GEJ-3809B

OPERATING MANUAL

CLASS E-44
RECTIFIER TYPE
LOCOMOTIVE

FOR
PENNSYLVANIA RAILROAD

GENERAL ELECTRIC
ERIE, PA.

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

Do not order parts from illustrations in this publication.

LOCOMOTIVE AND CAR EQUIPMENT DEPARTMENT

GENERAL ELECTRIC

ERIE, PA.

8-62 (2M)

PRINTED IN U.S.A.

FOREWORD

This instruction describes the features and procedures for operating the Pennsylvania Railroad E-44 locomotives. The scope of the information covers both the ignitron and silicon rectifier equipped units.

Locomotive units No. 4400 through No. 4459 are equipped with ignitron rectifiers, water-cooled. Locomotive units No. 4460 through No. 4465 are equipped with silicon rectifiers, air-cooled.

Operation of both type equipments is basically the same. The appropriate wall chart is mounted in the operator's cab for analyzing audible and visual alarms.

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OPERATING HANDLES (See Fig. 2)

MASTER-CONTROLLER HANDLE (MCH)

This handle has an OFF position and notches 1 through 29. Handle can be advanced only:

1. When Reverse Handle is in FORWARD or REVERSE.

2. When Braking Handle is in OFF.

3. When thumb latch is triggered.

When Master-controller Handle is moved from OFF to position 1, connection to the main transformer is made. This position also sets up the SOFT START feature by applying power to only 4 of the 6 traction motors. Advancing handle to positions beyond 1 furnishes power to all 6 traction motors. Operation restricted to 18th notch under certain conditions. Refer to "Miscellaneous Operating Instructions"

REVERSE HANDLE (RH)

Has 3 positions FORWARD, OFF and REVERSE. Reverse Handle can be moved only when Master-controller Handle and Braking Handle are in OFF. Reverse Handle can be installed or removed only in its OFF position.

BRAKING HANDLE (BKH)

Has positions OFF, READY and 1 through 17. Handle can be advanced only when Master-controller Handle is in OFF and Reverse Handle is in FORWARD or REVERSE. Refer to "Dynamic Braking", for detailed instructions.

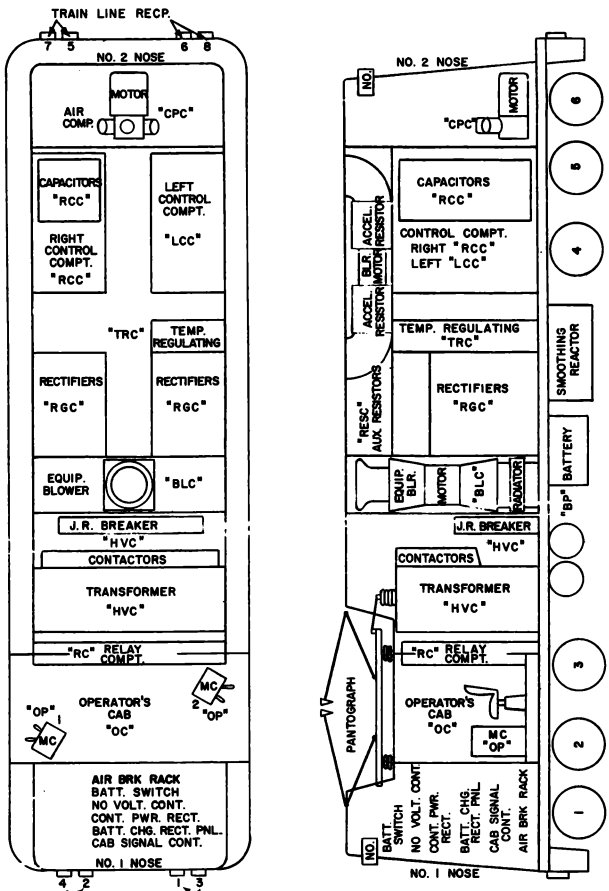
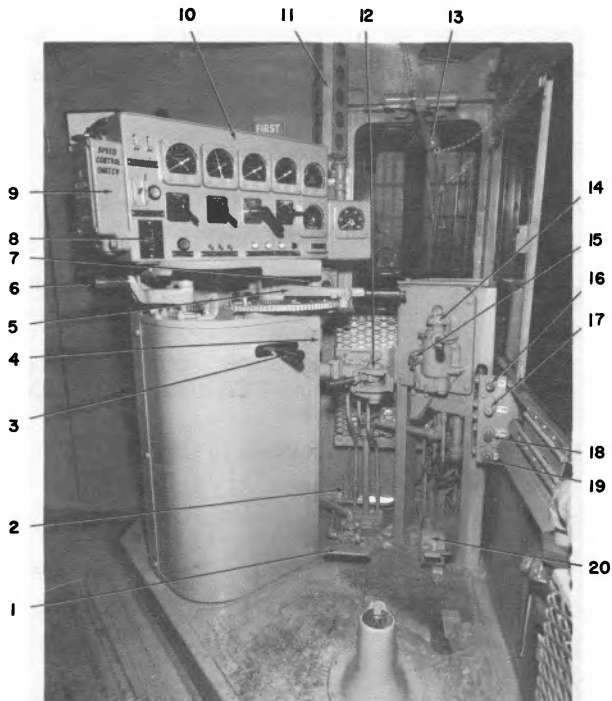


Fig. 1. Typical equipment layout (E-9774B)



1	Safety-control foot pedal	11	Cab signal
2	Warning whistle	12	Independent-brake valve
3	Reverse handle	13	Horn pull
4	Buzzer	14	Automatic-brake valve
5	Master-controller handle	15	Brake-valve cut-out cock
6	Dynamic-brake handle	16	Bell ringer
7	Alarm bell	17	Front sander
8	Heater switch	18	Rear sander
9	Speed-control switch	19	Window wiper
10	Gage panel	20	Acknowledging switch

Fig. 2. Engineer's position (E-11776)

CONTROL SWITCH (CS)

Located at Engineman's position. Switch has positions OFF, RUN and RESET.

OFF - Normal shutdown position.

RUN - Switch must be in this position before locomotive can be operated.

RESET - When handle is turned to this position it must be held for several seconds as it is spring returned to RUN. Switch in this position resets the JR breaker, ground relay (traction motors) and PCR relay, if tripped.

Pistol-grip handle is removable in OFF.

SPEED-CONTROL SWITCH

Located on side of Gage Panel. Switch has positions NOR. and REV.

NOR. - Normal running position.

REV. - Switch at Operator's Position ONLY must be in this position to operate over 15 mph in non-signal territory.

HEADLIGHT SELECTOR SWITCH

Has following positions:

1. Trailing Unit

   a. Longhood trail

   b. Shorthood trail

2. Single or Middle Unit

3. Leading Unit

   a. Shorthood lead

   b. Longhood lead

26L AIR BRAKE EQUIPMENT

The schedule 26L equipment arranged for single end, 2 station, multiple unit operation is used on this locomotive. Principal parts are:

1. 26-C Automatic-brake Valve
2. SA-26 Independent-brake Valve
3. Brake-valve Cut-Out Cock
4. 26-F Control Valve

26-C AUTOMATIC BRAKE VALVE (See Fig. 3)

The automatic-brake valve regulates brake pipe pressure to control both locomotive and train brakes. It has 6 handle positions, from left to right as follows:

Release (Running) Position

This position is for charging the equipment and releasing the locomotive and train brakes after an automatic application. This position is at the extreme left of the quadrant and is the normal position when automatic braking is not in use.

Minimum-reduction Position

This position is located to the right of the release position where the brake-valve handle reaches the first raised portion of the quadrant. With the brake-valve handle moved to this position, a light service application is obtained which causes a 6 to 8 psi brake pipe reduction.

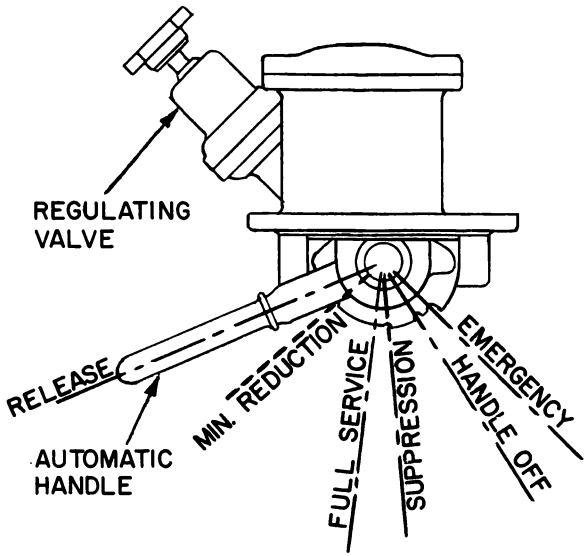


Fig. 3. Automatic brake valve handle positions (E-8924C)

Service Position

This position consists of a sector of the brake-valve handle movement to the right of the minimum-reduction position. Moving the brake-valve handle from the left to right of this sector increases the degree of brake application until at the extreme right where a full-service brake application is obtained.

Suppression Position

This position is located with the handle against the second raised portion of the quadrant to the right of the re-

lease position. This position provides a full-service brake application as with the brake-valve handle in the Service position, but in addition a suppression of any train-speed control and safety control application is obtained.

Handle—OFF Position

This position is located by the quadrant notch to the right of the suppression position. The handle is removable in this position.

Emergency Position

This position is located to the extreme right of the brake valve quadrant. This position is used for making brake valve emergency brake application.

SA-26 INDEPENDENT BRAKE VALVE

Applies and releases the brakes on the locomotive or releases the brakes on the locomotive after an automatic or emergency application.

Response is accomplished by movement of the handle from the extreme left, Release position, to the extreme right, Application position, with application zone between. An independent-brake application can only be released by movement of the brake handle towards Release position. An automatic service or emergency application can be released on locomotive by depressing the independent-brake valve handle in Release position. Independent-brake valve handle is removable in Release position.

BRAKE-VALVE CUT-OUT COCK

This cock is located on the front of the automatic brake stand and has positions IN and OUT. SELECT POSITION

FOR TYPE OF SERVICE BEING USED. The OUT position is used when locomotive is operated "dead" in a train. TO CHANGE POSITIONS PUSH IN HANDLE, HOLD DEPRESSED AND TURN.

26-F CONTROL VALVE

This valve is located in the No. 1 end nose compartment (Air-Brake Rack). When actuated by the brake valve, it operates to charge, apply and release the brakes.

A release cap is mounted on the control valve to provide either direct or graduated release of automatic brakes. Cap is to be set for direct release at all times, on subject locomotives.

HAND BRAKE

Located in No. 1 nose compartment. Hand brake is applied by turning hand wheel clockwise. Turn wheel counter-clockwise to release brakes.

AUXILIARY AIR EQUIPMENT
(See Fig. 2 and 4)

1. Horn Valve – Attached to cab sheet above engineer's position. Pulling down on cord operates horn.

2. Window-Wiper Valve – One at each engineer's position. Window wiper is operated and speed increased by turning knob clockwise. Turning knob to extreme counter-clockwise position causes wiper to move to the parked position.

3. Pantograph-hand Air Pump – Located in No. 1 nose compartment. Used to unlock pantograph ONLY when there is no air in system. (See 6a).

4. Sander Valve – Two at each operator's position. Controls front and rear sanding. Pull out to operate.

5. Bell-ringer Valve – One at each operator's position. Pull out to operate.

6. Pantograph-control Cocks – Four located on left wall of No. 1 nose compartment. (See Fig. 4.) The two upper cocks control DOWN movement of Front and Rear pantographs. With these handles in horizontal position, air will

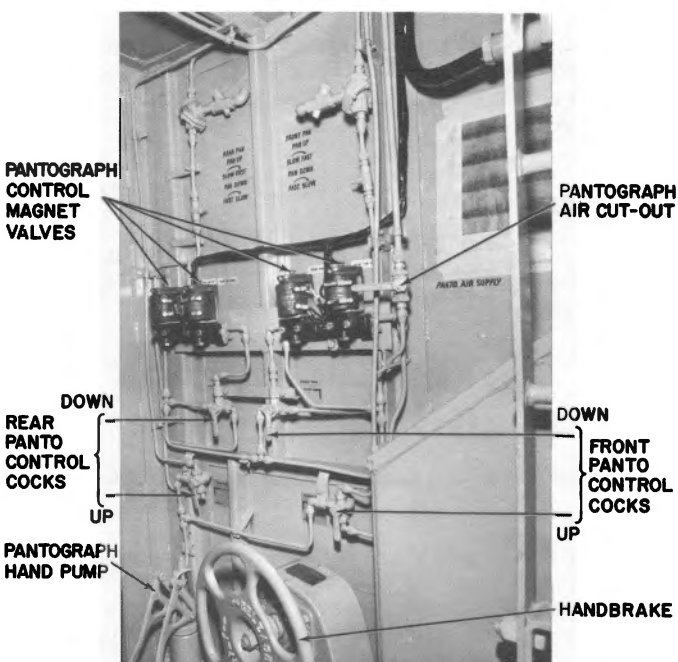


Fig. 4. Air piping (No. 1 nose compartment) (E-11777)

be applied to DOWN cylinders at all times. The two lower cocks control UP movement of Front and Rear pantographs.

All control cock handles should point down for normal locomotive operation. For other conditions proceed as follows:

a. No Air Supply – To raise pantographs when air supply is exhausted, turn preferred lower control cock to the right. Operate hand-air pump until pantograph has unlatched and engaged trolley wire. Then turn control cock to normal operating position.

b. Loss of Power – To lower pantograph after loss of power or electrical control failure, turn preferred upper control cock to the left. After pantograph has lowered and latched, turn control cock to normal operating position unless it is desired to hold pantograph in lowered position. MAIN AIR RESERVOIR SUPPLY MUST BE SUFFICIENT TO CAUSE PANTOGRAPH TO LATCH.

c. Pantograph Control – Upper cocks may be positioned for selective control of pantographs. Both UP switches should be used to raise pantographs.

INTER-CAB SIGNALLING

Signal is operated by pressing ATTENDENT CALL button on engineer's gage panel in operator's cab. (See Fig. 5.)

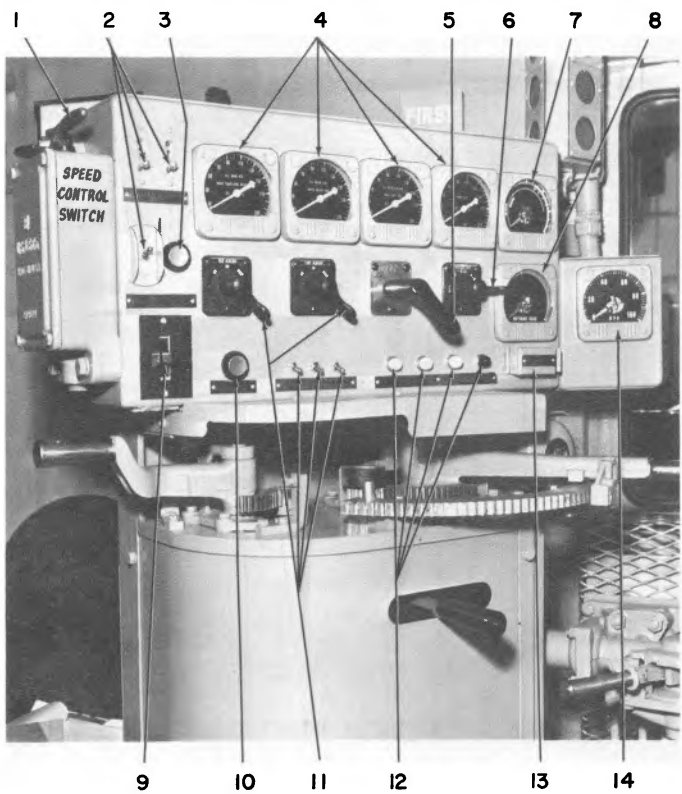
INDICATING LIGHTS

Indicating lights located on Engineer's Gage Panel (See Fig. 5) in operator's cab are as follows:

1. Power Knockout
2. Wheel Slip
3. Control Lock
4. Overload (Red)

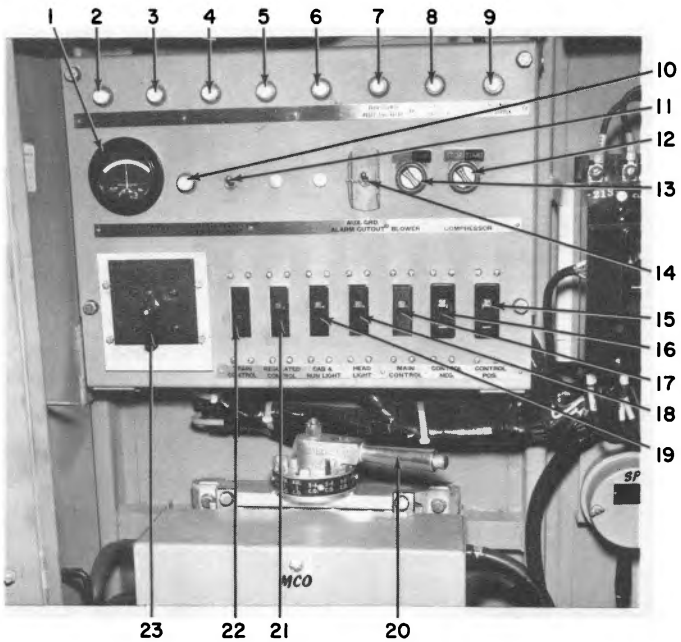
Indicating lights located in Relay Compartment, (See Fig. 6) in operator's cab are as follows.

1. Transformer Ground
2. Rectifier Ground
3. Traction-Motor Ground
4. Auxiliary Ground
5. JR
6. Transformer-Protective Relay
7. Transformer Over-Temperature
8. No-Unregulated D-c Supply
9. No-Regulated D-c Supply



1 Speed-control switch
2 Pantograph-control switches
3 Attendant call
4 Air gages
5 Main-control switch
6 Load-indicator transfer switch
7 Traction-motor load indicator
8 Notching guide
9 Heater switch
10 Safety-control switch
11 Light switches
12 Warning lights
13 Emergency-ground switch
14 Speed indicator

Fig. 5. Engineer's gage panel (E-11778)



MOTOR CUT-OUT SWITCH POSITIONS (Right to Left)

1. All in
2. 1-2 cut-out
3. 3-4 cut-out
4. 5-6 cut-out
5. RBL 2 (No. 2 blower and motors 3-4, 5-6 cut-out)
6. RBL 1 (No. 1 blower and motors 1-2, 3-4 cut-out)
7. All-out

Fig. 6. Switch and indicating light panel (relay compartment) (E-11779)

NOMEMCLATURE FOR FIG. 6

1	Battery-charging indicator	14	Auxiliary-ground-alarm cut-out
2	Transformer ground	15	Control positive
3	Rectifier ground	16	Control negative
4	Traction-motor ground	17	Main control
5	Auxiliary ground	18	Headlight
6	JR breaker trip	19	Cab and run light
7	Transformer protective-relay	20	Motor cut-out switch
8	Transformer over-temperature	21	Regulated control
9	No-unregulated d-c supply	22	Train control
10	No-regulated d-c supply	23	M. U. headlight set-up switch
11	Relay-compartment lights		
12	Compressor switch		
13	Blower switch		

When a lamp comes on or bell sounds at operator's position, abnormal conditions are indicated in one of the locomotive units in the consist. A lamp or lamps in the relay compartment indicates abnormal conditions exist in that unit.

POWER KNOCKOUT

1. POWER-KNOCKOUT light and loss of power without other lights, indicates one or more of the following conditions:

a. Equipment Blower not operating. Start the blower motor.

b. Power Cut-out Relay (PCR) tripping, due to excessive uncorrected wheel slip. Notch to OFF and move Control Switch to RESET until light goes out. Notch up again.

c. Power Cut-out Switch (PCS) tripping due to emergency brake application from locomotive. Notch Master-controller Handle (MCH) to off and release air brakes after emergency has cleared.

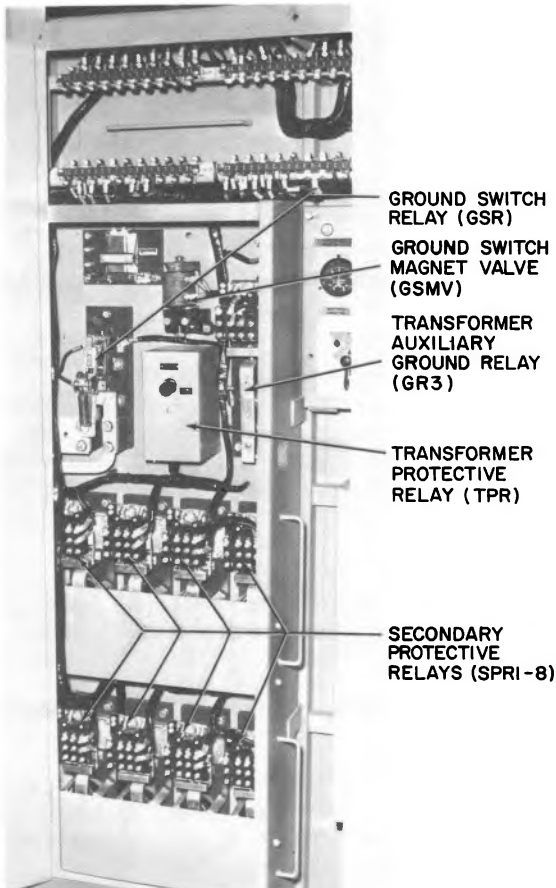


Fig. 7. Relay compartment (left side) (E-9778A)

d. Dynamic-Brake Cut-out Switch (DBCO) tripping, due to train initiated emergency brake application. Notch Dynamic-Brake Handle (BKH) to OFF. Recapture air brakes and release after emergency has cleared.

e. No excitation due to failure of Excitation Contactor (REC) to pickup. Notch to OFF and then notch up again.

NOTE: Power-Knockout Light does not indicate this condition when handles are on OFF position.

f. Water-pump Breaker (WPB) tripped. Notch to OFF and reset breaker, then notch up again. Check water level gauge. (See Fig. 12.)

g. Low-water temperature. Check to make certain water temperature is within normal operating range, 90 to 115 F and that Water-Pump Heater Breaker (WHB) has not tripped. If (WHB) is tripped, reset breaker. Be sure water temperature is within normal operating range, then notch up again.

2. POWER-KNOCKOUT light at operator's position and TRANSFORMER-PROTECTIVE RELAY light in relay compartment indicates that Transformer-Primary Protective Relay (TPR) or Transformer-Secondary Relays (SPR1-8) have tripped, or Emergency-Ground Switch was closed. This causes grounding and lowering of pantograph on affected unit only by tripping Ground-Switch Relay (GSR). All a-c power is lost. Notch to OFF. Inspect locomotive for evidence of trouble, especially if there has been an explosion, smoke or fire. If no defects are found, reset TPR or SPR and GSR noting which relay had tripped. Determine that pneumatic-ground contactor on roof is open.

If main reservoir air pressure is above 60 lb, a pantograph may be raised by use of UP button.

If a second GSR relay operation occurs, report to Superintendent of Transportation and be governed by instructions.

3. POWER-KNOCKOUT light at operator's position and JR light in the relay compartment of the affected unit, indicates a rectifier arc-back, fault overload current or tripped JR breaker. Traction-motor power is lost. Notch to OFF. Move control switch to RESET and release handle. Indicating lights should go out.

Notch up. On units No. 4400 through 4459 if JR breaker trips again, check Anode Heater Breaker (AHB). Also check rectifier cooling water temperature as described under OVERLOAD. Reset WATER PUMP MOTOR BREAKER (WPB)., in relay compartment to assure that water pump has not stopped. If this action repeats, notify Superintendent of Transportation.

On units No. 4460 through 4465, if JR breaker trips immediately, do not continue resetting. Notify Superintendent of Transportation.

WHEEL SLIP (See Fig. 5)

When Motoring, light at operator's position and sounding buzzer indicates that wheels are slipping. Immediately notch back on Master-controller Handle (MCH) and sand rails until slipping stops. Notch back up again when practicable. Traction motor power is not lost.

If no action is taken within 6 seconds after warning is indicated, traction-motor power will be removed automatically on slipping unit.

When in Dynamic Braking, light at operator's position and sounding buzzer indicates that maximum braking cur-

rent has been exceeded or wheels are sliding. Notch back on Dynamic-braking Handle to reduce current.

CONTROL LOCK

Rectifier Ground (See Fig. 8)

1. Single or Leading Unit. A CONTROL-LOCK light at operator's position (with alarm bell), plus TRACTION-MOTOR GROUND and RECTIFIER GROUND lights in relay compartment, indicates a ground exists in rectifier circuits. Traction-motor power is lost. Notch Master-controller Handle to OFF and move control switch to RESET until TRACTION-MOTOR GROUND light goes out and bell stops ringing. CONTROL-LOCK and RECTIFIER GROUND lights will remain on. Manually reset RECTIFIER-GROUND AUXILIARY RELAY (RGRA) in relay compartment, by pushing up on reset block and immediately releasing. After warning lights go out notch up on Master-controller Handle (MCH). If this condition is repeated, notch to OFF and reset with CONTROL SWITCH. CONTROL-LOCK and RECTIFIER-GROUND lights will stay on. Notch up on Main-controller Handle. Locomotive can be operated to position 18 on Master-controller Handle. Controller lock prevents operation above this notch. Operate in emergency only. Locomotive will be running with no ground protection. NOTIFY SUPERINTENDENT OF TRANSPORTATION.

2. Trailing Unit. When units are being operated in multiple and a rectifier ground occurs, the GROUND alarm bell and CONTROL-LOCK light will come on, at each operator's station. The TRACTION-MOTOR GROUND and RECTIFIER GROUND lights will come on, only in affected unit. Use same correction as for single or leading unit. See "Operating with Rectifier Ground" under MISCELLANEOUS OPERATING INSTRUCTIONS.

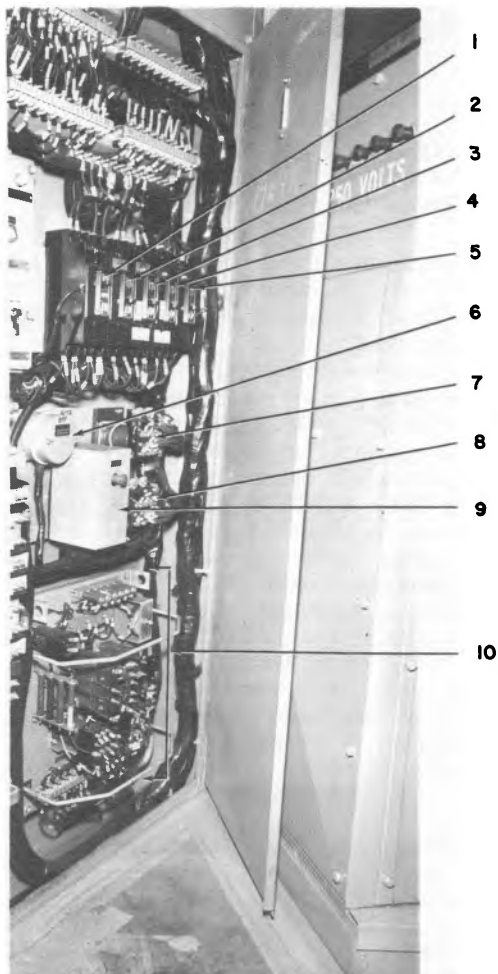


Fig. 8. Relay compartment (right side) (E-11780)

NOMENCLATURE FOR FIG. 8

1 Pyranol-pump breaker (PPB)
2 Cab-heater breaker (CHB)
3 Anode-heater breaker (AHB)
4 Excitation-transformer breaker (ETB)
5 Water-pump breaker (WPB)
6 Speed-indicator resistor box (SPP)
7 Rectifier-ground auxiliary relay (RGRA)
8 Transformer-auxiliary ground relay (TGRA)
9 Compressor and blower overload relay (BCTR)
10 Wheel-slip panel (WSP)

3. On units No. 4460 through 4465 JR breaker light is obtained for items 1 and 2 above.

Transformer Ground (See Fig. 8)

1. Single or Leading Unit. A GROUND alarm bell and CONTROL LOCK light at operator's position plus TRACTION-MOTOR GROUND, RECTIFIER GROUND and TRANSFORMER GROUND lights in relay compartment, indicates that a ground exists in the transformer. Traction-motor power is lost. Notch Controller Handle to OFF. Turn Control Switch to RESET. Then manually reset TRANSFORMER-GROUND AUXILIARY RELAY (TGRA) and RECTIFIER-GROUND AUXILIARY RELAY (RGRA) in relay compartment. To reset these relays, push up on reset block and release immediately. Notch up. If TGRA relay trips again, transformer is grounded. DO NOT CONTINUE RESETTING RELAY. LOCOMOTIVE CANNOT BE POWERED. NOTIFY SUPERINTENDENT OF TRANSPORTATION.

2. Trailing Unit. When units are being operated in multiple and a transformer ground occurs, the GROUND alarm bell and CONTROL LOCK lights will come on at

each operator's station. The TRACTION-MOTOR GROUND, RECTIFIER GROUND and TRANSFORMER GROUND lights will come on, only in the affected unit. Use same correction as for single or leading unit.

3. On units No. 4460 through 4465, JR breaker light is obtained for Items 1 and 2 above.

OVERLOAD (See Fig. 5)

Light (Red) at operator's position and buzzer sounding, indicates that rated traction motor horsepower is being exceeded. Notch back on Master-controller Handle until light goes out and buzzer stops sounding. (See GAGES AND INSTRUMENTS).

Light (Red) at operator's position and TRANSFORMER OVER-TEMPERATURE light in relay compartment indicates that rectifiers, tubes or transformer are overheating.

> **WARNING:** HIGH VOLTAGE ELECTRICAL EQUIPMENT IS HOUSED IN TEMPERATURE REGULATING COMPARTMENT AREA. DO NOT ENTER COMPARTMENT UNTIL PANTOGRAPHS ARE LOWERED AND LATCHED. REFER TO "SAFETY PRECAUTIONS".

If rectifier tubes are overheating, (locomotive units No. 4400 through 4459), check rectifier cooling water temperature gage in temperature regulating compartment. Normal operating temperature is 90 to 115 F. If temperature is high notch back on Master-controller Handle. Check that water is visible in sight gage glass of cooling water tank. Also check that Pyranol* Pump Breaker PPB is closed and pump is operating.

*Reg. Trade-mark of General Electric Co.

TRANSFORMER OVER-TEMPERATURE light will indicate only in locomotive unit affected. Traction motor power is not lost. Run locomotive at reduced throttle.

TRACTION MOTOR GROUND

Single or Leading Unit

A GROUND alarm bell at operator's position and a TRACTION-MOTOR GROUND light in relay compartment, indicates that a ground exists in the traction motor circuits. Traction-motor power is lost. Notch Main Handle to OFF and move control switch to RESET until light goes out and bell stops ringing. Notch up again. If ground repeats, try to operate locomotive in each position of traction motor cut-out switch on affected unit only, until ground is eliminated. Notch Main Handle to OFF and turn control switch to RESET, each time motor-cut-out switch is moved to a new position.

Trailing Unit

When units are being operated in multiple and a traction-motor ground occurs in any unit, the GROUND alarm bell at each operator's station will ring. The TRACTION-MOTOR GROUND light in relay compartment will come on, only in affected unit. Use same correction as for Single or Leading Unit.

Units No. 4460 through 4465

JR breaker light is on momentarily.

AUXILIARY GROUND

A GROUND alarm bell at operator's position and Auxiliary GROUND light (See Fig. 6) in relay compartment indicates a ground exists in auxiliary circuits. Traction motor power is not lost.

Reset AUXILIARY-GROUND RELAY (GR3) in left side of relay compartment. If relay trips again, locomotive may be operated normally. Break seal and throw Auxiliary-Ground Alarm Switch to OFF in affected unit. Report on MP-62E. Shop must correct fault at next turn-around point, restore Auxiliary-Ground Alarm Switch to normal and seal. When ground is cleared, GR3 relay must be manually reset.

NO UNREGULATED D-C SUPPLY (See Fig. 6)

Light at relay compartment indicates that NO-VOLTAGE Relay (NVR) is open. This is a normal indication when locomotive is not energized. If light does not go out when locomotive is energized, report failure.

NO REGULATED D-C SUPPLY (See Fig. 6)

Light at relay compartment of affected unit only, indicates that NO-REGULATED VOLTAGE Relay (ACR) is open. This is a normal indication when locomotive is not energized. If light does not go out when locomotive is energized, report failure.

RECTIFIER MISFIRE LIGHTS (See Fig. 9) (Locomotive Units No. 4400 through 4459)

Located in rectifier compartments on each side of locomotive. These lights can be seen through small windows on compartment doors. Continuous flashing indicates

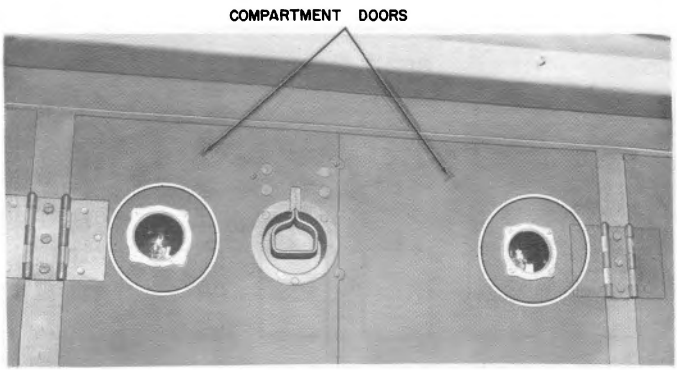


Fig. 9. Rectifier Misfire lights (locomotive units 4400–4459) (E-9780)

proper firing of rectifier tubes. A gap in the rhythm or continuous light, indicates a misfire. Inspection of these lights shall be made at intervals by the engine crew. Report this condition for correction.

NOTE: Refer to Fig. 10 for location and identification of misfire lights.

Rectifier Misfire Lights may be Checked as follows: With locomotive equipment prepared for normal operation, move Reverse Handle to FORWARD or REVERSE and Dynamic Brake Handle to No. 2 position. Misfire lights should operate.

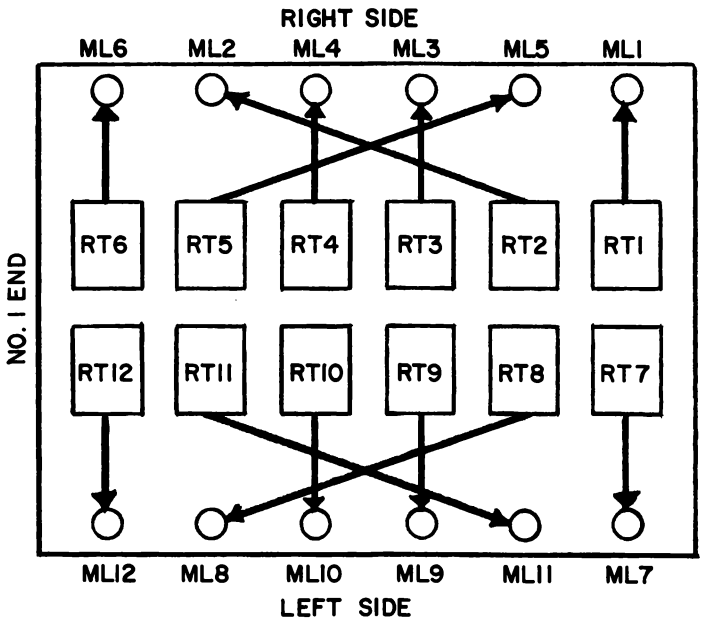


Fig. 10. Rectifier misfire lights—rectifier compartment (locomotive units 4400–4459) (E-9799)

CIRCUIT BREAKERS
(See Fig. 6)

1. When an overload or short circuit occurs, breaker will "trip" and open the circuit. The handle moves to the center position to indicate a tripped breaker.

2. Reset breaker by moving handle to OFF then to ON. In some cases, it may be necessary to wait for breaker to cool before the breaker can be reset.

BREAKERS	LOCATION
Cab Signal (CSMGB)	Relay Compartment
Regulated Control (RCB)	Relay Compartment
Running and Compt. Lights (RLB)	Relay Compartment
Headlights (HLB)	Relay Compartment
Main Control (MCB)	Relay Compartment
Control Negative (CNB)	Relay Compartment
Control Positive (CPB)	Relay Compartment
Pyranol Pump (PPB)	Relay Compartment
Cab Heater (CHB)	Relay Compartment
*Anode Heaters (AHB)	Relay Compartment
*Excitation Transformer (ETB)	Relay Compartment
*Water Pump (WPB)	Relay Compartment
*Rect. Water Heaters (WHB)	Right Control Compartment

SAFETY CONTROL

A pedal located at each operator's position must be depressed at all times during locomotive operation. If the operator's foot is removed from the pedal for longer than 6 seconds, brakes will apply at a service rate and the

*Applies to locomotive units No. 4400 through 4459

Power Cut-out Relay (PCR) will trip which de-energizes the locomotive traction power circuits. A warning whistle is provided in the operator's cab to signal that the pedal has been released. A safety control button on the engineer's gage panel can be used to nullify the use of the pedal while transferring foot pressure during operation of the locomotive.

A safety-control brake application can be suppressed by making a brake application sufficient to provide 25 or more pounds brake cylinder pressure before expiration of the 6 second warning delay period.

Once a safety-control brake application has been initiated the control must be reset in the following manner:

1. Move Main or Braking Handle on Master Controller to OFF.

2. Move automatic-brake valve handle to Suppression and leave in this position until application gage hand shows not less than 125 lb pressure. Then move automatic brake valve handle to Release position.

NOTE: Safety-control cut-out cock is located in air brake rack in nose compartment. Refer to Railroad regulations for instructions regarding this cut-out cock.

TRAIN-SPEED CONTROL

Train-speed Control imposes the following maximum speed limits, according to cab signal indication:

CAB SIGNAL INDICATION	MAXIMUM SPEED LIMIT
Clear	No Restriction
Approach Medium	45 mph
Approach	30 mph
Restricting	20 mph

When cab signal changes to a less favorable indication and speed is above that permitted by the governor setting, a manual brake suppression must be initiated before six seconds have elapsed in order to forestall a Speed-control brake application. When speed has been reduced to the limit imposed by cab signal indication, acknowledging switch must be operated. When the timing valve pressure has been restored to at least 35 lb, the brakes may be released. If brakes are released before speed has been reduced to that permitted by cab signal indication, Speed Control application will result.

A Train-speed Control brake application can be temporarily suppressed by making increased service reductions with the automatic-brake valve sufficient to keep the suppression pressure above 17 lb. In order to establish permanent suppression, the automatic-brake valve handle must be placed in SUPPRESSION position.

Once a Train-speed Control application has been initiated, the automatic-brake valve should be immediately placed in SUPPRESSION position to limit the application to a Full Service, otherwise the brake pipe pressure will continue to reduce to zero at a service rate. When application pressure builds up to approximately 125 lb, the acknowledging switch must be operated and when Timing-valve gage indicates about 40 lb pressure, the brakes can be released.

BATTERY-CHARGE INDICATOR (See. Fig. 6)

Pointer indications right of center indicate charging current (green). Pointer indications left of center indicate discharge current (red).

TRACTION-MOTOR LOAD INDICATOR (See Fig. 5 and 11)

This indicator is a color band instrument to be used as a guide for correct locomotive operation.

By turning the handle on the Load Indicator Transfer Switch (on engineer's gage panel) the operator can read the load on each pair of traction motors.

MOTORING BAND (0–23 mph)

The GREEN zone represents normal operation. In this zone, operating time is unrestricted, provided the overload light is not on and the notching guide is not in the RED zone.

The YELLOW zone is restrictive. Operation in this zone is permissible for short periods of time only. Numerals adjacent to the yellow zone indicate the maximum times in minutes for such operations. These times are not accumulative. When the short time overload has been used for the full allowable time, a "cooling-off" period must be provided. The "cooling-off" period is obtained by reducing the current to the GREEN zone for 30 minutes.

DYNAMIC BRAKING BAND

The braking band is the operator's guide for applying the dynamic brakes.

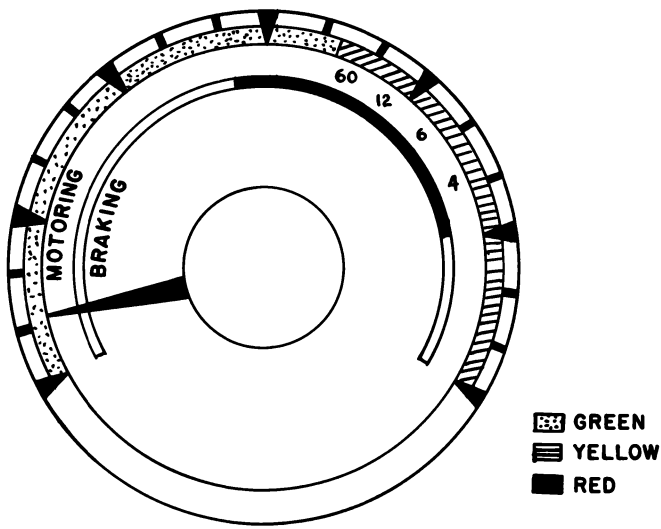


Fig. 11. Traction motor load indicator (E-11770)

Braking is permissible in the GREEN zone.

Do not brake in the RED zone of the Braking Band. Excessive braking in this zone is indicated by the buzzer and wheel slip light.

NOTCHING GUIDE
(See Fig. 5)

Above 23 mph, the GREEN zone represents normal unrestricted operation and the RED zone indicates locomotive overload. The overload is also indicated by the red overload light and the buzzer. At any time overload is indicated, CORRECTION MUST BE INITIATED WITHIN 18 SECONDS AFTER OVERLOAD OR LOSS OF TRACTION POWER WILL RESULT.

SPEED INDICATOR
(See Fig. 5)

Has a scale of 0-100 mph.

Located at operator's position.

Maximum locomotive speed-70 mph.

AIR GAGES
(See Fig. 5)

MAIN RESERVOIR AND EQUALIZING RESERVOIR

1. Normal main-reservoir pressure – 120 to 140 lb.

2. Proper equalizing-reservoir pressure – Should correspond with regulating valve setting and brake pipe pressure.

BRAKE CYLINDER AND BRAKE PIPE

1. Proper brake-cylinder pressure – 0 while in running position. Approximately 45 lb when independent brakes are fully applied.

2. Proper brake-pipe pressure – Should correspond with regulating valve setting and equalizing reservoir pressure.

APPLICATION PIPE AND SUPPRESSION PIPE

1. Application Pipe – During normal operation main reservoir pressure is registered. When a penalty occurs, caused by train speed control or safety control, the warning whistle will sound and gage pressure will start reducing.

2. Suppression Pipe – Registers the amount of suppression in accordance with the brake pipe reduction.

TIMING RESERVOIR

Normally registers 45-lb pressure. When timing valve is de-energized, this pressure diminishes to zero.

CONTROL AIR

1. Control-air Gage and reducing valve is located in Compressor Compartment. Proper operating pressure is 90 lb. The locomotive will not operate below 45 lb pressure.

2. A second gage with reducing valve is located on the Type 17KM45 controller. This device is located in the left Control Compartment. The proper pressure for this gage is 60 lb. Refer to "Safety Precautions".

MAIN-RESERVOIR GAGE

1. Location-Compressor Compartment

2. Should read same pressure as main-reservoir gage at operator's position.

3. Used to read main-reservoir pressure when setting compressor governor.

RECTIFIER COOLING WATER TEMPERATURE GAGE (See Fig. 12)

Located on Coolant tank in temperature-regulating com partment.

Scale - 20 to 240 F.

Normal operating temperature is 90 to 115 F.

RECTIFIER COOLING WATER LEVEL GAGE GLASS (See Fig. 12)

Water level must be between level marks with pump running.

NOMENCLATURE FOR FIG. 12.

1 Rectifier water-pressure switch (CWP)
2 Water-level gage
3 Cooling-water tank
4 Rectifier high-water temperature switch (HWT)
5 Temperature gage
6 Water pump and motor
7 Low-water temperature switch (LWT)
8 Water-heater thermostat (HCT)
9 Water-drain valve

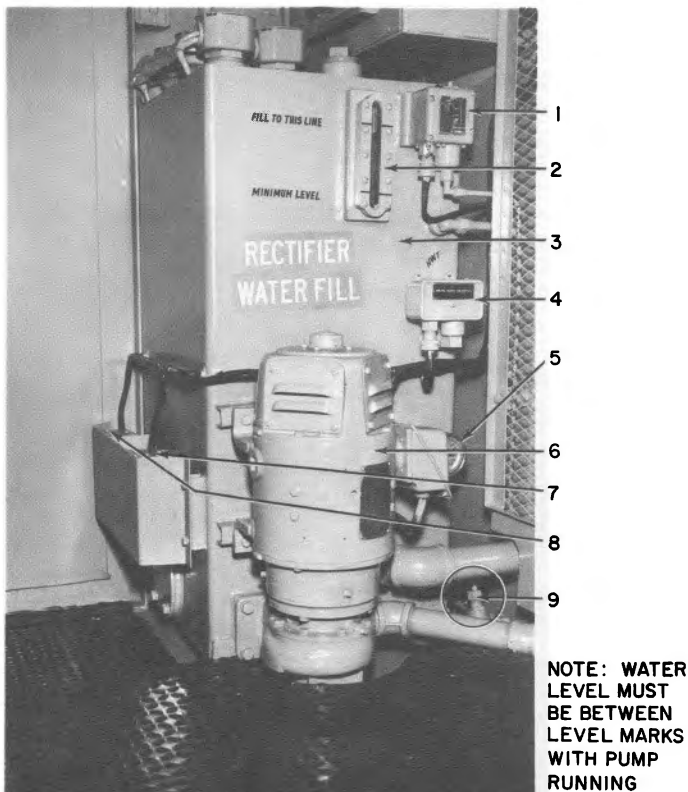


Fig. 12. Water temperature regulating compartment (locomotive units 4400–4459) (E-11781)

TRANSFORMER TEMPERATURE GAGE (See Fig. 13)

Located on transformer. May be located on either side of transformer casing.

Scale – 0 to 120 C.

Red Pointer with dot gives maximum reading. Other pointer shows actual temperature.

Maximum operating temperature 90 C.

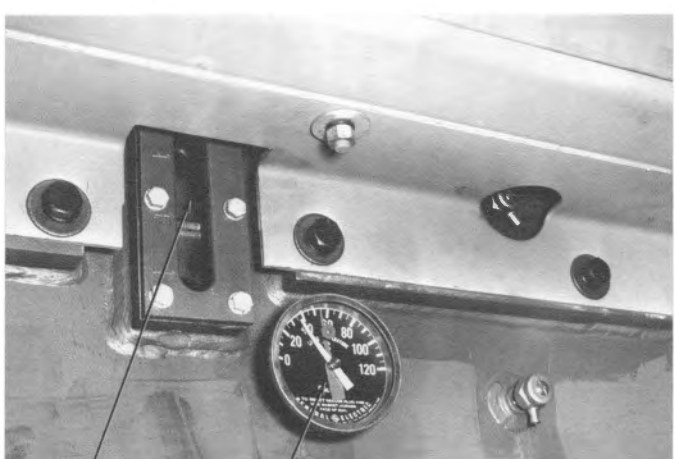


Fig. 13. Transformer temperature gage (right side of transformer) (E-11782)

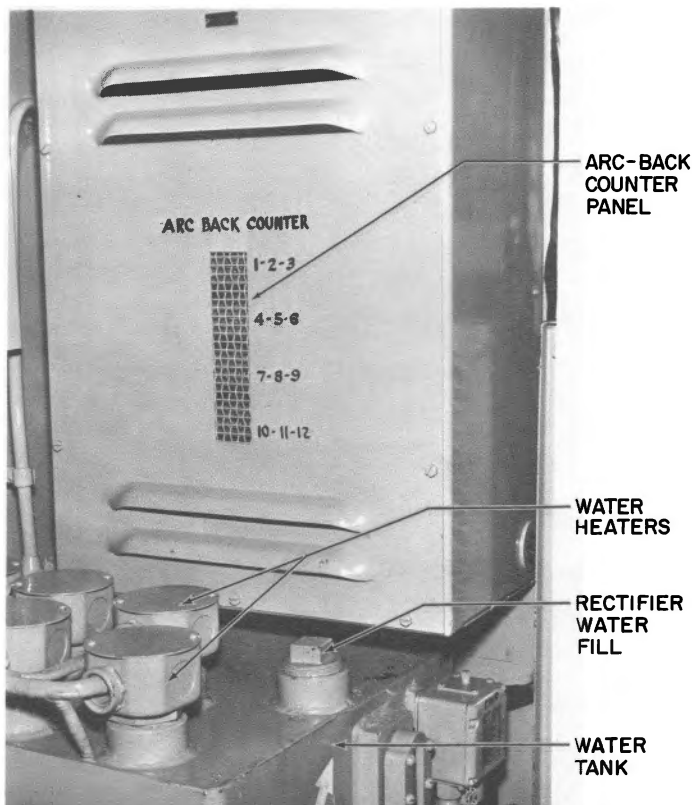


Fig. 14. Temperature regulating compartment (locomotive units 4400–4459) (E-9782A)

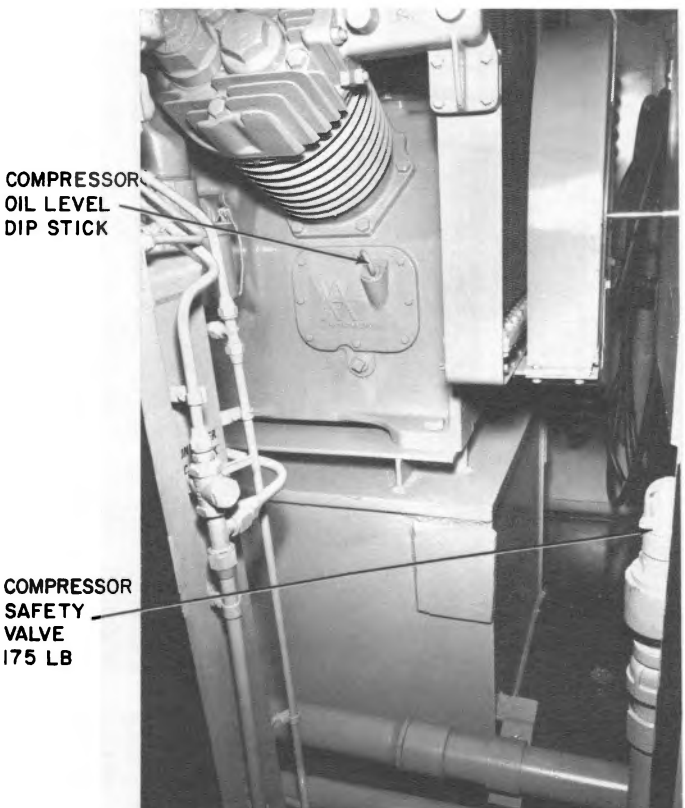


Fig. 15. Air compressor details (right side of compressor compartment) (E-11783)

PREPARATION FOR OPERATION

BEFORE BOARDING

1. Check for loose or dragging parts.

2. Check for liquids leaking from external piping.

3. Make certain sand boxes are filled.

4. Prepare locomotive-end connections for desired operation (see Fig. 16).

AFTER BOARDING

1. With pantograph lowered and latched down:

   a. Close Battery Switch, located in No. 1 nose. (See Fig. 20.)

   b. Check that motor cut-out switch is in normal operation position (ALL IN). Switch is located in relay compartment.

   c. Close all circuit breakers and switches in relay compartment. Check that Auxiliary-alarm Switch is in the Normal position and sealed.

   d. Check supply of rectifier coolant in sight glass on coolant tank located in temperature-regulating compartment.

   e. Check that Rectifier Water-heater Breaker (WHB) located in right control compartment, is closed.

   f. Check that all doors on compartment cabs are closed and latched.

2. Unground pantograph. Check that manual ground switch handles are in OPEN position. Note that TRANSFORMER PROTECTIVE RELAY light is out.

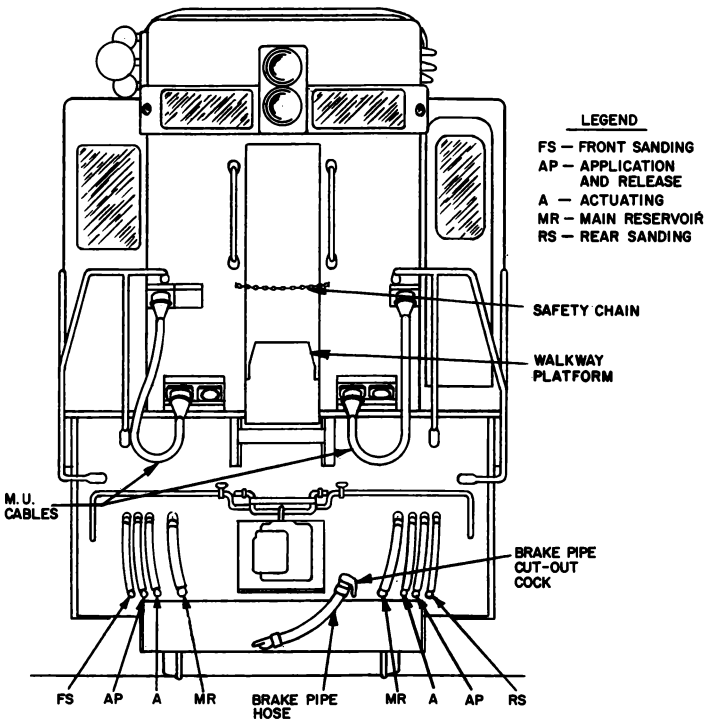


Fig. 16. Locomotive end connections (E-9786B)

a. If there is no air in the locomotive air system, position two-way cocks in proper position for hand pump operation. This will release pantograph and permit it to engage trolley wire. (See Auxiliary Air Equipment.)

b. When air is available, pantograph on each unit is raised by having control switch (CS) in RUN and holding desired pantograph UP switch in closed position. (See Pantograph-Control Cocks.)

c. If pantograph cannot be raised, Check Dead Sequence Switch in right Control Compartment of each unit.

NOTE: See ELECTRICAL OPERATING INSTRUCTIONS P.R.R. CT-290 for Pantograph Operation. Pantograph emergency pole is located under walkway on left side.

3. Turn handle on Control Switch to RESET and hold for approximately 3 seconds, then release. The POWER KNOCKOUT light at operator's position should go out. No indicating lights should be on at this time.

4. Place SPEED CONTROL switches in NORMAL position and acknowledge cab signal.

5. Install brake valve handles. Place automatic brake valve handle in RELEASE position and independent brake valve handle in FULL APPLICATION position.

6. Check for proper position of air cocks. (See Fig. 17 through 24.)

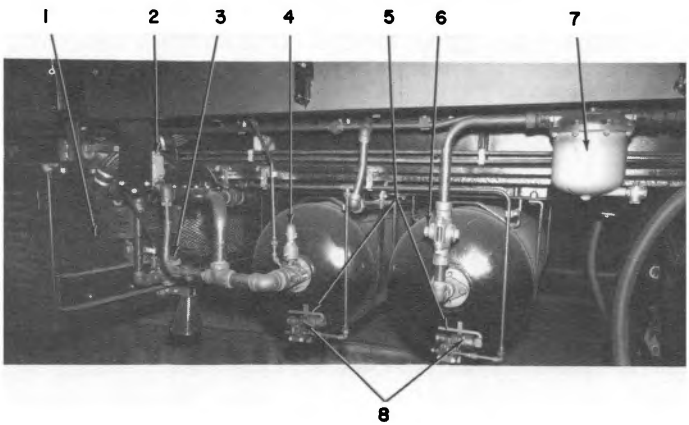
7. Before moving locomotive:

a. Install reverse handle.

b. Check main-reservoir pressure.

c. Make Brake application. Release hand brake.

d. Test sanders.



1 Battery compartment
2 M. R. cut-off valve
3 Compressor-dump valve
4 M. R. safety valve (150 lb)
5 Manual-condensate drains
6 M. R. cut-off cock
7 "H" filter
8 Automatic-condensate drains

Fig. 17. Air piping (right side of locomotive) (E-11784)

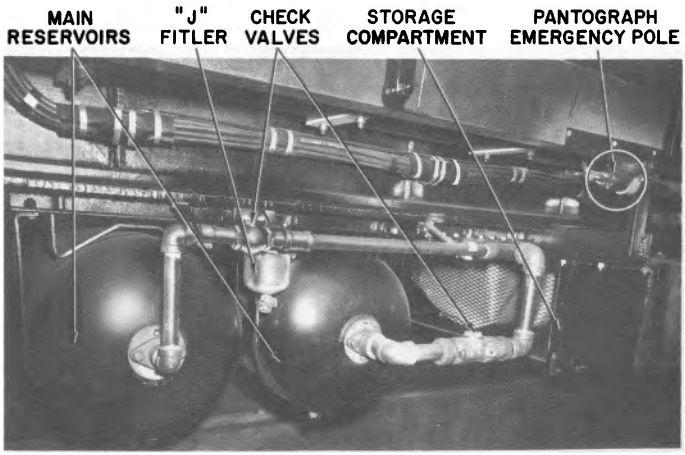


Fig. 18. Air piping (left side of locomotive) (E-11785)

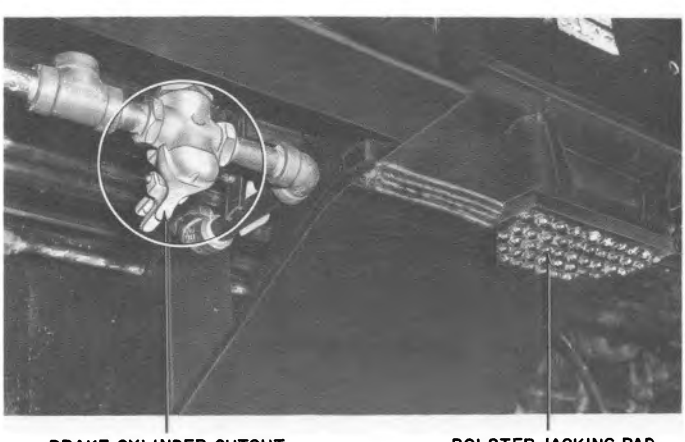


Fig. 19. Brake cylinder cut-out cock (E-9795)

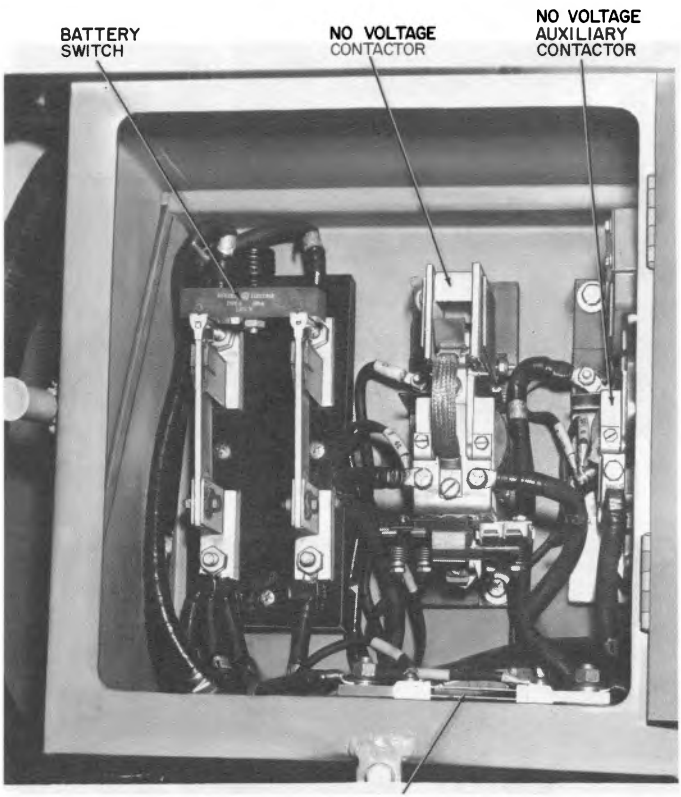
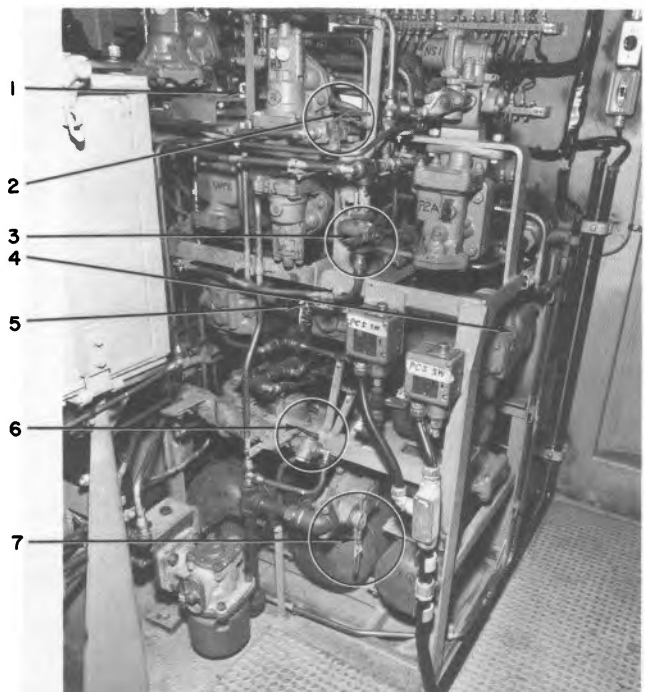


Fig. 20. No. 1 nose compartment details (E-9787A)



1 Sander cut-out cock
2 Speed-control cut-out cock
3 Change over cut-out cock
4 26-F control valve
5 Independent-brake cut-out cock
6 Dead-engine cut-out cock
7 Brake-pipe cut-out cock

Fig. 21. Air equipment rack (No. 1 nose compartment) (E-11787)

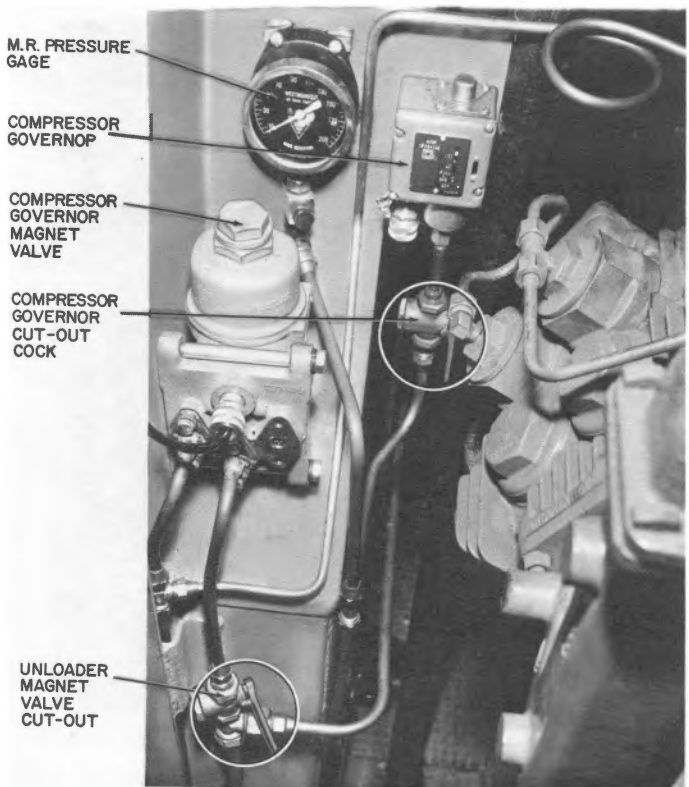


Fig. 22. Compressor compartment air piping (right side) (E-9792)

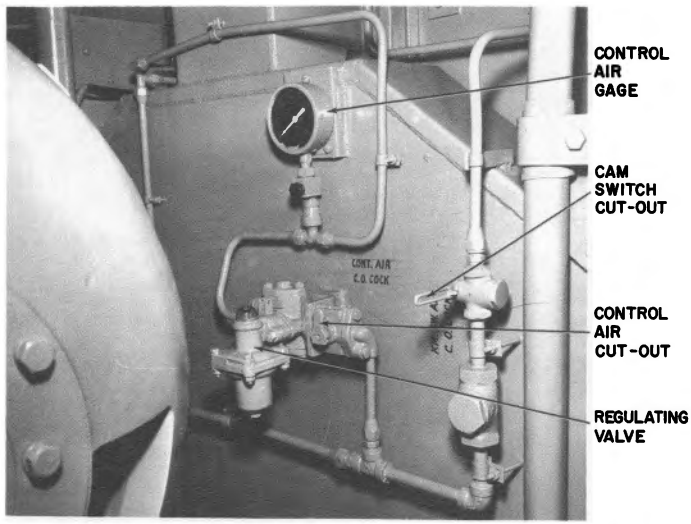


Fig. 23. Compressor compartment air piping (right side) (E-11786)

Main-Reservoir System	Position	Location
Main Reservoir Cut-out	Open	Main Reservoir
Governor Cut-out	Open	Compressor Compt.
"H" and "J" Filter Drain Cocks	Closed	Main Reservoir
Auxiliary System		
Control Air Cut-out	Open	Compressor Compt.
Cam Switch Cut-out	Open	Compressor Compt.
Pantograph Cut-out	Open	No. 1 Nose Compt.

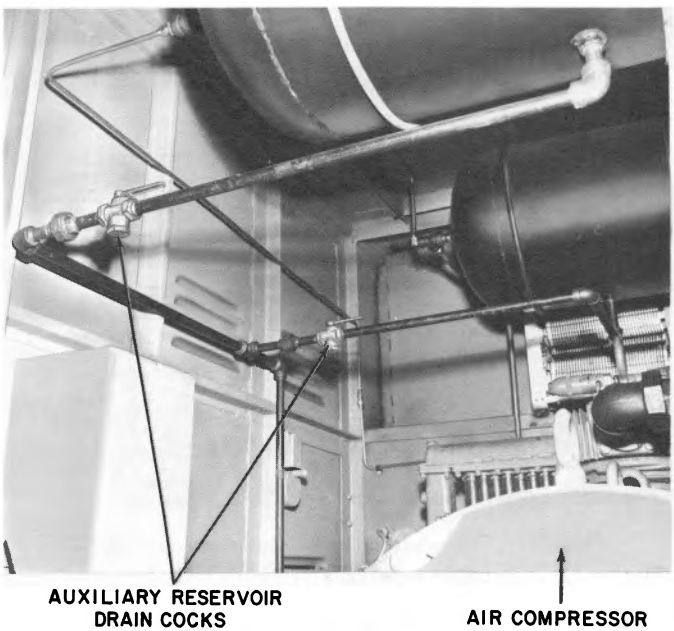


Fig. 24. Air piping (compressor compartment) (E-9794)

Valve Opener Cut-out	Open	No. 1 Nose Compt.
Horn Cut-out	Open	No. 1 Nose Compt.
Auxiliary Reservoir Drain (2)	Closed	Compressor Compt.
Sander Cut-out	Open	No. 1 Nose Compt.
Brake System		
Brake Valve Cut-out Cock	In	Operator's Cab

Brake Pipe Cut-out	Open	No. 1 Nose Compt.
Safety Control Cut-out	Open (Sealed)	No. 1 Nose Compt.
Emergency Brake Valve Cut-out	Closed	Operator's Cab
Dead Engine Cut-out	Live (Sealed)	No. 1 Nose Compt.
Double Cut-out Cock	Open	No. 1 Nose Compt.
Speed Control Cut-out Cock	Open (Sealed)	No. 1 Nose Compt.
Change-over Cock	Closed (Sealed)	No. 1 Nose Compt.

OPERATING PROCEDURE

MOVING LOCOMOTIVE

1. Move Reverse Handle to direction desired (FORWARD or REVERSE).

2. Release Brakes.

3. Trigger and release thumb button on the Main-controller Handle and notch up to desired running condition.

CAUTION: OBSERVE LIMITS OF TRACTION-MOTOR LOAD INDICATOR, OVERLOAD INDICATING LIGHT AND NOTCHING GUIDE.

STOPPING LOCOMOTIVE

1. Move Main-controller Handle to OFF.

2. Apply Air Brakes.

3. If leaving operator's station, move Reverse Handle to OFF.

REVERSING LOCOMOTIVE

1. Bring locomotive to full stop.

2. Move Reverse Handle to opposite direction.

3. Release brakes.

4. Advance Main-controller Handle.

DE-ENERGIZING LOCOMOTIVE

SHUTTING DOWN AUXILIARIES

Open following switches and brakers in Relay Compartment:

1. Blower
2. Compressor

} Turn to Stop

LOWERING PANTOGRAPH

Close pantograph down switch and when pantograph on each unit is down, open battery switch in nose.

MULTIPLE-UNIT OPERATION

The lead or controlling locomotive is the unit the engineman operates. The trail or controlled locomotive is the unoccupied unit.

COUPLING UNITS

WARNING: DO NOT INSTALL CONTROL TRAIN-LINE JUMPER CABLES UNTIL ALL CONTROLLER AND REVERSE HANDLES ARE IN THE OFF POSITION AND PANTOGRAPHS ARE DOWN AND LATCHED.

INSERT ELECTRIC TRAIN-LINE JUMPERS ON ONE SIDE ONLY, BEING SURE THAT JUMPER HEAD IS COMPLETELY INSERTED IN ITS RECEPTACLE.

CAUTION: DO NOT CROSS-CONNECT TRAIN-LINE JUMPER CABLES BETWEEN SOCKET CONNECTIONS ON EACH SIDE OF LOCOMOTIVE. UNDESIRABLE CIRCUITS WILL BE SET UP, WHICH WILL HAMPER LOCOMOTIVE OPERATION. WHEN JUMPERS ARE NOT IN USE, FREE HEAD MUST BE IN DUMMY RECEPTACLE.

1. Connect sanding pipes, brake pipe, main-reservoir equalizing pipe, independent application and release pipe and actuating pipe between units. Open all hose cocks at these connections. Lower walkways and arrange safety chains. (See Fig. 16.)

2. Prepare both units for starting according to preparation BEFORE and AFTER BOARDING LOCOMOTIVE.

3. In Trailing Unit

   a. Remove REVERSE and CONTROL switch handles.

   b. Place MU headlight set-up switch in proper position.

   c. Make a full-service brake pipe reduction with automatic-brake valve handle.

   d. Move brake valve cut-off to OUT position.

   e. Move automatic-brake valve handle to HANDLE OFF position and remove handle.

   f. Place independent-brake valve handle in RELEASE position and remove handle.

   g. Place Speed-control switches in NORMAL position.

   h. Close Double Cut-out Cock.

4. In Leading Unit

   a. Install Reverse and Control-switch handles. Place Control Switch in RUN.

   b. Place Speed-control switches in NORMAL position and acknowledge cab signal.

   c. Install automatic-brake valve handle and place in SUPPRESSION POSITION.

   d. Install independent-brake valve handle and place in FULL APPLICATION position.

   e. Move brake-valve cut-out cock to IN position.

   f. Place double cut-out cock in OPEN position.

g. Test brake equipment to be sure it functions properly.

h. Place MU headlight switch in proper position.

OPERATION

Both units operate from leading cab as one locomotive. Independent and automatic brakes operate on both units. Brakes can be operated from leading cab.

CHANGING OPERATING STATION

LEAVING OPERATING STATION (Single Unit)

1. Move Master-controller Handle to OFF.

2. Remove Reverse Handle.

3. Speed-control Switch must be in NORMAL position.

4. Make a full-service brake pipe reduction.

5. Move brake valve cut-out cock to OUT position.

6. Move Control Switch to OFF and remove handle.

7. Remove automatic and independent-brake valve handles.

OPPOSITE OPERATING STATION

1. Take control of air brakes at new operating station without delay as follows:

   a. Install brake valve handles and move automatic-brake valve handle to SUPPRESSION position and independent-brake valve handle to FULL APPLICATION position.

   b. Move brake valve cut-out cock to IN position.

   c. Test brake equipment to be sure it functions properly.

2. Install Reverse-Handle and Control-switch Handle.

3. Place Speed-control Switch in NORMAL position and acknowledge cab signal.

4. Operate locomotive in normal manner.

BRAKE PIPE LEAKAGE TEST

Before operating 26L brake equipment, a brake-pipe leakage test should be performed. Proceed as follows:

With the brake system fully charged and the brake valve cut-out cock in the IN position, move the automatic-brake valve handle promptly towards SERVICE position until the equalizing reservoir pressure has reduced 15 psi, then stop. Leave handle in this position.

As soon as the brake-pipe pressure has reduced to the level of the equalizing reservoir pressure (continuous blow from brake valve exhaust), depress the brake valve cut-out cock and move it to OUT position. Immediately observe the brake pipe gage and time the pressure drop for 1 min. The leakage must not exceed 3 lb/min.

At completion of the leakage test return the cut-out cock to IN position to restore control of brakes.

SPEED CONTROL OR CAB SIGNAL FAILURE

Refer to P. R. R. "Brake and Train Air Signal Instructions" No. 99-D-1.

DOUBLE HEADING AND HELPER SERVICE

When locomotive is coupled to the rear of train in helper service, or as a second locomotive in double heading, the handle of the automatic brake valve at station where power controls are in operation, should be moved through the service zone to Suppression position. Then move the brake valve cut-out cock to OUT position and permit automatic-brake valve handle to remain in Suppression position for duration of such service.

DEAD HEADING

1. Remove automatic and independent-brake valve handles.

2. Move brake valve cut-out cock to OUT position.

3. Open the dead engine feature cut-out cock.

4. Remove Control-switch and Reverse handles.

OPERATING THROUGH WATER

1. DO NOT exceed 2 mph if there is water above the railhead.

2. DO NOT pass through water over 2 in. above railhead.

PASSING OVER RAILROAD CROSSINGS

1. When operating at 15 mph or above, reduce power by notching back 4 notches until locomotive has passed over crossing.

OPERATING WITH TRACTION MOTORS CUT OUT

1. Motor cut-out switch is located in relay compartment. Operate with motors cut out only in emergency. Do not overload remaining motors. Observe traction-motor current on operative motors.

Cut-out Position	Condition
ALL IN	Power for all traction motors.
1-2 C.O.	Traction motors 1 and 2 not powered.

Cut-out Position	Condition
3-4 C.O.	Traction motors 3 and 4 not powered.
5-6 C.O.	Traction motors 5 and 6 not powered.
RBL 1 C.O.	No. 1 Power-resistor Blower cut out. Power available for traction motors 5 and 6 only.
RBL 2 C.O.	No. 2 Power-resistor Blower cut out. Power available for traction motors 1 and 2 only.
ALL OUT	ALL power to traction motors cut out.

2. If motors are cut out in leading unit, Master-controller Handle cannot be notched above position 18.

3. If traction motors are cut out in trailing unit, power is automatically restricted to notch 18 on that unit only.

4. If a traction motor is cut out on any unit, dynamic braking is not to be used.

OPERATING WITH RECTIFIER GROUND

1. Single or leading unit control lock light will be ON. Master-controller Handle cannot be notched above position 18.

2. Trailing Unit. If rectifier ground is in trailing unit, same lights will be on, power is automatically restricted to notch 18 of that unit only.

DYNAMIC BRAKING

TO APPLY

1. Locomotive must have been motoring in same direction for which dynamic braking is desired.

2. Move Master-controller Handle to OFF.

3. Move Braking Handle from OFF to READY.

4. If Main Handle had been in notch 12 or above, wait 10 seconds before advancing Braking handle. Observe braking scale limits of traction motor load indicators. Do not operate in Red Band. If braking limit is exceeded the wheel slip light will come on and buzzer will sound. When this occurs notch back until light goes out. Advance handle with judgement to bunch slack and to maintain desired braking effort.

> **NOTE:** Dynamic Braking cannot be obtained on any particular unit when any of its traction motors are cut out. Do not use dynamic braking on either unit if any traction motor is cut out. Do not use dynamic braking when a rectifier ground exists on any unit.

TO RELEASE

Move Braking Handle back to READY then OFF. Locomotive can now be motored.

AIR BRAKING WITH DYNAMIC BRAKING

1. The automatic air will not apply on the locomotive during ordinary service brake application, but will apply

in event of safety control or train speed control service application or an emergency application initiated by either the brake valve or train line. A safety control or train-speed control application or any emergency brake application will nullify dynamic brakes.

2. THE INDEPENDENT AIR CAN BE APPLIED AT ANY TIME, BUT ITS USE DURING DYNAMIC BRAKING MUST BE AVOIDED TO PREVENT SLIDING OF THE WHEELS.

OPERATING SAFETY RULES

1. Do not attempt to change the position of traction motor cut-out switch when Main-controller Handle is notched up.

2. DO NOT ENTER ANY HIGH-VOLTAGE COMPARTMENT WHEN LOCOMOTIVE IS ENERGIZED.

3. Do not touch motors, switches, protective barriers, or other electrical apparatus without being fully instructed as to their use.

4. Observe all necessary rules before doing any work on locomotive. REFER TO PENNSYLVANIA RAILROAD CT-290 ELECTRICAL OPERATING INSTRUCTION.

PORTABLE FIRE EXTINGUISHERS
(See Fig. 25)

One portable 20-lb dry chemical extinguisher is located in each nose compartment of the locomotive.

STATIONARY FIRE EXTINGUISHERS
(See Fig. 25)

Two stationary CO_2 fire extinguisher bottles are located in the temperature regulating compartment. These bottles are piped to extinguish fire in the smoothing reactor and any other fires occurring on the right or left side of the locomotive.

WARNING: LOWER ALL PANTOGRAPHS IN CASE OF FIRE TO PROTECT PERSONNEL FROM ELECTRICAL HARM.

EXTINGUISHING SMOOTHING REACTOR FIRE

IN TEMPERATURE REGULATING COMPARTMENT AREA

1. Open shut-off valve (2).
2. Remove seal and pull handle in pull box at right side door.

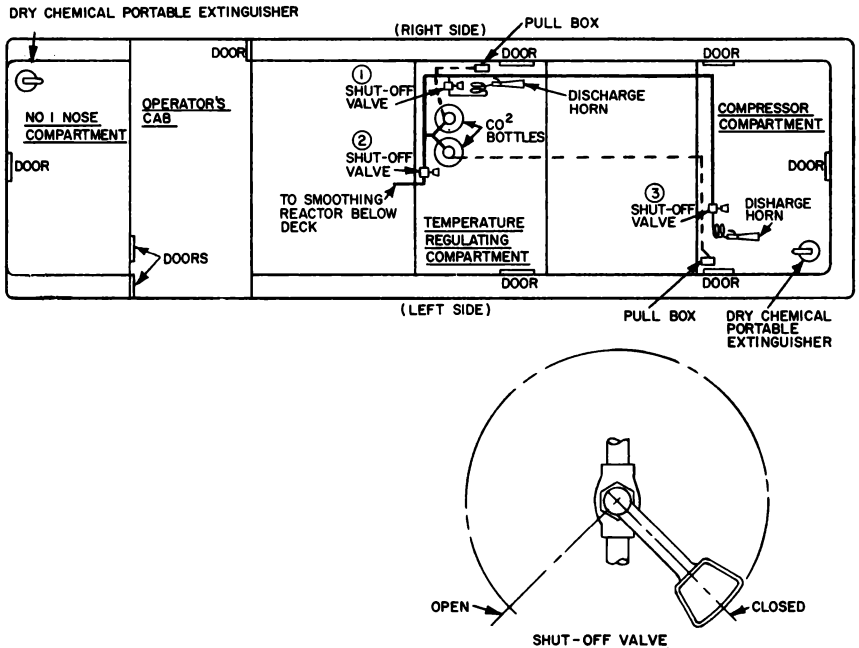


Fig. 25. Fire fighting system (E-9798)

EXTINGUISHING FIRE (Right Side)

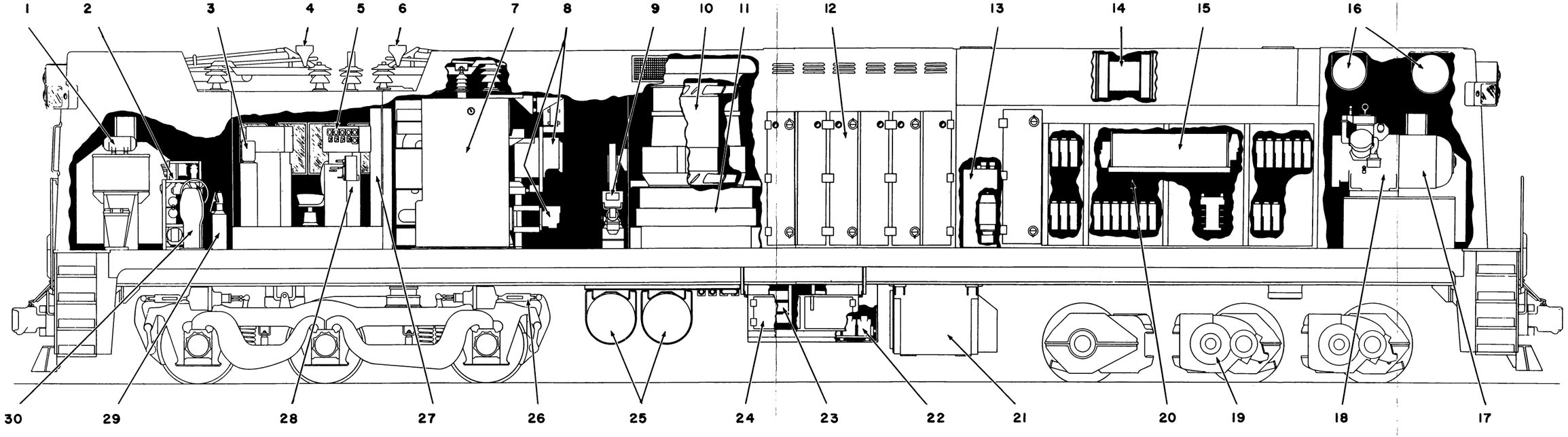
IN TEMPERATURE REGULATING COMPARTMENT AREA

1. Open shut-off valve (1).
2. Remove seal and pull handle in pull box at right side door.
3. Carry discharge horn to fire area.
4. Squeeze handle on discharge horn to release gas.

EXTINGUISHING FIRE (Left Side)

IN COMPRESSOR COMPARTMENT (Left Side)

1. Remove seal and pull handle in pull box.
2. Open shut-off valve (3).
3. Carry discharge horn to fire area.
4. Squeeze handle on discharge horn to release gas.



1	Cab signal motor-generator set	6	No. 2 pantograph	11	Radiator	16	Auxiliary air reservoirs	21	Smoothing reactor	26	Slack adjuster
2	Air brake rack	7	High voltage transformer	12	Rectifier compartment	17	Compressor motor	22	Battery compartment (right side)	27	Relay compartment
3	Drinking water stand	8	High voltage contactors	13	Rectifier temperature regulating equipment	18	Air compressor	23	Braking excitation resistors (center)	28	Engineer's brake valve
4	No. 1 pantograph	9	Jr. breaker	14	Resistor blower motor	19	Traction motor	24	Storage compartment (left side)	29	Pantograph hand pump
5	Engineer's gage panel	10	Equipment blower	15	Accelerating controller	20	Control compartment	25	Main air reservoirs	30	Hand brake

Fig. 26. Location of apparatus (E-9771A)