ELECTRIC-DRIVE ROTARY SNOW PLOW

X-900212

DESCRIPTION & OPERATING INSTRUCTIONS

Electrification Dept., Seattle, Wash.

Chicago, Milwaukee, St. Paul and Pacific Railroad Company

ELECTRIFICATION DEPARTMENT

618 WHITE BUILDING - SEATTLE 1. WASHINGTON

LAURENCE WYLIE
ELECTRICAL ENGINEER
H. R. MORGAN
ASST. ELECTRICAL ENGINEER
E. C. BARNES
ASSISTANT ENGINEER

April 6, 1955

Dear Jess,

I am sending you herewith a copy of book containing information on electric-drive rotary snow plow X-900212 and two photographs of the plow at Hyak.

One of the principal objections to the idea of an electric-drive snow plow before the plow was built was that a plow with electric drive would not be reliable. The X-900212 handled nearly all of the rotary snow plow work on the Coast Division during the past winter, and during one stretch while the plow worked almost continuously for 8 days and nights with no trouble, they had complete failure of two steam rotaries on the Rocky Mountain Division and we had to send them the only steam plow we had on the Coast Division, leaving the X-900212 to handle the job alone.

With best regards,

L. Wylie

Mr. Jess Conn
6020 34th N. E.
Seattle, Washington

DESCRIPTION OF EQUIPMENT

AND

METHOD OF OPERATION

ELECTRIC-DRIVE ROTARY SNOW PLOW X-900212

Electrification Department
The Milwaukee Road
Seattle, Washington
January 26, 1955

ELECTRIC DRIVE ROTARY SNOW PLOW X-900212

Outline of Equipment and Method of Operation

GENERAL

Rotary Snow Plow X-900212 is not self-propelled but is equipped with motors for driving rotary wheel. Power circuits and control equipment are provided so that driving motors may be operated either on 3,000-volt DC power from the trolley system by means of a pantograph or on variable voltage power from a generator of a Diesel electric locomotive by means of cables.

To permit operation under either of the above conditions, 74-volt control voltage and equipment are used. Power circuits and switches are provided to accommodate the 1500-volt DC traction motors to use of either 3,000-volt power from the trolley or variable voltage from a Diesel unit.

A motor-driven blower for cooling driving motors is provided, with motor connected in series with the driving motors on the ground side. The blower motor connections and operation are the same for operation on either Diesel or 3,000-volt power.

A master transfer switch, located in the high-voltage contactor compartment at the rear end of the equipment room, effects complete reconnection of power cables for either 3,000-volt or Diesel operation. Driving motor connections are changed from series to parallel, grounds removed, circuits isolated and separately excited fields converted to series connection. The control system is also transferred by operation of this same switch.

Motor cutout switches, located to the right of the master transfer switch, make it possible to cut out either of the driving motors in Diesel operation.

A voltage regulator maintains control voltage at 74 volts. This regulator is in service during 3,000-volt operation only as control voltage from the Diesel unit is regulated by equipment on that unit.

Drawing ED-5930 shows schematic wiring of snow plow X-900212.

3,000 VOLT CONNECTION

Power at 3,000 volts from overhead trolley is picked up by pantograph, carried to main transfer switch, JR high-speed circuit breaker, starting resistance and contactors to the armatures of the two driving motors connected in series and thence to blower and ground.

Three-thousand volt power also runs from the main transfer switch to a 3,000-volt motor generator set. This set includes a variable voltage high current capacity generator, or exciter, which is used to excite the fields of the driving motors, and a control generator, which in conjunction with a voltage regulator, holds 74 volts on the control system.

Seventy-four volt control power is fed through the 3,000-volt controller in the operating cab to the various 3,000-volt contactors and to the shunt field of the exciter which in turn excites the fields of the driving motors. After moving controller to the running notch, further movement decreases the current in the exciter shunt field circuit and thereby the current in the driving motor fields, thus effecting an increase in motor, or wheel speed. A relay in the driving motor field circuit prevents closing the motor line contactors until field has been established.

DIESEL CONNECTION

When set up for Diesel operation, extra flexible power and control cables are installed between the Diesel locomotives and the snow plow. Main power cables (both positive and negative) run from a special power terminal box on the Diesel locomotive to a terminal box on the back of the snow plow. Seventy-four volt control power is carried by another set of cables extending from the battery-charging receptacle on the Diesel locomotive to the terminal box on the back of the snow plow. Terminals are designed so that wrong connections cannot be made.

Wires for effecting transfer of control from Diesel to snow plow are carried in a regulation control jumper installed between the Diesel locomotive and the snow plow.

For Diesel operation power is carried from the Diesel locomotive to the terminal box on the rear of the snow plow, then to the transfer switch, JR high speed circuit breaker and through the starting and running contactors to the driving motors. The driving motors are connected in parallel as straight series motors. From the motors the power runs to the blower with its paralleling resistance, thence back to the Diesel locomotive.

A standard Diesel hostler-type controller is installed in the operating cab of the snow plow. When proper circuits on Diesel locomotive and on snow plow have been established, this controller governs the operation of the Diesel engine and generator and thereby the speed of the snow plow motors and wheel.

HYDRAULIC SYSTEM

Snow Plow X-900212 is equipped with a high-pressure hydraulic system, which is used to supply power to hydraulic cylinders which control movement of various apparatus on the plow. This hydraulic system consists of a motor driven high-pressure pump, oil reservoir, accumulator, cylinders and valves with network of high-pressure tubing. The operating pressure is now adjusted to 1,000 lbs. per square inch but may be adjusted to any pressure between 500 and 1500 lbs. as may be required.

When the snow plow is ready for operation and the control system is energized, the hydraulic system may be activated by closing HYDRAULIC PUMP BREAKER, located in panel above motor generator set, and by closing HYDRAULIC PUMP CONTROL switch located in switch panel on rear wall of operating cab. A pressure switch is provided which will automatically start and stop pump motor to maintain system pressure.

AIR SYSTEM

Snow plow X-900212 is equipped with two vertical air reservoirs located in each corner in forward end of the apparatus cab. These reservoirs receive air by means of a train air line from the locomotive connected to the snow plow. They supply air to operate the reverser, JR high speed breaker, pantograph and elevators.

A low air pressure relay is connected to this system so that in case the air pressure drops to 60 pounds, the JR high speed circuit breaker will open and a yellow pilot lamp on the instrument panel will light.

SPEED INDICATION AND CONTROL

A Chicago-Pneumatic Speed Recorder in the operating cab indicates rail speed.

An electrical tachometer on the instrument panel shows wheel speed. Generator for this tachometer is installed below the operating cab floor and is driven by belt from flange of the main drive shaft. This circuit also operates a relay system which opens the holding coil circuit of the JR high speed circuit breaker in case wheel speed exceeds 155 RPM.

A mechanical governor located at the end of the main drive shaft is also connected in the holding coil circuit of the JR high speed circuit breaker so that this also will open the JR breaker when wheel speed exceeds 155 RPM.

LUBRICATION

Driving Motors, suspension bearings, gears, MG Set and other motors are set up for the usual type of electric locomotive lubrication.

The main drive shaft is set up with oil plugs in the pedestal caps where accessible. Where inaccessible, as under the operating cab, pipe extensions run to oil boxes located at base of operating cab bulkheads. Journal oil is required for these bearings. In normal operation these bearings should be oiled prior to running the wheel and about every 3 hours thereafter.

The forward end of flanger is carried on suspension bearings mounted on #2 axle of front truck. These bearings are lubricated through pipe extensions to accessible area outside the truck.

Truck bearings are standard friction bearings, waste packed for journal oil lubrication.

CAB HEATING

The operating cab is equipped with a freight-locomotive type 3,000-volt heater for use when operating on trolley voltage. Control switch is located on left hand side of high voltage compartment at rear of apparatus cab.

When operating on power from a Diesel locomotive, heaters in forward corners of operating cab provide heating. Control switches are located in switch panel on right hand side of rear bulkhead door.

PANTOGRAPH

The pantograph is a standard electric locomotive-type pantograph operated by pantograph handle in operating cab. Grounding switch and lockdown mechanism are located on roof accessible from rear ladder on fireman's side. A hook on pantograph frame is also available to hold down pantograph when desirable.

When traveling to and from snow territory and when operating with Diesel power, pantograph should be locked down and grounded.

WHEEL BRAKES

Both trucks on snow plow X-900212 are equipped with air brakes.

A graduated conductor's valve in the operating cab permits engineer to apply train brakes in case of emergency.

Brakes on rear truck may be operated by hand brake wheels - one located outside and one located inside cab body.

OPERATION ON POWER FROM 3,000 VOLT DC TROLLEY SYSTEM

The same safety precautions apply to operation and maintenance of Snow Plow X-900212 as apply for our 3,000-volt DC electric locomotives. When preparing to operate snow plow on 3,000-volt power, proceed as follows:

1. See that air reservoir is fully charged.

2. See that power cables which may be attached to rear of snow plow are removed or thoroughly secured and terminals insulated.

3. See that TROLLEY CONTROL, HYDRAULIC PUMP and DIESEL CONTROL switches located in panel above MG set are in "OPEN" position.

4. See that 3,000-volt control switches located in switch panel on rear wall of operating cab are in "OPEN" position.

5. See that 3,000-volt controller is locked in "OFF" position.

6. See that the MASTER TRANSFER SWITCH located in contactor compartment at rear end of snow plow motor room is fully closed in the "UP" or 3,000-volt position. If necessary to throw this switch, secure pantograph handle, and see that pantograph is locked down and grounded before operating switch.

7. If pantograph is grounded, remove ground. Give usual warning signal - two short blasts, one long blast, two short blasts, of the whistle - wait 20 seconds, then raise pantograph.

8. Start motor generator set by closing switch in recessed panel on left side of contactor compartment at rear of snow plow motor room.

9. Close TROLLEY CONTROL switch located in panel above motor generator set.

10. Close 3,000-volt control switch located in switch panel on rear wall of operating cab.

11. Close JR breaker by closing JR breaker holding switch and momentarily closing the JR breaker closing switch in panel on rear wall of operating cab.

Circuits are now established to permit operation of rotary wheel by means of power from the trolley system. Direction of rotation, speed and power of wheel are regulated by means of 3,000-volt trolley power controller, which is located to the right of Diesel controller in rotary cab.

OPERATION OF WHEEL

CAUTION: - REMEMBER THAT SPEED OF ROTARY WHEEL MUST NOT EXCEED 150 RPM EITHER WHEN RUNNING FREE OR WHEN HANDLING SNOW. IF SPEED OF WHEEL GOES ABOVE 150 RPM AND OVERSPEED DEVICES DO NOT OPERATE, SPEED MUST BE REDUCED IMMEDIATELY BY OPERATOR.

TO THROW SNOW TO RIGHT

12. Move deflector into position for discharge to the right by turning deflector control valve (No. 3 valve on hydraulic control panel) to the right. Move trolley controller handle from vertical or "OFF" position two notches to the right. Wheel will start rotating. After approximately 15 seconds, move controller handle to the third notch on the right. This will connect motors driving wheel directly to the line with all resistance cut out and with a very strong field on motors. Now gradually move controller handle to the right, and wheel will accelerate. When desired wheel speed is reached, leave controller handle in that notch.

TO STOP WHEEL

13. To stop wheel move controller to second notch, where a dynamic braking circuit is established to stop rotation of wheel.

14. After wheel has come to a stop, move controller handle to "OFF" (vertical) position.

TO THROW SNOW TO THE LEFT

15. Move deflector into position for discharge to the left by turning deflector control valve (No. 3 valve on hydraulic control panel) to the left. Move trolley controller handle to the left, in the same sequence as described above.

GENERAL PRECAUTIONS

16. Rotary wheel should not be permitted to exceed a speed of 150 RPM. When handling heavy snow, the load on wheel will vary and may cause wheel speed to fluctuate. If speed of wheel becomes too low, move trolley controller handle as necessary to maintain the wheel speed desired. In case load falls off sharply and wheel speeds up, move controller handle toward vertical position to reduce speed of wheel. Two overspeed devices are provided and are adjusted to open the JR circuit breaker and stop rotation of wheel in case wheel speed exceeds 160 RPM.

17. When approaching heavy snow load, wheel speed should be up and rail speed down as the wheel engages the snow, then speed adjusted to hold the line current to not more than 400 amperes.

18. Do not leave the controller handle on "START" or slow speed running positions except for short intervals; otherwise, the driving motor field coils may be overheated.

OPERATION ON POWER FROM DIESEL UNIT

The same safety precautions apply to operation and maintenance of Snow Plow X-900212 as apply for Diesel and electric locomotives.

The Diesel unit coupled to snow plow will be considered the power unit and all other Diesel units will be considered traction units.

When preparing to operate the snow plow on power from Diesel unit, proceed as follows, being careful to perform each step in turn as listed; otherwise, serious damage to equipment and danger to operators may result.

IN DIESEL POWER UNIT CAB

1. Shut down Diesel engine.

2. Place all switches in "OFF" position on engineer's control panel.

3. Leave switches marked - FUEL PUMP - AUXILIARY GENERATOR FIELD - and ALTERNATOR FIELD - in "CLOSED" position. These switches are located in electrical control cabinet.

IN DIESEL POWER UNIT

4. Cut out all traction motors.

OUTSIDE OF DIESEL UNITS

5. Remove control jumper between Diesel power unit and adjacent Diesel traction unit.

6. Connect control jumper between snow plow and power unit.

7. Connect battery power cables between snow plow and battery-charging receptacle on power unit.

8. Connect main power cables between snow plow and special power terminal lugs on Diesel power unit.

ON SNOW PLOW

9. See that pantograph is in "DOWN" position and locked and grounded.

10. See that MASTER TRANSFER SWITCH, located in contactor compartment at rear end of snow plow is firmly closed in the "DOWN" or "DIESEL" position.

11. See that air reservoir is fully charged.

12. See that Diesel controller is in "IDLE" position.

13. Close DIESEL CONTROL SWITCH located in panel above MG set.

14. Close the following switches located in switch panel on rear bulkhead of operating cab:

DIESEL CONTROL
CONTROL & FUEL PUMP
ENGINE RUN

See that GENERATOR FIELD SWITCH is open.

IN DIESEL POWER UNIT CAB

15. Start Diesel engine.

16. Place ISOLATION SWITCH in "RUN" position.

IN SNOW PLOW OPERATING CAB

17. Close JR BREAKER HOLDING SWITCH located in switch panel on rear bulkhead of cab. Momentarily close JR BREAKER CLOSING SWITCH.

18. Close GENERATOR FIELD SWITCH located in switch panel on rear bulkhead of cab.

Circuits are now established to permit operation of Diesel Controller for regulation of power to motors driving rotary wheel.

OPERATION OF ROTARY WHEEL

CAUTION: - REMEMBER THAT SPEED OF ROTARY WHEEL MUST NOT EXCEED 150 RPM EITHER WHEN RUNNING FREE OR WHEN HANDLING SNOW. IF SPEED OF WHEEL GOES ABOVE 150 RPM AND OVERSPEED DEVICES DO NOT OPERATE, SPEED MUST BE REDUCED IMMEDIATELY BY OPERATOR.

TO THROW SNOW TO RIGHT

19. Move reverser handle on Diesel controller to right.

20. Advance Diesel controller handle gradually in usual manner until desired speed of rotary wheel is obtained.

TO STOP WHEEL

21. Return controller handle to "IDLE" position. This establishes a dynamic braking circuit which will stop wheel from rotating.

TO THROW SNOW TO LEFT

22. Move reverser handle on Diesel controller to left.

23. Advance Diesel controller handle gradually until desired wheel speed is obtained.

GENERAL PRECAUTIONS

24. Do not move reverser on Diesel controller while rotary wheel is in motion.

25. In case Diesel engine is to be stopped, press button in Diesel controller handle and move handle to "STOP" position.

26. An alarm bell located in operating cab of snow plow and connected to the alarm system of the Diesel unit, will ring under the following conditions:

Low oil pressure which stops engine.
Overspeed trip which stops engine.
Hot engine.
Alternator Voltage failure.
Ground relay operation.
NOTE: - Flashing over of motors driving wheel of snow plow will operate ground relay.

In case alarm bell rings it will be necessary to place Diesel controller on "IDLE", open GENERATOR FIELD SWITCH and go back to Diesel power unit and investigate. On clearing trouble, return to snow plow, start up Diesel engine, if stopped, and resume normal operation.

27. When approaching heavy snow load, wheel speed should be up and rail speed down as the wheel engages the snow, then speeds adjusted so that line current does not exceed 800 amperes (400 amperes per motor).

CONTROL OF HOOD, WINGS, FLANGER, ETC.

RAISING AND LOWERING HOOD

The hood is permanently attached to the main body of the snow plow, and the height of lower front edge of the hood above top of rail is regulated by raising or lowering front end of body. This is accomplished by means of clutch driving gears and screws, with power being obtained from the main shaft.

When being towed outside snow territory, as when moving to and from work, hood should be at maximum height, and blocks inserted between the body and bolster of front truck.

When preparing plow to handle snow, hood must be lowered in the following manner:

1. Remove plate and floor of operating cab.

2. Remove clutch center blocks and insert clutch lever.

3. With rotary wheel turning slowly to the right, engage clutch and raise hood sufficiently to remove blocks.

4. With rotary wheel turning to the left, engage clutch and lower hood to desired height above rail.

5. Remove clutch lever, replace clutch center blocks and floor plate.

Hood is now in position to plow snow.

TO ADJUST ELEVATOR

Adjust to desired height by hand wheel, and raise into operating position by means of air valve and cylinder.

TO OPERATE DEFLECTOR

Deflector is operated by means of hydraulic cylinder and control valve located in number 3 position of hydraulic control panel mounted in right forward corner of operating cab. To throw deflector to the right, or to the left, as desired, turn control valve handle to corresponding position.

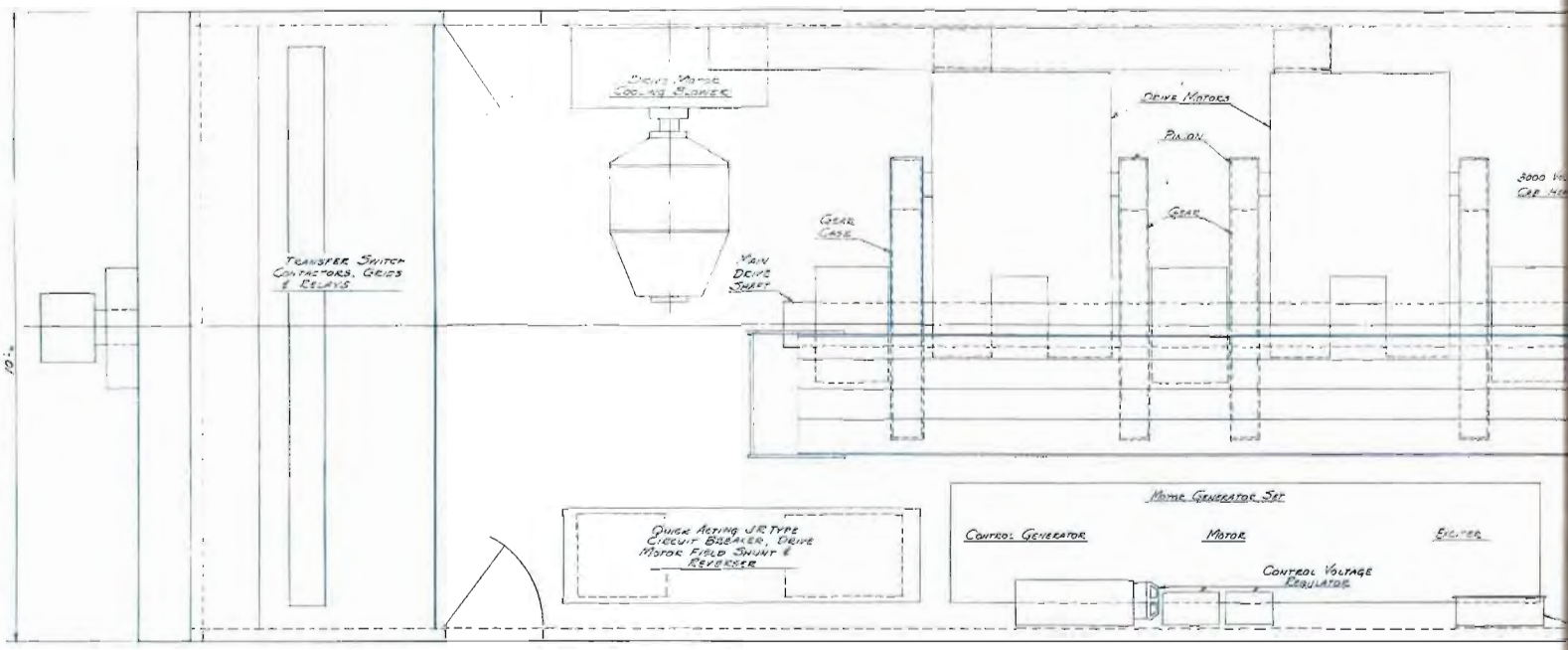
TO MOVE SIDE WINGS ON HOOD

These wings are operated by means of heavy hydraulic cylinders, operating rods and brackets on the outside of the wings and hood. The operating valves are located on left-hand end of hydraulic control panel. Wings can be placed in any desired position, and will be held in that position by hydraulic equipment.

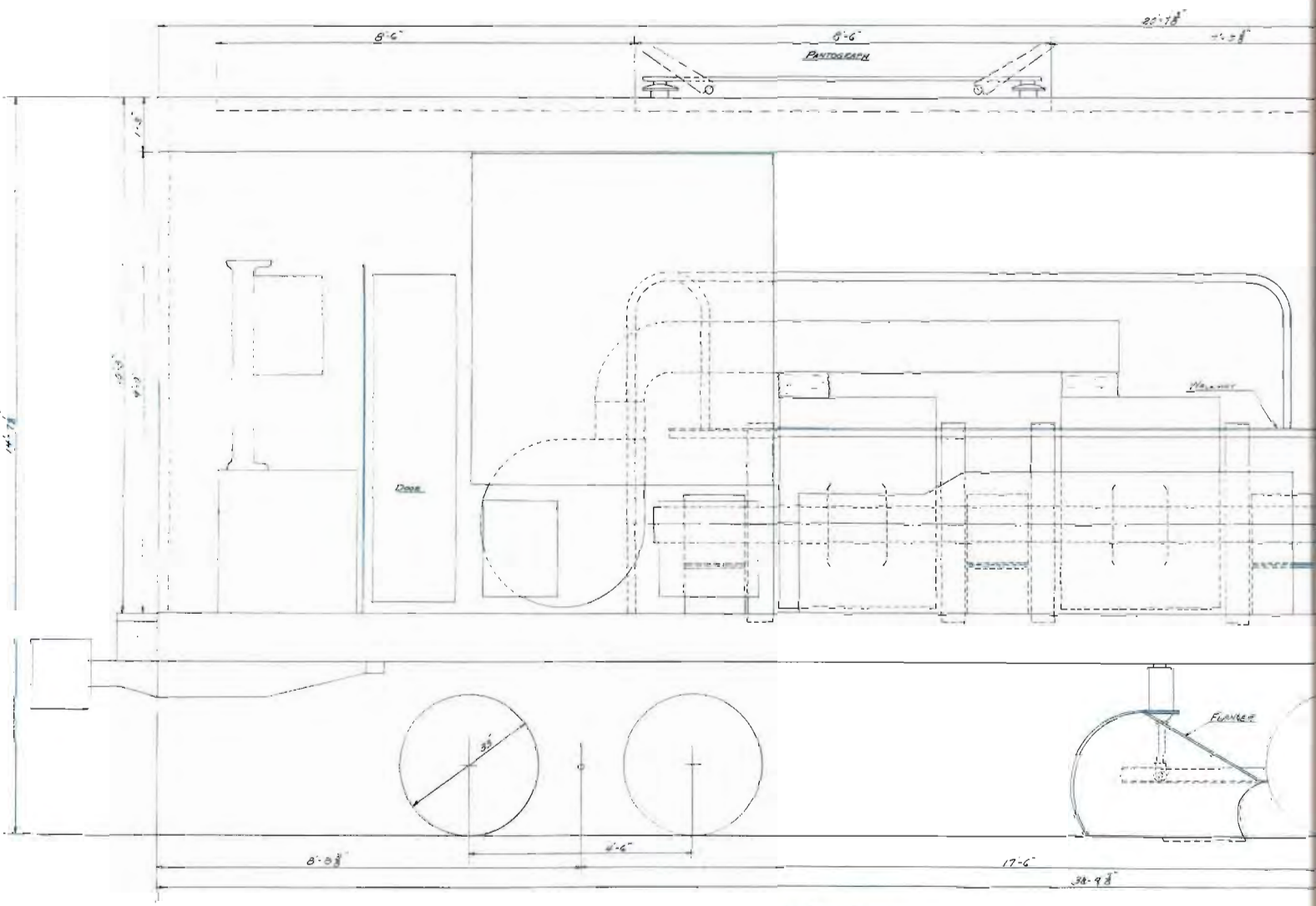
When plowing heavy snow with wings in the closed position, wings should be bolted securely in closed position with special bolts provided for that purpose.

TO RAISE OR LOWER FLANGER

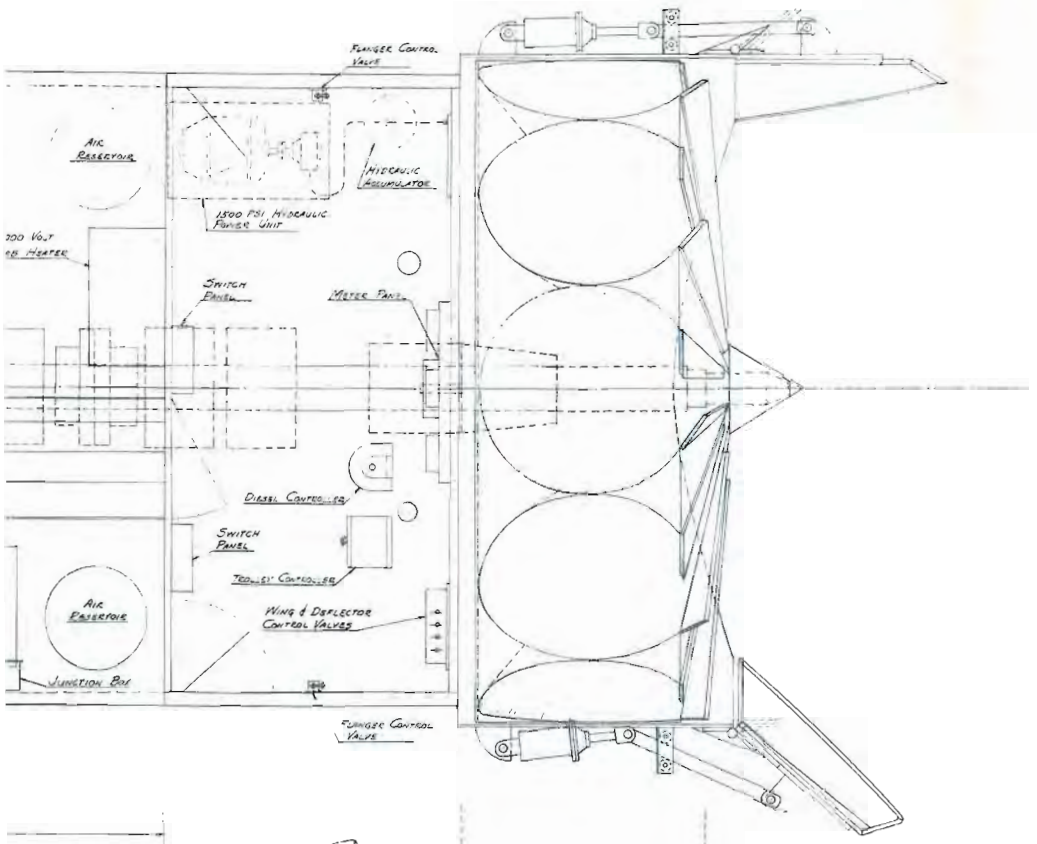
Flanger is lowered by gravity and raised by means of hydraulic cylinder and operating valve. Two such valves are provided, one being located on each side of cab immediately ahead of side door.

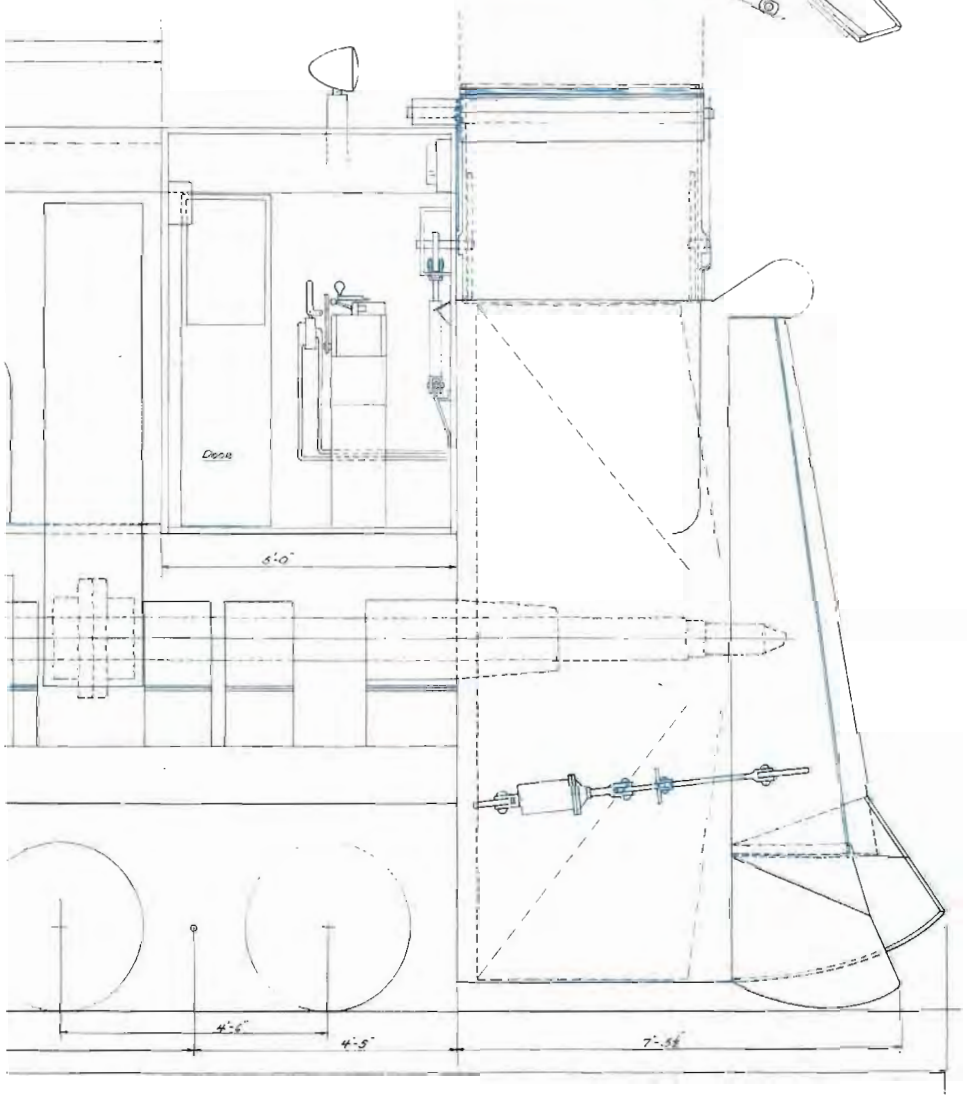


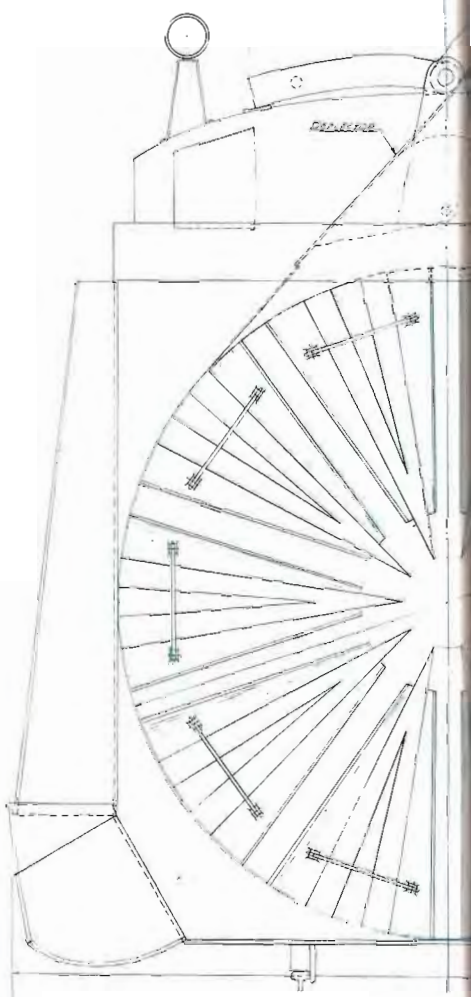
Plan View - Location of Equipment

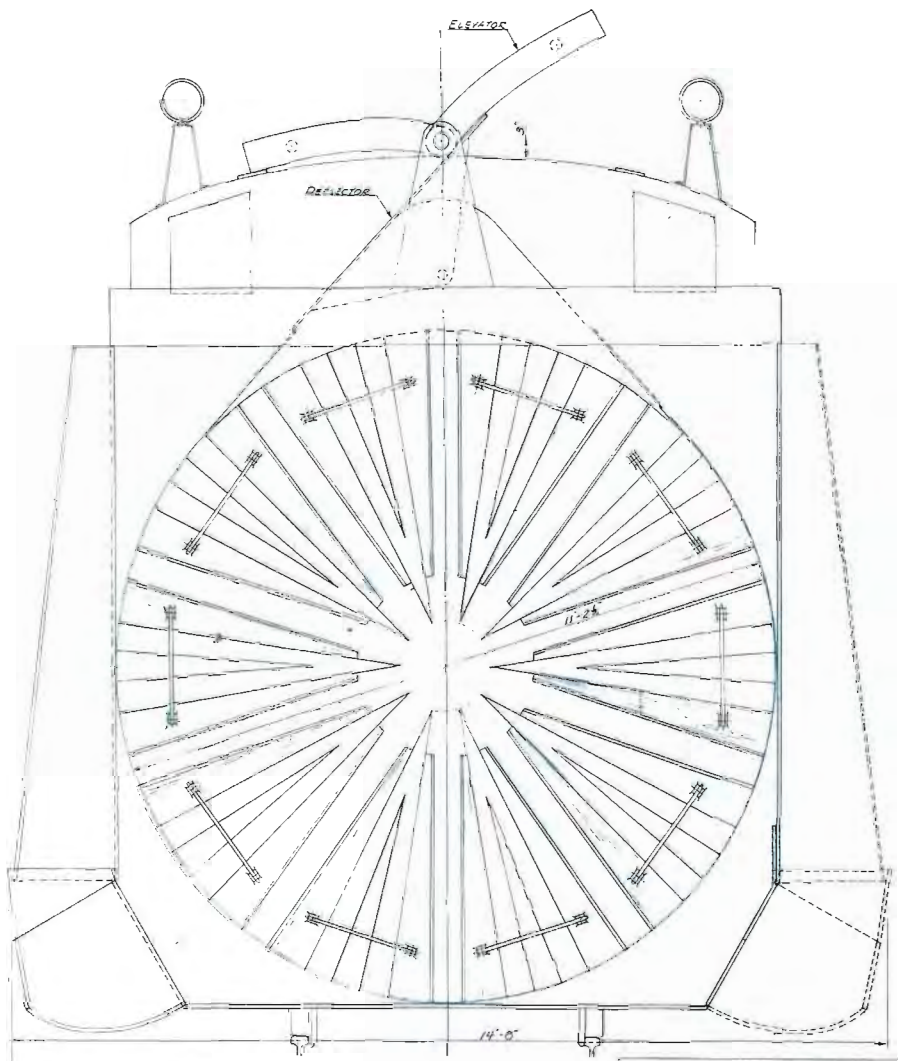


Right Side Cross Section


PLUNGER CONTROL VALVE
AIR RESERVOIR
HYDRAULIC ACCUMULATOR
1500 PSI HYDRAULIC PLUNGER UNIT
SWITCH PANEL
METER PANEL
DIESEL CONTROLLER
SWITCH PANEL
AIR RESERVOIR
WING & DEFLECTOR CONTROL VALVES
JUNCTION BOX
PLUNGER CONTROL VALVE


DOOR
5'-0"
4'-6"
4'-5"
7'-5½"





FRONT ELEVATION

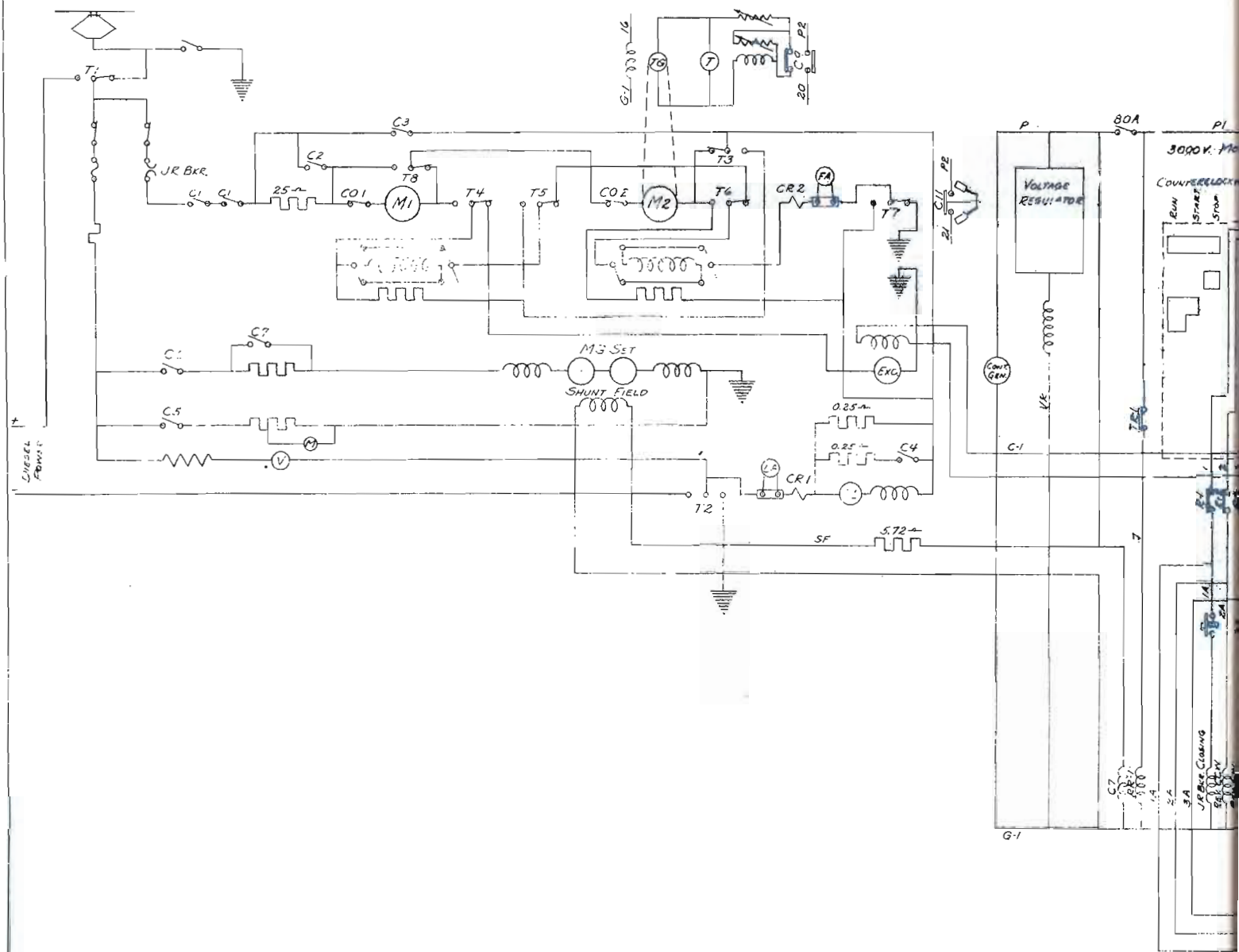
C.M.ST.P. & P. R.R. CO.
ELECTRIFICATION DEPARTMENT
SEATTLE WASH L. WYLIE ELECT. ENGR.

ROTARY SNOW PLOW
EQUIPPED WITH ELECTRIC DRIVE

DRAWN BY H.S.H. | CHECKED H.R.M. | APPROVED L. Wylie

SCALE 1"=1'-0" | DWG ED-6300

DATE DEC 7, 954



DIESEL CONTROL

SG

PC

AV

BV

CV

DV

FP

GF

S (DIESEL)

DIESEL 74 VOLT CONTROL POWER

+

-

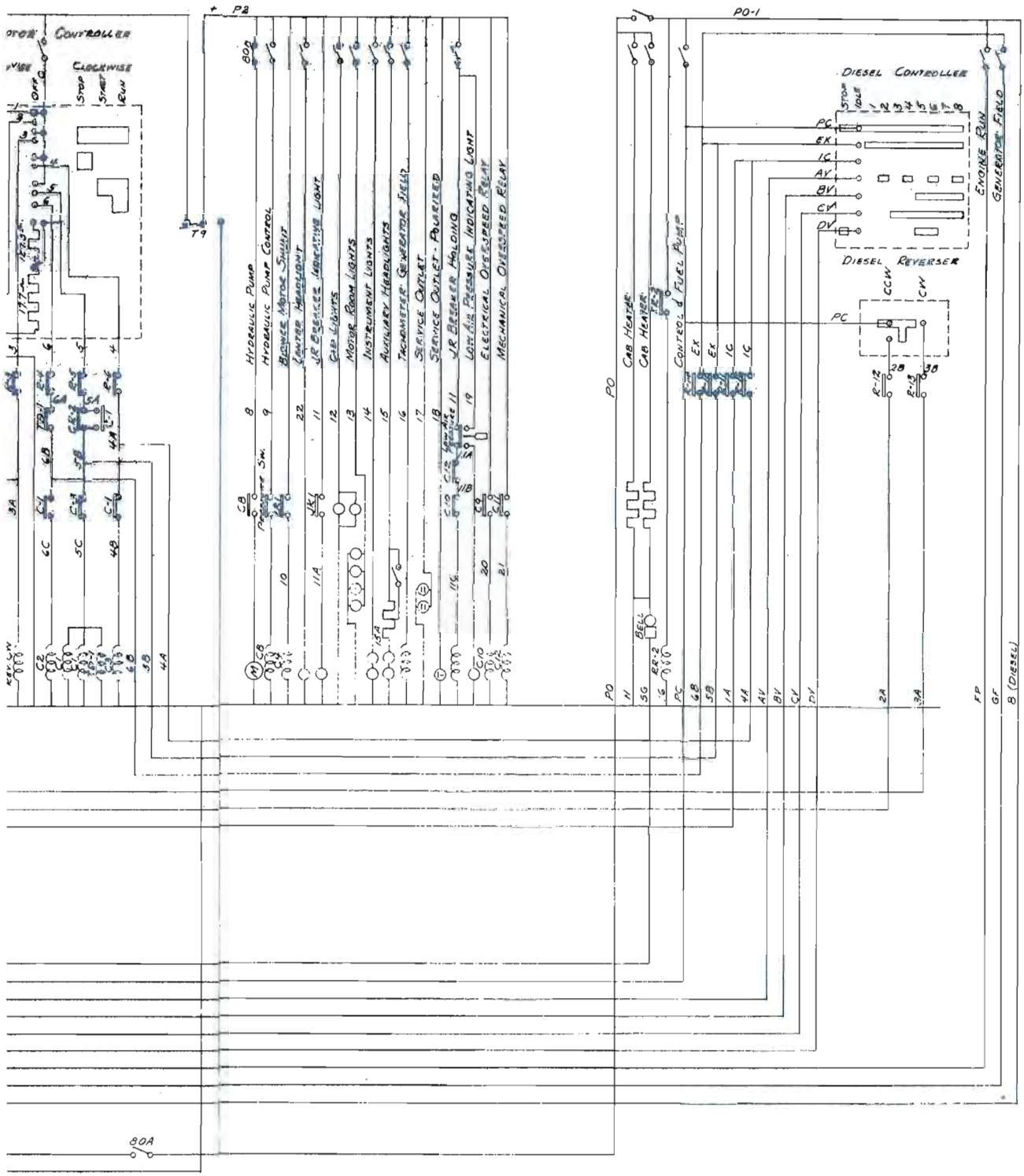
LEGEND:-

(TG) TACHOMETER GENERATOR

(T) TACHOMETER

(M) MOTOR

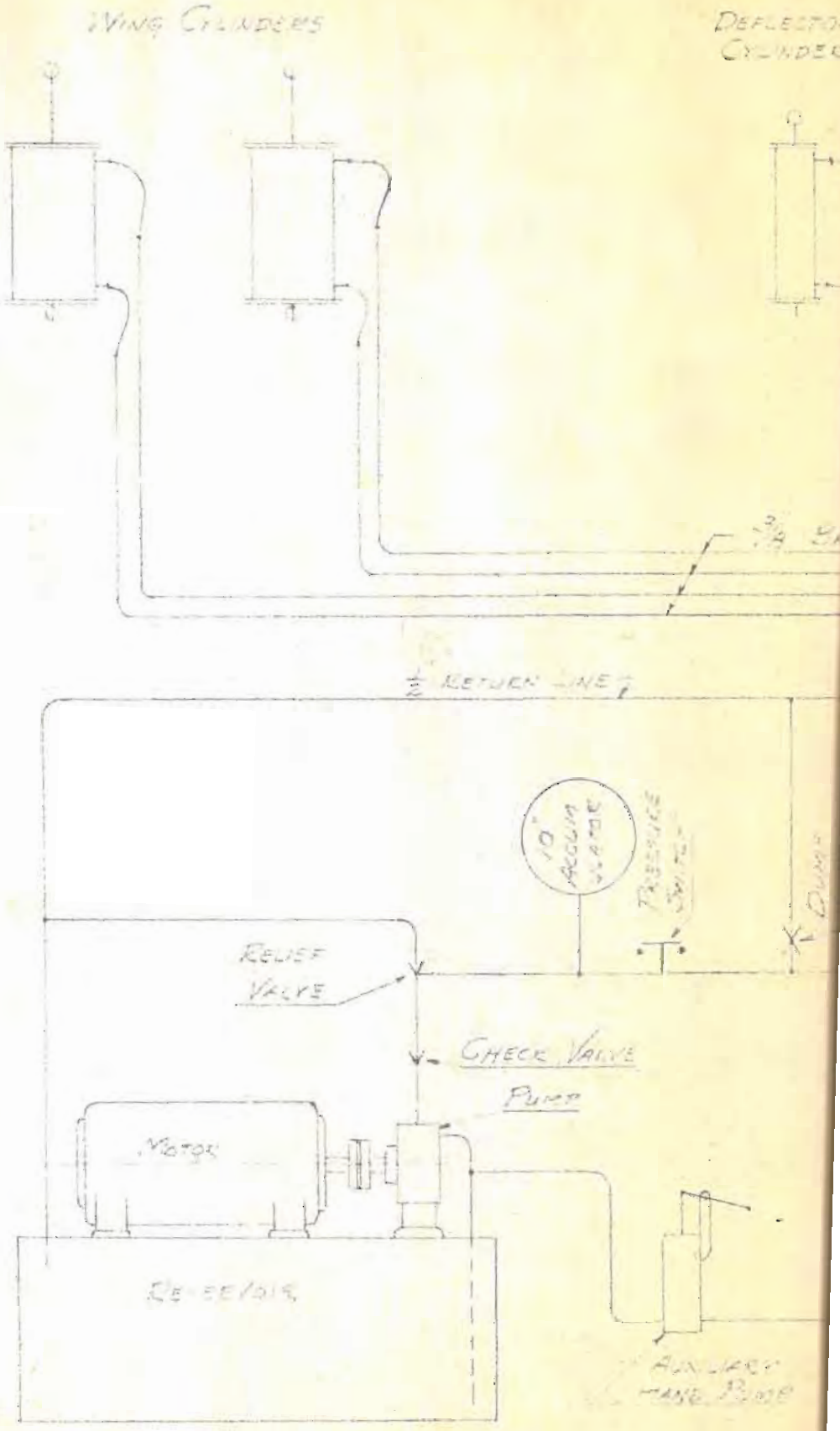
(BL) BLOWER MOTOR

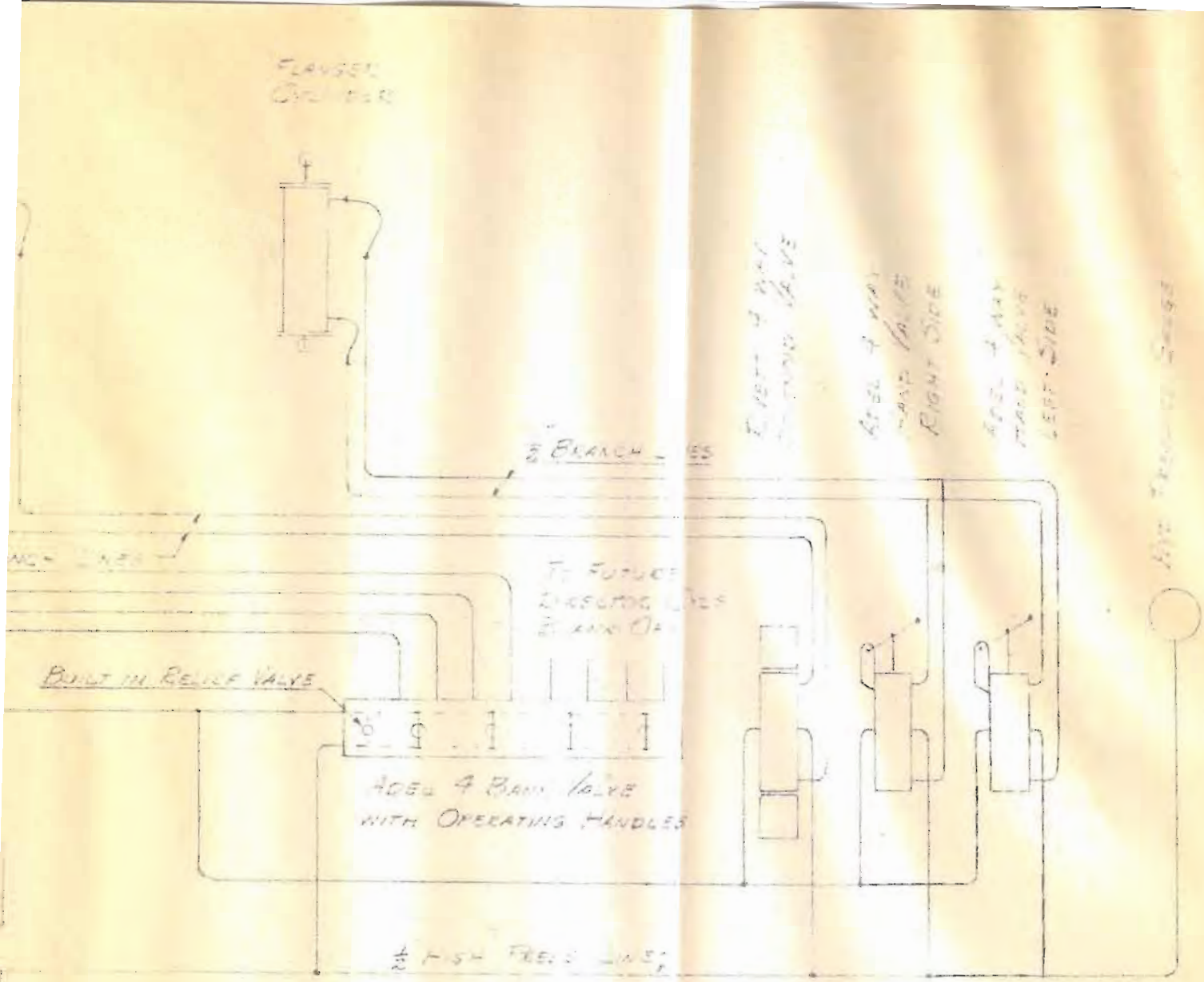


NOTES.-

CIRCUIT SHOWN SET FOR 3000 V. OPERATION
WITH CONTROLLER IN NEUTRAL
CR1 CLOSES AT 300A; CR2 AT 80A
REVISED 12-15-54; 11-9-54; 11-7-54 - M
ORIGINAL OCT. 27. 1954
FIELD SHUNTS ADDED 2/8/55 HH/H

C.M.ST.P & P.R.R. CO. ELECTRIFICATION DEPARTMENT	
SEATTLE, WASH.	L. WYLIE ELECT. ENGR.
ROTARY SNOW PLOW EQUIPPED WITH ELECTRIC DRIVE SCHEMATIC WIRING DIAGRAM	
DRAWN BY M/H	CHECKED M.
SCALE –	DWG. ED-5330
DATE JAN. 27, 1955	


WING CYLINDERS
DEFLECTOR CYLINDER
3/4
1/2 RETURN LINE
RELIEF VALVE
CHECK VALVE
PUMP
MOTOR
RESERVOIR
AUXILIARY HAND PUMP



Note: Oil to Hose Comm to all Cylinders

C.M.St P. & P.R.R. CO. ELECTRIFICATION DEPARTMENT		
SEATTLE, WASH.	L. WYLIE ELECT. ENGR.	
Schematic Hydraulic System Electric Drive Rotary Snowplow		
DRAWN BY	CHECKED M	APPROVED
SCALE —	DWG. ED-3463	
DATE Nov 3 1934		

Main Pump Cam Revised 11/23/34 HH
Left Side Valve Added 11/23/34 HH
Cam [illegible] 11/23/34 HH

DESCRIPTION OF ELECTRIC DRIVE ROTARY SNOW PLOW X-900212

DEVELOPED BY C. M. St. P. & P. RAILROAD COMPANY

GENERAL

A heavy steam-powered rotary snow plow, designated as X-900212, which had been operated since 1912, was converted to electric drive by removing the 600 HP steam boiler and steam engine equipment, and making such other changes as were necessary to permit use of electric motors for driving the main shaft and snow wheel.

Dimensions of snow plow and location of principal items of equipment, and schematic diagram of electric power and control circuits are shown on Drawings ED-6800 and ED-5930, respectively.

Snow Plow X-900212 is not self-propelled but must be handled by a pusher locomotive, which may be either an electric, Diesel or steam locomotive. This snow plow is designed to operate on electric power from either the 3,000-volt DC trolley system or on power from the DC generator of a Diesel electric locomotive.

This snow plow is equipped with two G. E. No. 253, 1500-volt, direct-current traction motors geared to an 8" drive shaft with a total length of 26'2", with rotary wheel keyed to forward end of shaft. Each motor is equipped with twin gears and pinions, with a ratio of 18 to 82. These motors are each rated at 450 HP continuously at 1500 volts, but can be used to develop up to 750 HP each for intermittent duty at 1500 volts per motor.

In converting this snow plow from steam to electric drive, the principal mechanical changes were as follows:

Steam boiler and steam engine equipment were removed.

Equipment cab and frame were shortened two feet to avoid necessity of relocating rear truck center casting.

Framework, floor, side walls and roof of both the operator's cab and the equipment cab were removed and replaced with new steel.

Wheel was entirely rebuilt with all new scoops and blades.

Side wings (both upper and lower) were replaced with new wings.

Air equipment for operating side wings was removed from in front of the wheel and replaced by hydraulic cylinders located outside of and back of side wings.

A high-pressure, high-capacity, 74-volt DC, electric motor-operated hydraulic system was installed.

Air-operated cylinder for raising and lowering flanger was replaced with hydraulic cylinder. Flanger-operating valves were installed at both right side and left side of operator's cab.

Air brakes were applied to front trucks, to which brakes had not previously been applied account restricted clearance.

A 2-section steel shaft, 8" in diameter, 26'2" over-all length, with couplings, bearings, etc., and fitted with 4 gears, was installed to provide for application of electric driving motors.

Front-vision, clear-view, safety-glass windows were applied to both sides of operator's cab in place of narrow slots previously provided.

Automatic and straight air brake control equipment was removed from the operator's cab and replaced by conductor's valve.

Miner D-3415 hand brake with hand wheel on outside of cab and hand wheel on inside of cab was applied at left rear end of equipment cab.

Hand wheel for operating snow deflector was replaced with a cylinder for hydraulic operation.

Low reading (0-15 MPH) speed indicator was installed with flexible drive connected to axle of front truck wheel.

Mechanical and electric overspeed trips to limit speed of main shaft and wheel were installed.

The principal items of electrical equipment used on this snow plow are as follows:

Standard air-raised, spring-and-gravity-lowered, pantograph-type current collector with grounding switch and lock-down device.

Master change-over switch. A heavy, multiple-blade, manually-operated switch is provided for changing all power and driving motor connections from 3,000-volt to Diesel operation, or vice versa, as desired.

Quick-acting JR-type circuit breaker for interrupting power in case of improper operation of controller or faults in electrical equipment or circuits.

Contactors, grids, relays etc., for controlling power to driving motors.

Three-thousand volt DC motor generator set with variable voltage - high current capacity generator for providing separate field excitation for driving motors, and a separate 74-volt DC fixed voltage control generator to provide power for operation of switches, relays etc., used to control the speed and power for driving the main shaft and wheel.

Electric motor-driven blower for providing ventilation for cooling driving motors. Blower motor is connected in series with the driving motors on the ground side of these motors. With this connection the speed of blower motor will increase as the load on the driving motors increases.

Voltage regulating panel and motor-operated rheostat for regulating control voltage.

Master controller in operator's cab for starting and stopping, and for controlling the direction of rotation, speed and power input to the shaft and wheel when operating on 3,000 volts.

Hostler's controller for control and regulation of power from Diesel unit when operating the rotary wheel with Diesel power.

Electric cab heater located in apparatus compartment with vents to operator's cab.

Electric space heaters in forward corners of operator's cab.

Electric tachometer generator connected to main shaft.

Cab meters are provided as follows:

Voltmeter to indicate voltage from trolley or Diesel locomotive.

Line ammeter to indicate armature current to driving motors.

Field ammeter to indicate field current of driving motors.

Electric tachometer to indicate shaft RPM.

Speed indicator and recorder to indicate plow MPH.

Hydraulic pressure gauge to indicate pressure on hydraulic system.

OPERATION ON POWER FROM 3,000-VOLT DC TROLLEY SYSTEM

Snow plow X-900212 is self-contained, in that it requires only coupling of draft gear and air hose between snow plow and any type of pusher locomotive to prepare it for operation on power from the trolley system. For such operation, any steam, electric, or single-unit Diesel locomotive can be used.

OPERATION ON POWER FROM A DIESEL ELECTRIC LOCOMOTIVE

For operation of electric-drive snow plow X-900212 with power from a Diesel electric locomotive the following relatively-simple procedure is required:

1. Couple Diesel electric locomotive with two or more units to the snow plow.

2. Remove control jumper between Diesel unit coupled to snow plow and the next Diesel unit.

3. Cut out all traction motors on Diesel unit.

4. Throw change-over switch in snow plow to "DIESEL" position.

5. Connect power cables between power connections at the rear of snow plow and generator on Diesel locomotive.

6. Connect control power cable between snow plow and Diesel battery receptacle.

7. Connect Diesel control jumper between coupler socket at rear of snow plow and control coupler socket on Diesel locomotive.

8. Now, by proper positioning of paralleling control switches in the Diesel operating cab and in the snow plow operating cab, control of the Diesel generator is transferred to the snow plow operating cab. By means of the Diesel hostler-type controller located in the operator's cab of the snow plow, the engineer in charge of the snow plow has control of the generating unit in the Diesel locomotive. The traction motors on the Diesel unit are cut out and the entire electrical output of this unit is available for operation of the electric driving motors and the control circuits on the snow plow.

9. The controller in the snow plow now regulates the speed and power output of the Diesel generating unit to control the amount of power applied to the shaft for driving the snow plow wheel and thereby the speed of the wheel.

When power from a Diesel locomotive is used for operation of the snow plow, the driving motors on the snow plow are connected in parallel, with the fields of these motors connected in series with the armatures. To increase the speed of these motors above speed which normally would be obtained with 900 - 1,000 volts from the Diesel unit, field shunting is used as found to be necessary.

The Milwaukee Road
Electrification Department
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