often trip during engine starting, especially when the engine is cold or when the water tank pressure cap has been removed to add water. The detector should be reset as soon as the engine starts and is idling, or else the engine will shut down after a time delay established by the governor.

Check the low water reset pushbutton after every engine start.

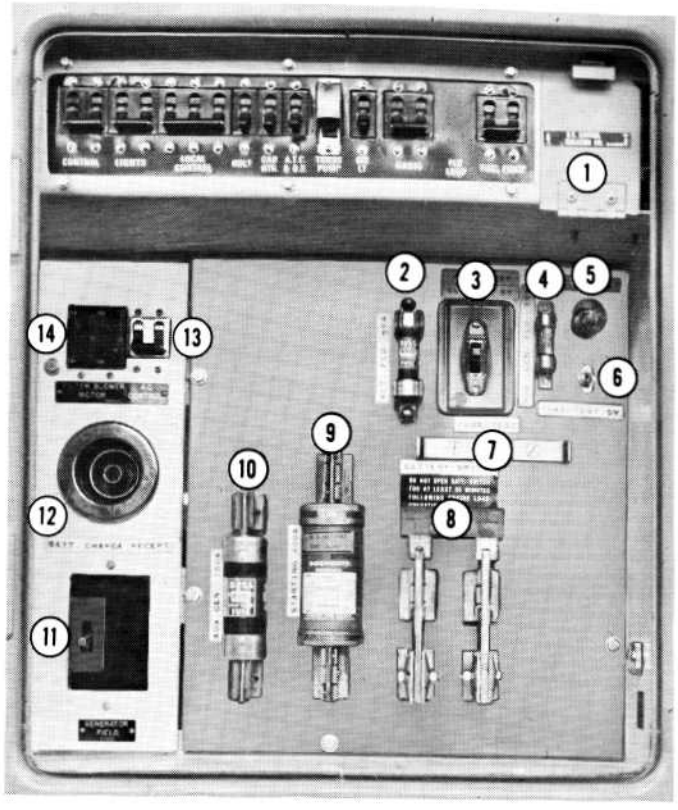
NOTE: The reset buttons on some detectors will not latch in when the engine is shut down. If such a condition is encountered, reset the device after engine start.

SWITCH AND FUSE PANEL

The panel shown in Fig. 2-2 is located within the electrical cabinet that forms the rear wall of the locomotive cab. Its position is directly below the engine control panel which is located in the upper left hand corner of the electrical cabinet.

Battery Charging Fuse And Receptacle

As a modification when requested by the railroad, provision is made at the switch and fuse panel for connection of an external source of DC power to charge the locomotive battery. The battery charging fuse may be provided to protect the charging circuit.



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1. High Voltage Control Isolation Switch
2. D14 Alternator Field Fuse
3. Ground Relay Cutout Switch
4. Auxiliary Generator Field Fuse
5. Fuse Test Light
6. Fuse Test Switch
7. Fuse Test Terminals
8. Main Battery Switch
9. Starting Fuse
10. Auxiliary Generator Fuse
11. Generator Field Circuit Breaker
*12. Battery Charging Receptacle
13. AC Control Circuit Breaker
14. Filter Blower Motor Circuit Breaker

*Extra Equipment

Fig. 2-2 — Circuit Breaker Panel, And Switch Fuse Panel

D14 Alternator Field 60-Ampere Fuse

The D14 alternator receives its excitation through a pair of slip rings connected to the low voltage DC auxiliary generator output. To protect these windings, a 60-ampere fuse is provided in the excitation circuit. This fuse must be good and in place at all times during locomotive operation.

In the event that the fuse is blown, D14 alternator excitation and resulting power output will cease, setting off the no power alarm, and reducing the engine speed to idle.

Auxiliary Generator Field 30-Ampere Fuse

The field excitation circuit of the auxiliary generator is protected by a 30-ampere fuse. This fuse must be good and in place at all times during locomotive operation.

In the event that this fuse is burned out, it stops auxiliary generator output to the low voltage system and also stops fuel pump operation. An alternator failure (no power no battery charge) alarm would then occur. The engine will go to idle speed and then stop from lack of fuel.

Ground Relay Cutout Switch

The purpose of the ground relay cutout switch is to eliminate the ground protective relay from the locomotive circuits during certain shop maintenance inspections. It MUST ALWAYS BE KEPT CLOSED in normal operation, otherwise the protection offered by the ground relay will be nullified and possible serious equipment damage could occur. It may be opened, however, in the event of extreme emergency upon

receipt of definite instruction to that effect from a responsible officer of the railroad.

Fuse Test Equipment

To facilitate the testing of fuses, a pair of fuse test blocks, a test light and a test light toggle switch are installed on the fuse panel. Fuses may be readily tested as follows. First, move the toggle switch to the ON position to make sure the fuse test light is not burned out. Extinguish the light by moving the toggle switch to the OFF position. Place a fuse across the test blocks so that the metal ends of the fuse are in firm contact with the blocks. If the fuse is good, the light will come on. If the fuse is burned out, the light will not come on and a new fuse is required.

It is always advisable to test fuses before installing them in their circuits. Always isolate the circuits in question by opening their switches before changing or replacing fuses.

Auxiliary Generator Fuse

This fuse connects the auxiliary generator to the low voltage system. It protects against excessive current demands. A 150 ampere fuse is installed for the basic auxiliary generator and a 250 ampere fuse is installed for the heavy duty generator. In the event that the fuse is burned out, it stops auxiliary generator output to the low voltage system and also stops fuel pump operation. An alternator failure (no power) alarm would then occur. The engine will go to idle speed and then stop from lack of fuel.

CAUTION: The 250 ampere fuse is of the same physical size as the starting 400 ampere fuse. Do not interchange the fuses.

Starting 400-Ampere Fuse

The starting fuse is in use only during the period that the diesel engine is actually being started. At this time, battery current flows through the fuse and starting contactor to the cranking motors.

Although this fuse should be in good condition and always left in place, it has no effect on locomotive operation other than for engine starting. A defective fuse can be detected when attempting to start the engine, since at that time (even though the starting contactors close) the cranking circuit is open.

Main Battery Knife Switch

The large double-pole single-throw knife switch at the lower portion of the fuse panel is the main battery switch. It is used to connect the battery to the locomotive low voltage system and should be kept closed at all times during operation.

This switch may be opened during certain shop maintenance procedures and in instances where the engine is shut down and the locomotive taken out of service for an extended layover. This will prevent the battery from being discharged in the event the lights or other low voltage devices are inadvertently left operating during the layover. Particular attention should be given when a notation at the switch cautions against opening the switch immediately after engine shutdown. At least 35 minutes should be allowed following engine shutdown before this switch is opened after load operation at or above throttle position No. 3. That is, cooldown time for the turbocharger bearings can be considered to accumulate below throttle position No. 3 even though the 35 minute timing of the turbocharger auxiliary lube oil pump begins at engine shutdown.

Steam Generator 100-Ampere Fuse

When the locomotive is equipped with a steam generator for use in passenger service, this fuse is used to protect the circuits to the steam generator.

AC CIRCUIT BREAKER PANEL

Generator Field Circuit Breaker

The AR10 generator receives its excitation through a pair of slip rings connected to the D14 alternator output through a controlled rectifier. The circuit breaker is provided to protect the controlled rectifier and the generator field windings.

AC Control Circuit Breaker

The D14 alternator is the power supply for various excitation and wheel slip control devices. The breaker is employed to protect the circuitry. The No AC Voltage relay NVR is also located in this circuit. If the breaker trips during locomotive operation, a NO POWER alarm will be given.

Filter Blower Motor Circuit Breaker

A blower is used to evacuate dirty air from the central air compartment inertial filters. This breaker is provided to protect the blower motor circuit.

CIRCUIT BREAKER PANEL

This panel is located above and forward of the switch and fuse panel, but behind the same cabinet door. It contains the following equipment.

Control 40-Ampere Circuit Breaker

This circuit breaker must be in the ON position before locomotive operation is possible. It sets up the fuel pump and control circuits for engine starting. Once the engine is running, power is supplied through this breaker from the auxiliary generator to maintain operating control.

Lights 30-Ampere Circuit Breaker

This circuit breaker must be ON to supply power for the individual switches provided for platform, engine room, and identification lights.

Local Control 30-Ampere Circuit Breaker

This circuit breaker must be in the ON position before operation of the locomotive is possible. During operation it establishes "local" power from the auxiliary generator to operate heavy duty switchgear and various control devices.

Turbo Pump Motor 30-Ampere Circuit Breaker

This circuit breaker must be in the ON position to start the engine and operate the turbocharger auxiliary lube oil pump. It must remain in the ON position to provide auxiliary lubrication to the turbocharger at engine start and after the engine is shut down. A guard is provided over this breaker switch to prevent accidental movement to the OFF position.

Miscellaneous Circuit Breakers

These breakers can include one each for the headlight, automatic train control, overspeed switch, cab heater, radio, signal light, and field loop if applicable. The

circuit breakers should be placed in the ON position to obtain the desired operation.

Fuel Pump Circuit Breaker

The fuel pump circuit breaker must be ON for normal operation.

High Voltage Control Isolation Switches

These switches are provided for isolation of control circuits that are connected across the output of the main generator. They enable testing and calibration of circuits through the use of a controlled voltage from an MG set.

WARNING: High voltage is present at the switches during locomotive operation.

ENGINE CONTROL PANEL

The engine control panel, Fig. 2-3, is located at the upper left hand corner of the electrical cabinet that forms the rear wall of the cab. This panel contains various switches and alarm lights, along with a battery charging meter or light. Since all of these items will be used at one time or another during operation, a brief description of their individual functions is provided.

Note that an alarm bell accompanies alarm signal light indications. The bell will ring in all units of a locomotive consist, but the light will come on only in the affected unit.

Remote Traction Motor Cutout Switch (If Provided)

The traction motor cutout switch operates to cut out a defective motor along with an electrically related motor. This permits operation with four motors. The

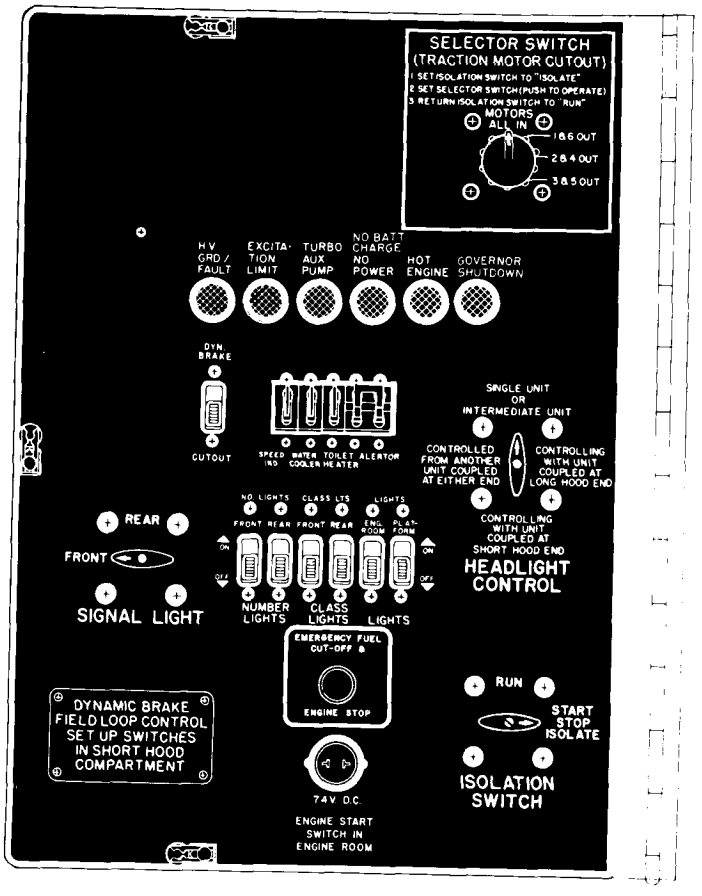

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Fig. 2-3 – Engine Control Panel With Typical Extras

power control system automatically limits power to prevent overloading the operative motors.

High Voltage Ground/Fault Light

The high voltage ground light indicates an electrical path to ground caused by insulation failure, the presence of water, or an electrical arc. When the light

is on, the locomotive will not develop power and the engine will remain at idle.

The light can be put out by pressing the H.V. Grd. reset pushbutton. It is not necessary to isolate the unit, nor is it necessary to have the throttle in idle while pressing the button.

When the high voltage ground light comes on for the third time after resetting, isolate the affected unit.

CAUTION: Always report ground relay light indications to proper maintenance personnel.

Excitation Limit Light

An electrical system relates generator excitation to main generator output and acts to hold power at an acceptable level during various temporary conditions of locomotive operation. Should this sytem lose calibration or somehow fail, there would be no protection against abnormally high generator current.

An excitation limit relay senses high generator field current and acts to modulate it. When this action occurs, generator current and voltage are held to acceptable values.

The excitation limit condition is normally temporary and no action is required by the operator; however, if the condition persists, the green excitation limit light comes on, a timing relay drops generator excitation and locks in the excitation limit circuit.

Turbocharger Auxiliary Pump Motor Light

This light will come on as soon as the main battery switch and turbo lube pump circuit breaker are closed. It indicates that the turbocharger auxiliary lube oil

pump is supplying lube oil to the turbocharger. It will remain on for approximately 35 minutes after the main battery switch is closed. When the fuel prime engine start switch is operated after the 35 minute period, the time cycle is again re-established and the light remains on for another 35 minutes.

The light will also come on and remain on for approximately 35 minutes after the engine is stopped. It provides an indication that the auxiliary lube oil pump is supplying oil to cool the turbocharger bearings.

No Battery Charge/No Power Light

This light will come on and the alarm bell will ring any time that the no AC voltage relay NVR opens with the isolation switch in RUN position and the ER switch in ON position. This will occur if the auxiliary generator fails to excite the D14 alternator, or if the D14 fails for any reason.

Hot Engine Alarm Light

The hot engine alarm light (red) operates in conjunction with the alarm bell to warn the operator that the engine cooling water has reached an excessive temperature.

Governor Shutdown

A mechanism to detect low engine lubricating oil pressure or high suction is built into the engine governor. This mechanism is actuated by true oil pressure failure or by dumping oil from the engine oil line leading to the governor. In either event a small button will pop out of the governor body, indicating that the mechanism has tripped the low oil alarm switch. The amber light on the engine control panel

will come on to indicate that the low oil mechanism has tripped.

When a Crankcase (Oil Pan) Pressure/Low Water/Low Oil alarm occurs it is necessary to determine whether the crankcase pressure – low water detector has tripped to dump engine oil from the line leading to the governor, or whether a true oil failure has occurred. This can be determined by checking the crankcase pressure – low water detecting device, Fig. 3-2, for protruding reset buttons. A protruding upper button indicates excessive oil pan pressure; a protruding lower button indicates low water.

WARNING: When it is determined that the crankcase pressure detector has tripped, make no further engine room inspections. Do not attempt to restart the engine, Isolate the unit and drain the cooling system in accordance with railroad regulations.

If neither the crankcase pressure nor the low water pressure detector has tripped, and engine oil level is satisfactory with cooling water level marginal and a hot engine condition apparent, allow engine to cool before restarting.

Miscellaneous Switches

Switches are included in circuits for various lights and devices on the locomotive. The switches are closed as desired to operate the class lights, the number lights, the engine room lights, and the platform lights.

Dynamic Brake Cutout Switch

On units so equipped, when this switch is placed in the CUTOUT position, the individual unit will not

operate in dynamic braking. It will however, continue to operate normally under power. The switch can be used to limit the number of units in a consist that will operate in dynamic braking, or it may be used to cutout a unit that is defective in dynamic braking, yet allow it to operate under power.

Headlight Control Switch

The twin sealed-beam front and rear headlights are controlled by the front and rear headlight switches on the locomotive control panel. A dimming switch is mounted on the right side of the controller. Before these switches will function, the 30-ampere headlight circuit breaker must be placed ON.

On locomotives equipped for multiple unit operation, a remote headlight control switch is mounted on the engine control panel. This remote headlight control switch provides for operation of the rear unit headlight from the lead unit. The switch positions are set on each unit as follows:

1. On Lead Unit

   If only a single locomotive unit is being used, place the switch in SINGLE UNIT position.

   In multiple unit service, if trailing units are coupled to the No. 2 or long hood end of the lead unit, place the switch in the CONTROLLING – COUPLED AT LONG HOOD END position.

   In multiple unit service, if trailing units are coupled to the No. 1 or short hood end of the lead unit, place switch in CONTROLLING – COUPLED AT SHORT HOOD END position.

2. On Intermediate Units

   On units operating in between other units in a multiple unit consist, place the switch in the SINGLE UNIT position.

3. On Trailing Units

   The last unit in a multiple unit consist should have the headlight control switch placed in the CONTROLLED – COUPLED AT EITHER END position.

Unit Selector Switch

The unit selector switch is used only on locomotives equipped with dynamic brakes and a field loop circuit. Its purpose is to adjust circuit resistance for uniform dynamic brake operation.

This switch should be set to the No. 1, 2, 3, or 4 position, depending on the number of locomotive units physically and electrically connected together. The switch position should not be changed for any reason other than to correspond to a change in number of units being operated. For example, it should not be changed if one of the units is isolated or shut down while it remains in the locomotive consist.

This switch position is of importance only in the lead or controlling locomotive unit during operation in dynamic braking. It has no function in intermediate or trailing units.

NOTE: Switch position may be changed only while the throttle is in IDLE or locomotive is at rest. It should never be moved while operating in dynamic braking.

Engine Start Switch Legend

The fuel prime/engine start switch is located on the equipment rack in the engineroom, Fig. 2-1. This location allows the operator to manipulate the engine layshaft lever during engine cranking, thereby facilitating faster starting with less drain on the locomotive battery.

Emergency Fuel Cutoff And Engine Stop Pushbutton

The diesel engine will stop whenever the engine stop pushbutton is pressed. The reaction to the pushbutton is immediate, it need not be held in until the engine stops.

Isolation Switch

The isolation switch has two positions, one labeled START/STOP/ISOLATE, the other labeled RUN. The functions of these two positions are as follows:

1. START/STOP/ISOLATE Position

   The isolation switch is placed in this position whenever the diesel engine is to be started. The start switch is effective only when the isolation switch is in this position.

   The START position is also used to isolate the unit, and when isolated the unit will not develop power or respond to the controls. In this event the engine will run at idle speed regardless of throttle position. This position will also silence the alarm bell in the event of a no power or low lube oil alarm. It will not, however, stop the alarm in the event of a hot engine.

If the locomotive is equipped with remote traction motor cutout switch, the isolation switch must be placed in the ISOLATE position before the cutout switch can be operated.

2. RUN Position

After the engine has been started, the unit can be placed "on the line" by moving the isolation switch to the RUN position. The unit will then respond to control and will develop power in normal operation.

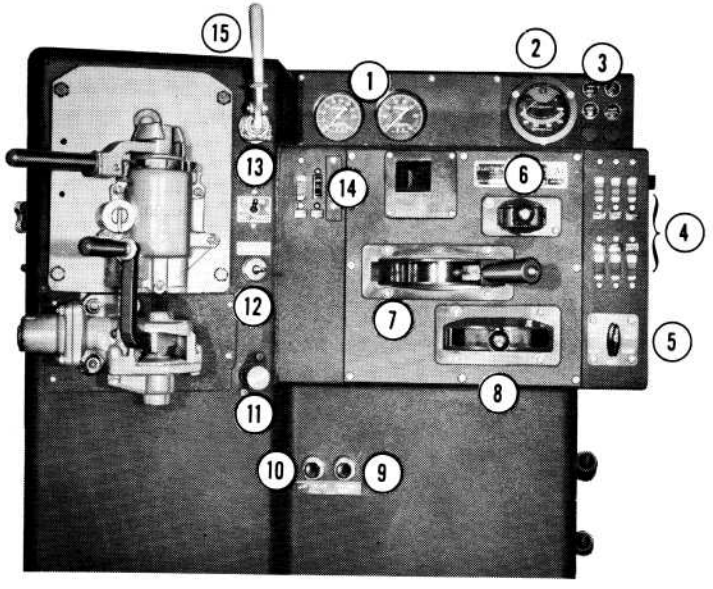
LOCOMOTIVE CONTROLLER

The locomotive controller is shown in Fig. 2-4. It contains the switches, gauges, and operating levers used by the operator during operation of the locomotive. The individual components of the controller are described, together with their functions, in the following paragraphs.

High Voltage Ground Reset Pushbutton

The ground relay detects high voltage grounds during operation under power. When it trips, the alarm bells ring in all units of a consist. On the unit affected, generator excitation is lost, the diesel engine goes to idle speed, and the high voltage ground light on the engine control panel comes on.

To reset the high voltage ground relay and restore locomotive power, wait 10 seconds and press the high voltage ground reset pushbutton on the locomotive control stand. It is not necessary to isolate the unit nor is it necessary to place the throttle in idle position before pressing the reset button unless the locomotive is at a standstill.



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1. Air Gauges
2. Load Current Indicating Meter
3. Indicating Lights
4. Operating Switches
5. Headlight Dimming Switch
6. Selector Lever (Optional Extra)
7. Throttle Lever
8. Reverse Lever
9. Ground Reset Pushbutton
10. Attendant Call Pushbutton
11. Bell Pushbutton
12. Sanding Lever
13. Lead Truck Sanding Switch
14. Dynamic Brake Circuit Breaker
15. Air Horn Lever

Fig. 2-4 — Locomotive Controller

Repeated resetting of the high voltage ground relay is permissible, but instructions as issued by the railroad regarding repeated resetting must be followed. However, in the absence of definite instructions to the contrary, isolate a unit when the ground relay light comes on for the third time after resetting.

CAUTION: Always report high voltage ground relay light indications to proper maintenance personnel.

Air Gauges

Air gauges to indicate main reservoir air pressure as well as various pressures concerned with the air brakes are prominently located along the top of the controller.

Load Current Indicating Meter

The locomotive pulling force is indicated by the load indicating meter located at the upper portion of the controller. This meter is graduated to read amperes of electrical current, with 1500 being the maximum reading on the scale. On special order the meter may be color coded to indicate operating time limits at various meter pointer positions.

The meter is connected so as to indicate the current flowing through the No. 2 traction motor. Since the amperage is the same in all motors, each motor will carry the amount shown on the meter.

On locomotives equipped with dynamic brakes, the load current indicating meter indicates braking effort during operation of dynamic brakes. Since the dynamic brake regulator controls maximum braking current, the meter should seldom if ever indicate more than 700 amperes, which is the rating of the dynamic braking resistor grids.

NOTE: The IDAC wheel slip control system functions to correct slips by instantaneous reduction of power in small increments and by application of sand. The cumulative effect of a large number of power reductions in rapid succession is to cause the locomotive to maintain power at a level where adhesion can be maintained. Do not misinterpret this loss of power as a defect in the control system.

Indicating Lights

Four or more indicating lights are installed to provide a visual warning of operating difficulties. The four basic lights are wheel slip, PCS open, brake warning, and sand. The functions of these lights are as follows:

1. Wheel slip light

   Intermittent flashing of the wheel slip light indicates that the wheel slip control system is doing its job and is correcting the slips. The throttle and locomotive power should not be reduced unless severe lurching threatens to break the train.

   Note that minor slips or wheel creep will not activate the wheel slip light, but automatic sanding may take place along with regulation of power to the wheels. Do not misinterpret this power control as loss of power due to a fault.

WARNING: A wheel slip light flashing slowly and persistently or burning continuously may indicate a pair of sliding wheels or circuit difficulty. Stop the locomotive and make a careful inspection to ascertain that there are no locked sliding wheels.

2. PCS OPEN Light

   The PCS or pneumatic control switch functions to automatically reduce locomotive power in the event that an emergency or safety control air brake application occurs. It does so by reducing the speed of ALL engines to idle.

CAUTION: The engine run switch should be in the OFF position in all trailing units, or (depending on the type and position of locomotives in the consist) it is possible that

the PCS switch of the lead unit will not act to reduce engine speeds to idle.

When the switch is tripped the PCS OPEN indicating light on the controller will come on. This light is extinguished and locomotive power restored by resetting the PCS switch. This occurs automatically, provided that:

a. Control of the air brake is recovered.

b. The throttle is returned to IDLE position.

3. Brake Warning

A brake warning light is installed on units equipped with dynamic brakes and functions in conjunction with a brake warning relay. The purpose of the relay and light is to indicate excessive braking current when operating in dynamic braking.

Due to the use of an automatic brake limiting regulator, the warning light should seldom if ever come on and then only momentarily. Correction for excessive current generally occurs automatically and quite rapidly.

In the event that the brake warning light comes on and does not go out quickly, the braking strength should be immediately reduced to prevent possible equipment damage. Excessive braking strength can be reduced by moving the throttle toward idle position.

4. Sand

This light comes on to indicate that the SANDING No. 1 TRUCK switch is closed and that sand is

being applied to the No. 1 axle. The light is not affected by the manual, emergency, or wheel slip sanding circuits.

Operating Switches

A group of switches is located along the front face of the controller, each identified by a name plate indicating switch function. The switches are in the ON position when moved upward.

Before the engine is to be started, the control and fuel pump switch must be placed ON. To obtain power from the locomotive, the generator field switch must be ON. To obtain control of engine speed, the engine run switch must be ON. These three important switches are grouped at the right side of the controller. They must be placed in the OFF position on controllers of trailing units.

Other switches control sanding, attendant call, and various lights. They are placed on as needed.

Headlight Dimming Switch

A five position switch is located on the controller to the right of the throttle. In one position it provides for dim headlights on both ends of the locomotive. In the other four positions it provides for a bright or medium headlight at either the front or the rear of the locomotive.

For this switch to function, the two headlight switches on the controller as well as the headlight circuit breaker on the switch and fuse panel must be placed ON.

Selector Lever

The controller is equipped with a selector lever, Fig. 2-5, in instances where the locomotive unit is equipped with dynamic brakes or when it is necessary to manually control transition on trailing units not equipped for automatic transition. On units so equipped, this lever serves to establish proper circuits for either of these functions. The position of the lever is indicated in the lower of the two illuminated windows located at the upper left corner of the controller front panel. The lever is spring loaded so that movement all the way in one direction will index

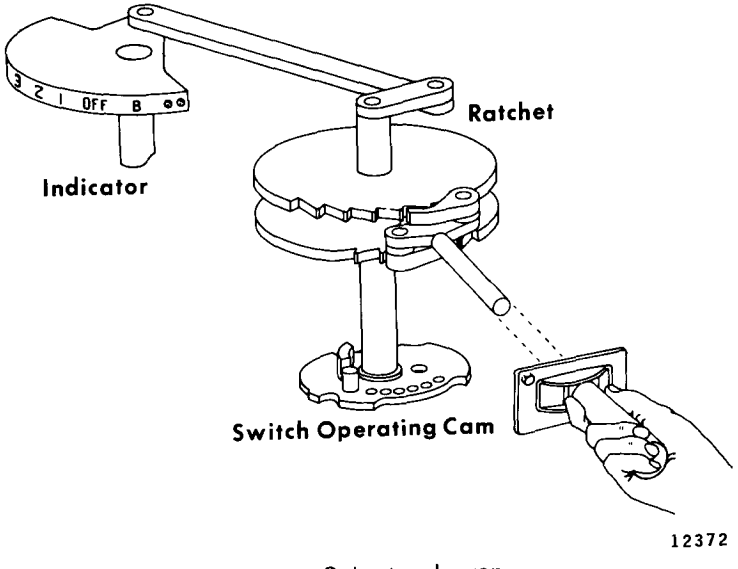


Fig. 2-5 — Selector Lever

the selector cam one notch only in that direction. It must be allowed to return to center position before indexing again in either direction. When the selector lever is indexed to the B or braking position, the dynamic braking electro-magnetic contactors are energized. In this position the throttle lever moves freely (without notching) to control a braking rheostat and dynamic braking strength.

When the lever is moved to the center or OFF position, all circuits are open. This position is used for locking the controller in unattended or trailing units.

For operation under power, the lever would be indexed to the No. 1 position. Succeeding positions such as Nos. 2, 3, and 4 would be used only when it is necessary to cause transition on any nonautomatic trailing units operating in the locomotive consist.

Throttle Lever

The throttle lever actuates switches within the controller to establish low voltage electrical circuits to the engine governor for purposes of controlling engine speed. The throttle has ten positions namely, STOP, IDLE and running speeds 1 through 8 as shown in Fig. 2-6. Each of these positions is shown in the illuminated indicator in the upper left hand corner of the controller.

To stop all engines, the throttle lever is pulled out away from the controller and then moved one step beyond IDLE to the STOP position. The IDLE position is as far forward as the throttle lever can be moved without pulling it away from the controller.

Each running notch on the throttle increases locomotive power by increasing generator excitation or engine speed or both. At time of locomotive start each notch

provides a fixed and immediate level of generator excitation. This level brings about an immediate and fixed response to throttle position during starting.

When operating in dynamic braking (selector lever in "B") the throttle lever serves as a braking handle. It moves freely without notching to control dynamic braking.

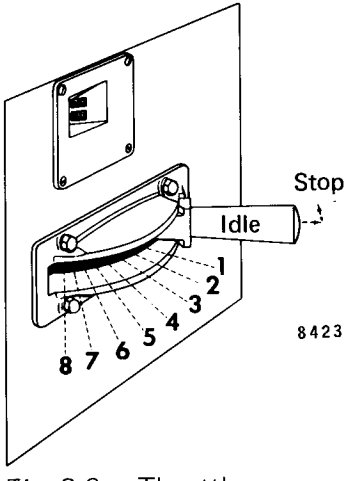


Fig. 2-6 – Throttle Lever

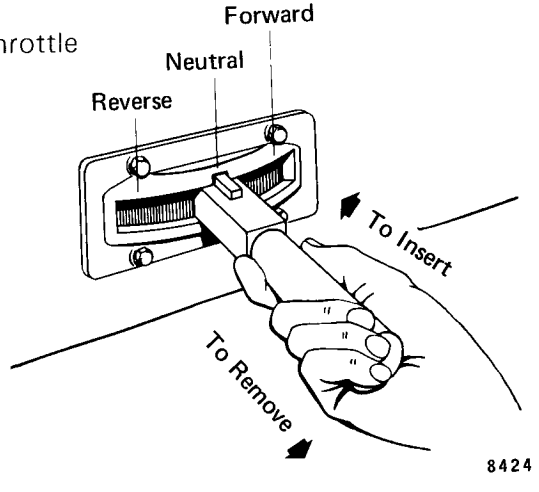


Fig. 2-7 – Reverse Lever Positions

Reverse Lever

The reverse lever, Fig. 2-7, has three positions; forward, neutral and reverse. The direction in which the locomotive moves is controlled by movement of this lever to the forward or reverse position. With the lever in neutral, no power will be developed if the throttle is opened. The reverse lever should be moved ONLY when the locomotive is standing still.

The reverse lever can be removed from the controller only when the lever is in neutral position, the throttle is in IDLE and the selector lever is in OFF. Removal of the reverse lever locks the operating controls in the controller. The reverse lever should be removed from the controllers in all but the lead unit of a multiple unit locomotive consist.

Bell Ringer

When the bell ringer is operated, compressed air is directed to the locomotive warning bell operator.

Sanding Switches

1. SANDING NO. 1 TRUCK Toggle Switch

   The signal from this switch is not trainlined. The switch provides sand to only the number 1 axle of the lead unit of a consist. This method of sanding dresses the rail and is adequate for most conditions.

2. SAND Lever Switch

   When the sanding switch lever is operated, electrical energy is directed through interlocks of reverser switchgear to operate either the forward or reverse sanding magnet valves in all units of a consist. The

basic switch may be operated in any direction for correct sanding and it is non-latching. A directional sanding switch may be provided as an optional extra, and the switch may be latching if requested by the railroad.

Electrically controlled sanding is the basic system used but since the locomotive may be operated in multiple with older units that are equipped only for pneumatic control of sanding, trainlined pneumatic control of sanding may be provided as an optional extra in addition to electrical control. In such cases, trainlined actuating pipes must be connected between units.

MECHANICAL INTERLOCKS ON THE CONTROLLER

The levers on the controller are interlocked so that:

1. With reverse lever in neutral —

   a. Throttle can be moved to any position.

   b. Selector lever can be moved to any position; OFF, or 1 through 4, except "B."

2. Reverse lever in forward or reverse —

   a. Throttle can be moved to any position.

   b. Selector lever can be moved to any position.

3. Throttle lever in IDLE position —

   a. Reverse lever can be moved to any position.

   b. Selector lever can be moved to any position.

4. Throttle lever in STOP position —

   a. Reverse lever can be moved to any position, but can not be removed from the controller.

   b. Selector lever can be moved to any position.

5. Throttle above IDLE position —

   a. Reverse lever position can not be changed.

   b. Selector lever can not be moved out of "B" into OFF or from 1 to OFF. It may however be moved as desired between 1 and 4.

6. Selector lever in OFF position —

   a. Reverse lever can be moved to any position and removed from controller if throttle lever is in IDLE position.

   b. Throttle can be moved between IDLE and STOP only.

7. Selector lever in "B" position —

   a. Reverse lever can not be moved.

   b. Throttle lever can be moved to any position.

8. Selector lever 1, 2, 3, or 4 —

   a. Reverse lever can be moved to any position.

   b. Throttle lever can be moved to any position.

   Where positions 2, 3, and 4 are incorporated in the selector for manual transition, the handle may be moved to these positions if the reverse lever is in

forward or reverse, and with the throttle in any position. Permissible movement of the throttle and reverse levers with the selector in 2, 3, or 4 is the same as with the selector in 1.

AIR BRAKE EQUIPMENT, Fig. 2-8

Basic locomotives are equipped with the type 26L air brakes. Since type 26L is standard equipment, only that type of air brake will be discussed in this manual.

The 26L air brake control equipment is located to the left of the controller. As shown in Fig. 2-8, this equipment consists of an automatic brake, independent brake, multiple unit valve (when MU control is installed), cutoff valve and a trainline air pressure

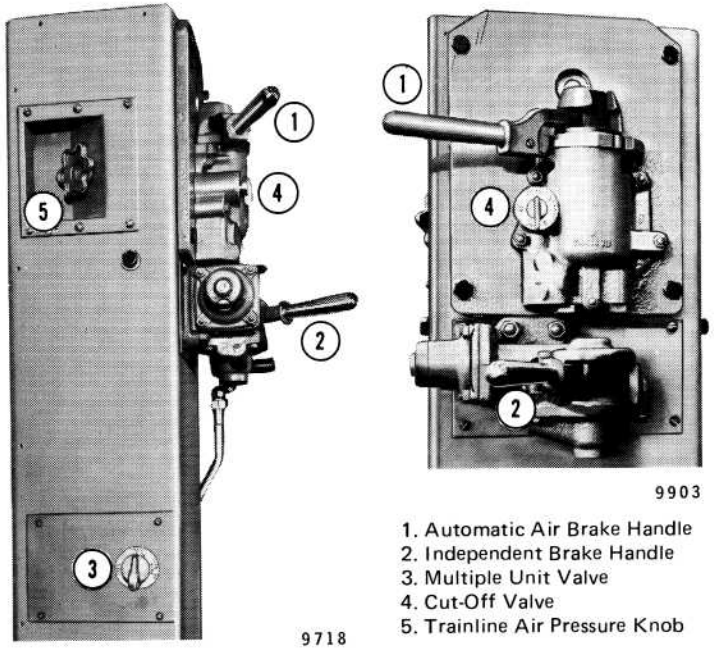


Fig. 2-8 — Air Brake Equipment

adjustment device. The dead engine feature, a part of the 26L equipment, is shown in Fig. 2-9. The cock is accessible from outside the locomotive through side doors provided. The pressure regulator is set at the maintenance point and is not to be set by the operator.

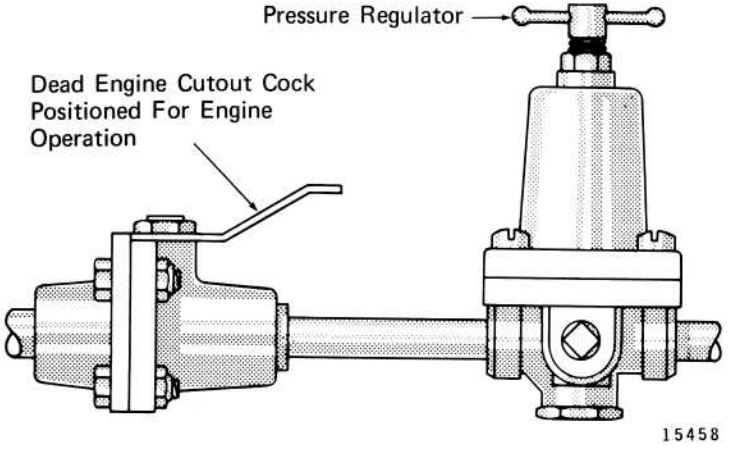


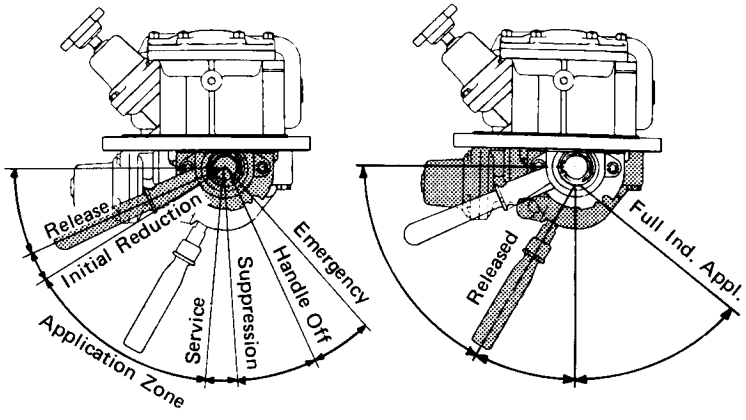
Fig. 2-9 — Dead Engine Cutout Cock And Pressure Regulator

Automatic Brake Valve

The automatic brake valve handle may be placed in any of six operating positions as shown in Fig. 2-10.

Independent Air Brake, Fig. 2-11

The independent air brake handle is located directly below the automatic brake handle. It has two positions; namely, RELEASE and FULL APPLICATION. Between these two positions is the application zone. Since this is a self-lapping brake, it automatically laps off the flow of air and maintains brake cylinder pressure corresponding to the position of the handle in the application zone.



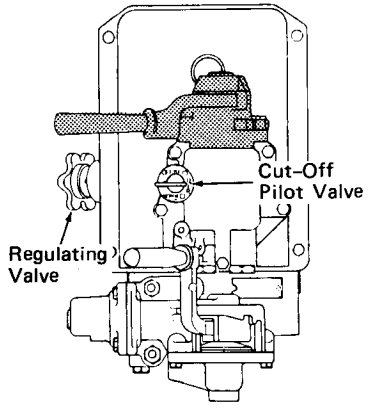


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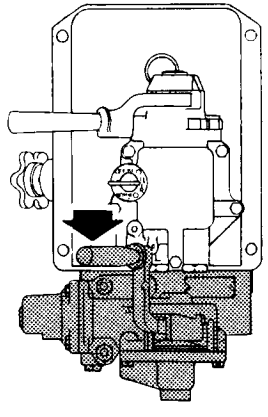
Fig. 2-10 — Automatic Brake Handle Positions



Press Lever Down To Release Automatic Application Of Locomotive Brakes

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Fig. 2-11 — Independent Brake Handle Positions

Depression of the independent brake valve handle when in the RELEASE position causes release of any automatic brake application existing on the locomotive.

Multiple Unit Valve

The multiple unit (MU-2) valve is located on the left hand side of the air brake stand, as shown in Fig. 2-8. Its purpose is to pilot the F1 selector valve which is a device that enables the air brake equipment of one locomotive unit to be controlled by that of another unit.

The basic MU-2 valve has three positions which are:

1. LEAD or DEAD
2. TRAIL 6 or 26*
3. TRAIL 24

The valve is positioned by pushing in and turning to the desired setting.

*Whenever the MU-2 valve is in the TRAIL 6 or 26 position, and if actuating trainline is not used, then the actuating end connection cutout cock must be opened to atmosphere. This is necessary to prevent the inadvertent loss of air brakes due to possible pressure build-up in the actuating line.

Cut-Off Valve

The cut-off valve is located on the automatic brake valve housing directly beneath the automatic brake valve handle. This valve has the following three positions:

1. CUT-OUT
2. FRT (Freight)
3. PASS (Passenger)

Trainline Pressure Adjustment

The trainline air pressure adjusting knob is located behind the automatic brake valve at the upper portion of the brake stand. It is shown in Fig. 2-8.

BRAKE EQUIPMENT POSITIONS

When operating locomotives equipped with 26L air brakes, the brake equipment should be positioned according to the information given in Fig. 2-12.

Type Of Service	Automatic Brake Valve	Independent Brake Valve	Cutoff Valve	Dead Engine Cutout Cock	26D Control Valve	26F Control Valve	MU2 Valve	Overspeed Cutout Cock	Deadman Cutout Cock
SINGLE LOCOMOTIVE EQUIPMENT									
Lead	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	Open	Open
Double Heading	Suppression	Release	Cutout	Closed		Graduated Direct	Lead	Open	Open
Shipping Dead In Train	Handle Off Position	Release	Cutout	Open	Relief Valve At Control Reservoir 73±2 Lbs.	Direct	Dead	Closed	Closed
MULTIPLE LOCOMOTIVE EQUIPMENT AND EXTRAS									
Lead	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	Open	Open
Trail	Handle Off Position	Release	Cutout	Closed		Graduated Direct	*Trail 6 or 26 Trail 24	Open	Open
Shipping Dead In Train	Handle Off Position	Release	Cutout	Open	Relief Valve At Control Reservoir 73±2 Lbs.	Direct Release	Dead	Closed	Closed
Double Heading	Suppression	Release	Cutout	Closed		Graduated Direct	Lead	Open	Open
Dual Control:									
Operative Station	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	Open	Open
Non-Operative Station	Handle Off Position	Release	Cutout						

*Whenever the MU2A valve is in "Trail 6 or 26" Position and if the actuating train line is not used, then the actuating end connection cutout cock must be open to atmosphere; so as to prevent the inadvertant loss of air brakes due to possible pressure buildup in the actuating line.

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Fig. 2-12 – Brake Equipment Positions